National Advisory Committee for Aeronautics

Research Abstracts

NO. 6 SEPTEMBER 4, 1951

CURRENT NACA REPORTS

NACA TN 2323

THEORETICAL INVESTIGATION OF SUBMERGED INLETS AT LOW SPEEDS. Alvin H. Sacks and John R. Spreiter. August 1951. 48p. diagrs., photos. (NACA TN 2323)

The flow field in a submerged inlet is investigated by theoretical, wind-tunnel, and visual-flow studies. Equations are developed for the growth of the ramp-floor boundary layer for parallel, divergent, and convergent ramp walls; and a general equation is derived relating the boundary-layer pressure losses to the boundary-layer thickness. The formation of a vortex pair in the divergent-ramp inlet is discussed, and relationships are established between the vortex pressure losses and the geometry of the inlet.

NACA TN 2391

FURTHER COMPARISONS OF THEORETICAL AND EXPERIMENTAL LIFT AND PRESSURE DISTRIBUTIONS ON AIRFOILS IN CASCADE AT LOW-SUBSONIC SPEED. S. Katzoff and Margery E. Hannah. August 1951. 24p. diagrs. (NACA TN 2391)

Comparisons of theoretical and experimental lift coefficients and pressure distributions were made for five compressor-type cascades of highly cambered NACA 6-series airfoils. The experimental lift coefficients were 0.2 to 0.4 less than the theoretical for the same mean-flow direction. When the theoretical lift was made equal to the experimental lift by simply adjusting the circulation to the desired value, the Kutta condition being neglected, close agreements were obtained between the pressure distributions. The data (low-speed) were obtained by the newer technique of NACA TN 2028, and the comparisons are substantially better than those previously reported in NACA TN 1376.

NACA TN 2425

PLASTIC STRESS-STRAIN RELATIONS FOR 75S-T6 ALUMINUM ALLOY SUBJECTED TO BIAXIAL TENSILE STRESSES. Joseph Marin, B. H. Ulrich and W. P. Hughes, Pennsylvania State College. August 1951. 48p. diagrs., photos., 5 tabs. (NACA TN 2425)

Constant-stress-ratio tests, variable-stress-ratio tests, and special tests were made on a tubular 75S-T6 aluminum-alloy specimen. The stresses used were essentially biaxial and tensile stresses. The constant-stress-ratio test results gave control data and showed the influence of biaxial stresses on the yield, fracture, and ultimate strength of the material. It is possible to determine from certain variable-stress-ratio tests whether there is any significant difference between the flow and deformation type of theory. The special tests checked specific assumptions made in the theories of plastic flow.

NACA TN 2426

AN INVESTIGATION OF AIRCRAFT HEATERS. XXXIV - EXPERIMENTAL DETERMINATION OF THERMAL AND HYDRODYNAMICAL BEHAVIOR OF AIR FLOWING BETWEEN A FLAT AND A WAVE-SHAPED PLATE. L. M. K. Boelter, V. D. Sanders, G. Young, M. Morgan and E. H. Morrin, University of California. August 1951. 30p. diagrs. (NACA TN 2426)

Investigation was conducted on thermal and hydrodynamical behavior of air flowing along a passage of which one side was flat and steam-heated and the other side was wave-shaped and unheated. Turbulence produced by air flowing over wavy surfaces approximately doubles heat-transfer rate for narrow duct widths. At large duct widths, the effect is negligible. Pressure drop was greatly increased over that for a straight duct. Pressure drop was increased to at least 4 times for large duct widths and to at least 10 times for small duct widths.

NACA TN 2428

AN INVESTIGATION OF AIRCRAFT HEATERS. XXXVI - PRELIMINARY INVESTIGATION OF A COMBUSTION-TYPE AIRCRAFT HEATER. L. M. K. Boelter, W. R. Elswick, V. D. Sanders and M. W. Rubesin, University of California. August 1951. 15p. diagrs. (NACA TN 2428)

Experimental results on the thermal performance of an aircraft combustion-type heater are presented. Evaluation of the thermal effectiveness of the heater reveals that the effects of gaseous radiation and turbulence due to combustion are negligible.

NACA TN 2433

A CRITICAL REVIEW OF NOTCH SENSITIVITY IN STRESS-RUPTURE TESTS. W. F. Brown, Jr. and George Sachs. August 1951. 29p. diagrs. (NACA TN 2433)

A critical review of the English and German literature on notch rupture testing was made to establish the influence of notching on various heat-treated steels and several nonferrous alloys when subjected

to long-time loading at elevated temperatures. A correlation between rupture ductility and notch sensitivity is established for low-alloy steels. Notch rupture data are compared with data obtained at room temperature to reveal the general effects of notch geometry. Notch embrittlement observed for low-alloy steels in rupture tests is discussed with regard to a precipitation reaction and is correlated with the composition and heat treatment.

NACA TN 2434

A BIHARMONIC RELAXATION METHOD FOR CALCULATING THERMAL STRESS IN COOLED IRREGULAR CYLINDERS. Arthur G. Holms. August 1951. 49p. diagrs., 4 tabs. (NACA TN 2434)

A numerical method was developed for calculating thermal stresses in irregular cylinders cooled by one or more internal passages. The use of relaxation methods and elementary methods of finite differences was found to give approximations to the correct values when compared with previously known solutions for concentric circular cylinders possessing symmetrical and asymmetrical temperature distributions.

NACA TN 2437

SOME MEASUREMENTS OF THE EFFECT OF GASEOUS IMPERFECTIONS ON THE CRITICAL PRESSURE RATIO IN AIR AND THE SPEED OF SOUND IN NITROGEN. Coleman duP. Donaldson and Jim J. Jones. August 1951. 15p. diagrs., photos., tab. (NACA TN 2437)

Experiments were made to measure the speed of sound in nitrogen at room temperatures in the pressure range of 0 to 2000 pounds per square inch absolute and the critical pressure ratio of air expanded isentropically from stagnation conditions in the same range. The experimental results were then compared with the values obtained by using the Van der Waals equation and the Beattie-Bridgeman equation.

NACA TN 2440

WIND-TUNNEL INVESTIGATION AND ANALYSIS OF THE EFFECTS OF END PLATES ON THE AERODYNAMIC CHARACTERISTICS OF AN UNSWEPT WING. Donald R. Riley. August 1951. 55p. diagrs., photo., 2 tabs. (NACA TN 2440)

Wind-tunnel results on end-plate effects on the aerodynamic characteristics of an unswept and untapered wing of aspect ratio 4 are presented, and experimental values of the end-plate effects on the lift-curve slope and induced drag are determined and compared with theory. Expressions are developed for the lift-drag and maximum lift-drag ratios and results compared with calculated values. A theoretical analysis is presented to indicate the effect of factors influencing the lift-drag and maximum lift-drag characteristics.

NACA TN 2441

OPTICAL METHODS INVOLVING LIGHT SCATTERING FOR MEASURING SIZE AND CONCENTRATION OF CONDENSATION PARTICLES IN SUPERCOOLED HYPERSONIC FLOW. Enoch J. Durbin. August 1951. 28p. diagrs., photos., 2 tabs. (NACA TN 2441)

Optical methods involving light scattering for measuring the size and concentration of condensation particles in supercooled hypersonic air flow are discussed. For verification of these methods, radii of ammonium-chloride particles were determined, and a comparison of these results with other measurements gave good agreement. By using these methods the size and concentration of condensation particles in supercooled hypersonic air flow were measured. A table of angular-light-intensity-distribution functions is given for use in measuring small particles having an index of refraction of 1.20, the index of refraction of oxygen and nitrogen.

NACA TN 2442

A PHOTOELASTIC INVESTIGATION OF STRESS CONCENTRATIONS DUE TO SMALL FILLETS AND GROOVES IN TENSION. M. M. Frocht, Illinois Institute of Technology. August 1951. 45p. diagrs., photos., 5 tabs. (NACA TN 2442)

Factors of stress concentration for deep, sharp, and symmetrically arranged grooves and fillets in tension members have been determined photoelastically and are given in this report. Curves are given showing the distribution of the principal stresses on the section through the grooves. Complete isopachic patterns for several basic cases of grooved bars are included.

NACA TN 2443

THE SIMILARITY LAW FOR HYPERSONIC FLOW ABOUT SLENDER THREE-DIMENSIONAL SHAPES. Frank M. Hamaker, Stanford E. Neice and A. J. Eggers, Jr. August 1951. 22p. diagrs. (NACA TN 2443)

The similarity law for steady hypersonic flow about slender three-dimensional shapes is derived in terms of customary aerodynamic parameters. The law is employed to determine simple relations for correlating the pressures, forces and moments acting on related shapes in hypersonic flows. In the special case of inclined bodies of revolution, these expressions for the forces and moments are generalized to include some significant effects of the viscous cross force.

NACA RM 51E04

INVESTIGATION OF TORSION CREEP-TO-RUPTURE PROPERTIES OF N-155 ALLOY. C. W. MacGregor and F. J. Walcott, Jr., Massachusetts Institute of Technology. August 1951. 26p. diagrs., photos., 4 tabs. (NACA RM 51E04)

An investigation of the tension creep-to-rupture properties of the alloy steel N-155 was undertaken. Rupture times in the 10-to-1000-hour range were considered and tests were made at the temperatures 1200°, 1350°, and 1500° F. The effect of stress concentration in the form of transverse circular

holes was investigated under the same conditions. Comparisons of the effects of simple combined stresses (as in torsion) were made with torsion creep-to-rupture properties.

NACA RM E51E15

COMBUSTION OF SMOKE IN DIFFUSION AND BUNSEN FLAMES. Thomas P. Clark. August 1951. 13p. diagrs., photos. (NACA RM E51E15)

Varying amounts of smoke, both in the form of concentrated filaments and dilute homogeneous mixtures with the combustible, were burned in diffusion flames of ethylene and in bunsen flames of ethylene-air mixtures. Stable flames of both types were found capable of burning large amounts of carbon smoke if the smoke was finely divided. It was found that finely divided smoke passing through the flame zone in the form of a laminar filament could be completely burned at a relative smoke-fuel carbon ratio within the filament as high as 3.5:1. Conversely, low over-all concentrations of smoke could pass through the reaction zone without burning completely, if the smoke was agglomerated into flecks of soot. The smoke was found to burn in both the inner and the outer cones of the bunsen flame.

NACA TM 1301

THE FLOW OF GASES IN NARROW CHANNELS. (Über die Strömung von Gasen in engen Kanälen). R. E. H. Rasmussen. August 1951. 46p. diagrs., photo., 2 tabs. (NACA TM 1301. Trans. from Annalen der Physik, v.29, ser.5, no.8, August 1937, p.665-697).

Measurements were made of the flow of gases through various narrow channels a few microns wide at average pressures from 0.00003 to 40 cm. Hg. The flow rate, defined as the product of pressure and volume rate of flow at unit pressure difference, first decreased linearly with decrease in mean pressure in the channel, in agreement with laminar-flow theory, reached a minimum when the mean path length was approximately equal to the channel width, and then increased to a constant value. The product of flow rate and square root of molecular number was approximately the same function of mean path length for all gases for a given channel.

NACA TM 1306

THREE PAPERS FROM CONFERENCE ON "WING AND TAIL-SURFACE OSCILLATIONS" - MARCH 6-8, 1941, MUNICH. I. REMARKS CONCERNING AERODYNAMICALLY BALANCED CONTROL SURFACES. (Bemerkung zum aerodynamisch innenausgeglichenen Ruder). H. Söhngen. II. AERODYNAMICALLY EQUIVALENT SYSTEMS FOR VARIOUS FORMS OF CONTROL SURFACES WITHIN THE SCOPE OF THE TWO-DIMENSIONAL WING THEORY. (Aerodynamische Ersatzsysteme für verschiedene Ruderformen im Rahmen der zweidimensionalen Tragflächentheorie). L. Schwarz. III. COMPARATIVE CALCULATIONS CONCERNING AERODYNAMIC BALANCE OF CONTROL SURFACES. (Vergleichsrechnungen zum aerodynamischen Ruderinnenausgleich). F. Dietze. August 1951. 47p. diagrs., tab. (NACA TM 1306. Trans. from Lilienthal Gesellschaft für Luftfahrtforschung, Berlin. Bericht 135, p.61-74).

NACA TM 1307

LATERAL CONTROL BY SPOILERS AT THE DVL. (DVL - Unterbrecherquersteuerung). M. Kramer, Th. Zobel and C. G. Esche. I. SYSTEMATIC WIND-TUNNEL TESTS CONCERNING THE PROBLEM OF LATERAL CONTROL BY SPOILERS PERMEABLE TO AIR. M. Kramer and Th. Zobel. II. CONTRIBUTION TO THE LATERAL CONTROL BY SPOILERS AT THE DVL. M. Kramer. III. FLIGHT TESTS IN THE LATERAL CONTROLS BY SPOILERS ON THE AIRPLANE MODEL FIESELER FI 156. C. G. Esche. August 1951. 82p. diagrs., photo., tab. (NACA TM 1307. Trans. from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin. FB 964).

The present report describes the development of spoiler control at the DVL during the period from the end of 1936 until the beginning of 1939.

DECLASSIFIED NACA REPORTS

NACA RM E7C03

DETERMINATION OF RAM-JET COMBUSTION-CHAMBER TEMPERATURES BY MEANS OF TOTAL-PRESSURE SURVEYS. I. Irving Pinkel. March 3, 1947. 10p. diagrs., tab. (NACA RM E7C03) (Declassified from Restricted, 7/3/51)

Describes a method for determining the total temperature of the gases at the combustion-chamber outlet of a ram-jet engine from the loss in total pressure measured across the combustion chamber. Presents a working chart for determining the ratio of the total temperature of the gases at the combustion-chamber outlet to the total temperature of the gases at the combustion-chamber inlet. Values of total temperature ratio across the combustion chamber of a 20-inch ram jet were obtained at pressure altitudes from 6000 to 15,000 feet. The difference between the temperature ratio across the combustion chamber determined from the chart and that obtained from thermocouple measurement was within 6.2 percent of the thermocouple-temperature ratio and within the accuracy of thermocouple measurements.

NACA RM E7C05

INCREASE IN STABLE-AIR-FLOW OPERATING RANGE OF A MIXED-FLOW COMPRESSOR BY MEANS OF A SURGE INHIBITOR. Eugene B. Laskin and Milton G. Kofskey. April 3, 1947. 21p. diagrs., photos. (NACA RM E7C05) (Declassified from Restricted, 7/3/51)

Presents a description and design principles of a surge inhibitor for increasing the stable-air-flow operating range of a mixed-flow compressor operating at high impeller tip speeds. Test results of the compressor unit with the surge inhibitor showed a considerable gain in stable-air-flow operating range over the range of equivalent impeller tip speeds from 1255 to 1738 fps. The surge inhibitor was capable

of increasing the net stable-air-flow operating range more than 8 times its original value at an equivalent tip speed of 1550 fps. The efficiency and the pressure ratio in the normal stable-air-flow operating range were not impaired when the surge inhibitor was inoperative.

NACA RM E9E02

CRITERIONS FOR CONDENSATION-FREE FLOW IN SUPERSONIC TUNNELS. Warren C. Burgess, Jr. and Ferris L. Seashore. June 16, 1949. 41p. diagrs., photos., tab. (NACA RM E9E02) (Declassified from Confidential, 7/3/51)

The results of an investigation of water vapor condensation shocks in the air passing through supersonic tunnels are presented. Criterions for condensation free flow are established by correlating experimental observations with the Volmer theory of nuclei formation. Experimental observations were made at Mach numbers up to 2.00. The criterions are presented in a form independent of tunnel-inlet stagnation pressure and are extended theoretically to a Mach number of 4.0. Preliminary evidence of the effect of tunnel size on the criterions is presented.

NACA RM L6K22

TWO-DIMENSIONAL WIND-TUNNEL INVESTIGATION AT HIGH REYNOLDS NUMBERS OF TWO SYMMETRICAL CIRCULAR-ARC AIRFOIL SECTIONS WITH HIGH-LIFT DEVICES. William J. Underwood and Robert J. Nuber. March 12, 1947. 35p. diagrs., photos., 2 tabs. (NACA RM L6K22) (Declassified from Restricted, 7/3/51)

The investigation was made of airfoils of 6-percent and 10-percent thickness equipped with 0.20-chord plain trailing-edge flaps, 0.15-chord drooped-nose flaps, and 0.10-chord leading-edge extensible flaps. The tests were run at high Reynolds numbers and low Mach numbers ($M \leq 0.14$). Maximum section lift coefficients of 1.95 and 2.03 were obtained at a Reynolds number of 6×10^6 for the optimum combination of drooped-nose and plain flaps for the 6- and 10-percent-thick airfoils, respectively.

NACA RM L8K26

CALCULATION OF AERODYNAMIC FORCES ON A PROPELLER IN PITCH OR YAW. John L. Crigler and Jean Gilman, Jr. February 15, 1949. 32p. diagrs. (NACA RM L8K26) (Declassified from Restricted, 7/3/50)

An analysis was made to determine the applicability of existing propeller theory and the theory of oscillating airfoils to the problem of determining the magnitude of the forces on propellers in pitch or yaw. Strip calculations using compressible airfoil characteristics were first made as though steady-state conditions existed successively at several blade positions of the propeller blades during one revolution. A theory of oscillating airfoils in pulsating incompressible potential flow was then considered from which it was possible to determine factors which would modify the steady-state forces.

BRITISH REPORTS

N-9011*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) STURGEON T.T. MK.2 VR.363 (2 MERLIN 140 S/1). CLIMB AND LEVEL SPEED PERFORMANCE, FUEL CONSUMPTION AND SPECIFIC AIR RANGE (WITHOUT TARGET). May 31, 1951. 26p. diagrs., 10 tabs. (AAEE Rept. A.A.E.E./845/1, pt.9)

With take-off weight of 22,100 lb and intermediate power, the maximum rate of climb was 2,030 ft/min up to full throttle height (9,800 ft), the Service ceiling was 34,800 ft, and the time to Service ceiling was 34.5 min. With weight 21,000 lb, maximum continuous power, and at the full throttle height (23,200 ft), the cruising speed was 282 knots T.A.S. With weight 20,480 lb and at cruising speed of 130 knots I.A.S., the following values were obtained for specific air range: (1) 5,000 ft, M.S. gear - 2.50 N.M.P.G.; (2) 15,000 ft, M.S. gear - 2.78 N.M.P.G.; (3) 25,000 ft, M.S. gear - 2.60 N.M.P.G.

N-9047*

Royal Aircraft Establishment (Gt. Brit.) THE G10/240E DECADE COUNTING VALVE. G. C. Rowley. April 1951. 15p. diagrs. (RAE Tech. Note MS 6)

This note describes the gas-filled decade valve recently developed by Standard Telephones and Cables Ltd., and gives details of suitable circuits. The choice of components for stepping speeds up to 30,000 pps is discussed.

N-9051*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) FIREFLY MK.5 VT.428 (GRIFFON 74). CHECK HANDLING TRIALS WITH AIR/SEA RESCUE CONTAINERS FITTED. May 25, 1951. 3p. (AAEE Rept. A.A.E.E./780,e, pt.11)

When carrying one type "G" air/sea rescue container under each wing, the handling characteristics were indistinguishable from those when carrying other underwing stores. It is considered safe, as far as handling characteristics are concerned, to clear the carriage of these units up to a maximum I.A.S. of 300 knots (the highest tested) It is considered that the carriage of the air/sea rescue container under one wing and either a 45 or 90 gallon drop tank under the other, may be cleared without further tests.

N-9129*

Royal Aircraft Establishment (Gt. Brit.) AN INSTRUMENT FOR INVESTIGATING BOUNDARY LUBRICATING PROPERTIES. E. D. Tingle. March 1951. 21p. diagrs., photo. (RAE Tech. Note Chem. 1148)

A rapid method of comparing the boundary lubricating properties of materials and the durability of

solid-lubricant films is described. A modified Wells instrument provides a record of the friction between lubricated metal surfaces at a range of sliding speeds from 0.26 to 5.1 c/s. A standard preparation technique for comparative tests is described.

UNPUBLISHED PAPERS

N-8908*

CRITICAL REVIEW OF VARIOUS REPORTS ON THE INSTABILITY OF FLAT SANDWICH PLATES. (Literatuurstudie over sandwichconstructies IV). F. J. Plantema. 16p., 4 tabs. (Trans. from Nationaal Luchtvaartlaboratorium, Amsterdam. S.364, December 1949)

Presents a review of reports on the buckling of flat sandwich plates. Various treatments on cylinders are not included, while the bending of flat plates is noted only incidentally. Considerations about the efficiency (optimum design) are also excluded.

National Advisory Committee for Aeronautics

Research Abstracts

NO. 9 OCTOBER 15, 1951

CURRENT NACA REPORTS

NACA TN 2449

INVESTIGATION OF INFLUENCE OF CHEMICAL COMPOSITION ON FORGED MODIFIED LOW-CARBON N-155 ALLOYS IN SOLUTION-TREATED AND AGED CONDITION AS RELATED TO RUPTURE PROPERTIES AT 1200° F. E. E. Reynolds, J. W. Freeman and A. E. White, University of Michigan. September 1951. 111p. diagrs., photos., 11 tabs. (NACA TN 2449)

Use of careful control over processing conditions in this investigation has shown that it is possible to correlate stress-rupture properties of forged alloys of the low-carbon N-155 alloy type at 1200° F with systematic variations in chemical composition and that a wide range in properties can be obtained by such variations. However, no alloy was obtained which had properties which were outstanding compared with those of the standard basic analysis of low-carbon N-155 alloy.

NACA TN 2466

A GENERAL CORRELATION OF TEMPERATURE PROFILES DOWNSTREAM OF A HEATED AIR JET DIRECTED PERPENDICULARLY TO AN AIR STREAM. Edmund E. Callaghan and Robert S. Ruggeri. September 1951. 37p. diagrs. (NACA TN 2466)

An experimental investigation was conducted to determine the temperature profile downstream of a heated air jet directed perpendicularly to an air stream. The profiles were determined at several positions downstream of the jet as a function of jet density, free-stream density, jet velocity, jet temperature, free-stream velocity, and orifice flow coefficient. A method is presented which yields a good approximation of the temperature profile in terms of dimensionless parameters of the flow and geometric conditions.

NACA TN 2487

EFFECT OF GROUND INTERFERENCE ON THE AERODYNAMIC CHARACTERISTICS OF A 42° SWEPTBACK WING. G. Chester Furlong and Thomas V. Bollech. October 1951. 24p. diagrs., photos. (NACA TN 2487. Formerly RM L8F04)

The effects of ground interference on the aerodynamic characteristics of a 42° sweptback wing have been determined at distances above the ground 0.68 and 0.92 of the mean aerodynamic chord (measured from the 0.25 mean aerodynamic chord). The wing was tested without flaps and with inboard trailing-edge split and outboard leading-edge flaps deflected. The wing had an aspect ratio of 4, a taper ratio of 0.625, and NACA 64_1-112 airfoil sections perpendicular to the 0.273 chord line. The results are, in general, comparable to those reported for unswept wings. The longitudinal stability at the stall was not materially affected at the ground heights of the present tests.

NACA TN 2492

A METHOD OF SOLVING THE DIRECT AND INVERSE PROBLEM OF SUPERSONIC FLOW ALONG ARBITRARY STREAM FILAMENTS OF REVOLUTION IN TURBOMACHINES. Chung-Hua Wu and Eleanor L. Costilow. September 1951. 25p. diagrs. (NACA TN 2492)

A method is presented for the determination of the supersonic flow past arbitrary turbomachine blades along stream surfaces of revolution and for the design of these blades for a prescribed velocity or turning distribution around the blades. The shapes of the stream surfaces are arbitrary. The method takes into account the variable distance between adjacent stream surfaces.

NACA TN 2494

LIFT AND MOMENT ON OSCILLATING TRIANGULAR AND RELATED WINGS WITH SUPERSONIC EDGES. Herbert C. Nelson. September 1951. 34p. diagrs. (NACA TN 2494)

The linearized velocity potential for a thin, flat, tri-triangular or related wing with supersonic edges, undergoing harmonic torsional oscillations and vertical translations in a constant supersonic stream, is derived in terms of a frequency parameter. Closed expressions for the velocity potential, section force and moment coefficients for the triangular wing are developed to the third power of the frequency of oscillation.

NACA TN 2497

GENERALIZED CONICAL-FLOW FIELDS IN SUPERSONIC WING THEORY. Harvard Lomax and Max. A. Heaslet. September 1951. 45p. diagrs. (NACA TN 2497)

Linearized, compressible-flow analysis is applied to the study of quasi-conical supersonic wing theory. Single-integral equations are derived which relate either the loading to the shape of a lifting surface or the thickness of a symmetrical wing to the pressure distribution for triangular wings with subsonic lead-

ing edges. The forms of these equations and their inversions are simplified through the introduction of the finite part and the generalized principal part of an integral. Applications of the theory, in the lifting case, include previously known results. In the nonlifting case, it is shown that for a specified pressure distribution the theory does not always predict a unique thickness distribution. This is demonstrated for a triangular plan form having a constant pressure gradient in the stream direction.

NACA TN 2498

FLIGHT INVESTIGATION OF THE EFFECT OF ATMOSPHERIC TURBULENCE ON THE CLIMB PERFORMANCE OF AN AIRPLANE. Harry Press and Herbert C. McClanahan, Jr. October 1951. 30p. diagrs., 5 tabs. (NACA TN 2498)

The results of an investigation consisting of a series of one-engine climb tests with a twin-engine transport airplane indicate that light turbulence of the type generally present in clear air over flat terrain has no significant effect on the average rate of climb for a series of runs. Turbulence does, however, increase the variation in the rate of climb from run to run. The standard deviation of the rate of climb attributable to turbulence decreases rapidly when the climb duration is increased from 1 to 5 minutes.

NACA TN 2500

A COMPARISON OF THE TURBULENT BOUNDARY-LAYER GROWTH ON AN UNSWEPT AND A SWEPT WING. John M. Altman and Nora-Lee F. Hayter. September 1951. 30p. diagrs., photos. (NACA TN 2500)

Turbulent boundary-layer measurements are presented for a 45° swept and a two-dimensional unswept wing. A comparison is made of the displacement thickness, the momentum thickness, and the shape parameters for the two wings based on the component of velocity normal to the leading edge. The tests were conducted at a Reynolds number of about 4 million based on the component of velocity normal to the leading edge.

NACA TN 2501

EXPRESSIONS FOR MEASURING THE ACCURACY OF APPROXIMATE SOLUTIONS TO COMPRESSIBLE FLOW THROUGH CASCADES OF BLADES WITH EXAMPLES OF USE. John T. Sinnette, Jr., George R. Costello and Robert L. Cummings. October 1951. 33p. diagrs. (NACA TN 2501)

Four necessary conditions for steady irrotational compressible flow through a straight cascade of blades are derived from the irrotationality condition and the conservation of mass and momentum, and these conditions are used to obtain expressions for measuring the accuracy of approximate compressible flow solutions. Application to typical compressor cascades indicated that an approximation based on linear relation between pressure and specific volume is considerably more accurate than the incompressible approximation or the Prandtl-Glauert approximation.

NACA TN 2502

EXAMPLES OF THREE REPRESENTATIVE TYPES OF AIRFOIL-SECTION STALL AT LOW SPEED. George B. McCullough and Donald E. Gault. September 1951. 52p. diagrs., photo., 6 tabs. (NACA TN 2502)

A summary of airfoil-section stalling characteristics, based on experimental investigations of five airfoil sections, is presented. Section stalling characteristics of three types are considered and are designated: trailing-edge stall, leading-edge stall, and thin-airfoil stall. The corresponding boundary-layer flows are discussed, and illustrative examples of the force, moment, pressure-distribution, and boundary-layer characteristics of each type are furnished.

NACA RM A51G09

SCHLIEREN INVESTIGATION OF THE WING SHOCK-WAVE BOUNDARY-LAYER INTERACTION IN FLIGHT. George E. Cooper and Richard S. Bray. September 1951. 26p. diagrs., photos. (NACA RM A51G09)

Schlieren photographs obtained in flight of the shock-wave interaction with a thick turbulent boundary layer on a wing are presented together with measured boundary-layer characteristics. Good correlation with theoretical and wind-tunnel investigations of boundary-layer shock-wave interaction was obtained, particularly with respect to the lower Mach number for the establishment of a forked or bifurcated type of shock wave.

NACA RM E51G20

PRELIMINARY RESULTS OF A DETERMINATION OF TEMPERATURES OF FLAMES BY MEANS OF K-BAND MICROWAVE ATTENUATION. Leonard Rudlin. September 1951. 20p. diagrs. (NACA RM E51G20)

The temperature effects on the attenuation of K-band microwaves, at a frequency of 26,500±30 megacycles per second, through natural-gas and propane flames containing added alkali halide salts, were investigated over a temperature range from 1900° to 2500° K. The preliminary data of this investigation indicated that the attenuation varies appreciably with the sodium-line-reversal temperatures of the flames and is independent of the particular hydrocarbon fuels that were used for temperature sources and of the particular halide components of the compounds used, in the concentrations employed to produce easily measurable attenuation. A reproducibility of ±25° K was obtainable.

NACA RM E51G24

RESOLUTION OF ANNEALING EXPERIMENTS FOR THE STUDY OF NONEQUILIBRIUM STATES. Philip Schwed. September 1951. 15p. diagrs. (NACA RM E51G24)

The two techniques for conducting annealing experiments for the purpose of determining the distribution of atoms of a solid among nonequilibrium states are

considered. Related definitions for resolving power for annealing with steadily rising temperature and for annealing at a series of fixed temperatures are given. The necessary separation of activation energies for the resolution of two different nonequilibrium states is found to be greater in the case of a steadily rising temperature, but of the order of 10 percent of the activation energy for both techniques. The resolving power in the case of a steadily rising temperature is independent of the rate of temperature rise.

NACA TM 1277

PRESENT STATE OF DEVELOPMENT IN NON-STEADY MOTION OF A LIFTING SURFACE. (Lo stato attuale delle ricerche sul moto instazionario di una superficie portante). P. Cicala. October 1951. 96p. diagrs., 3 tabs. (NACA TM 1277. Trans. from Aerotecnica, v.21, no.9-10, Sept.-Oct.1941, p.557-591, 670-685, 759-773).

A summary is given of the principal results on air forces for a wing undergoing unsteady motion in an incompressible fluid and of methods followed by various investigators, as of 1941. Part I contains results for a wing of infinite aspect ratio; part II deals with procedures for wings of finite aspect ratio; part III contains results for force components in the direction of motion (propulsion or drag); part IV considers the results of some experimental investigations. Each part contains an evaluation of existing publications.

NACA TM 1314

ON THE TURBULENT FRICTION LAYER FOR RISING PRESSURE. (Zur turbulenten reibungsschicht bei druckanstieg). K. Wieghardt and W. Tillmann. October 1951. 46p. diagrs. (NACA TM 1314. Trans. from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin. UM 6617, November 20, 1944).

Among the information presented are included displacement, momentum, and kinetic energy thicknesses, shearing stress distributions across the boundary layer, and surface friction coefficients. The Gruschwitz method and its modifications are examined and tested. An energy theorem for the turbulent boundary layer is introduced and discussed but does not lead to a method for the prediction of the behavior of the turbulent boundary layer because relations for the shearing stress and the surface friction are lacking.

NACA TM 1315

DISPLACEMENT EFFECT OF THE LAMINAR BOUNDARY LAYER AND THE PRESSURE DRAG. (Verdrängungswirkung der laminaren Grenzschichten und Druckwiderstand). H. Görtler. October 1951. 43p. diagrs., 3 tabs. (NACA TM 1315. Trans. from Ingenieur-Archiv, v.14, 1944, p.286-305).

The displacement effect of the boundary layer on the outer frictionless flow is discussed for both steady and unsteady flows. The analysis is restricted to cases in which the potential flow pressure distribution remains valid for the boundary-layer calculation. Formulas are given for the dependence of the pressure drag, friction drag, and total drag of circular cylinders on the time from the start of motion for cases in which the velocity varies as a power of the time. Formulas for the location and for the time for the appearance of the separation point are given for two dimensional bodies of arbitrary shape.

BRITISH REPORTS

N-10282*

Royal Aircraft Establishment (Gt. Brit.)
A SIMPLE TEST GEAR FOR MEASUREMENT OF EXTINCTION VOLTAGE OF COLD CATHODE DIODES UNDER DYNAMIC CONDITIONS. N. E. G. Hill. May 1951. 8p. diagrs., 3 tabs. (RAE Tech. Note EL.21)

Describes a test gear developed to enable extinction voltage data to be collected on cold cathode diodes under operating conditions. The test gear is a simple variant of the striking voltage test gear which has been described in an earlier report. It enables the striking and extinction voltages of a diode to be measured simultaneously to the nearest 1 volt.

N-10286*

Royal Aircraft Establishment (Gt. Brit.)
PHOTOGRAPHIC LENS TESTING. R. W. Fish. March 1951. 31p. diagrs., photos. (RAE Tech. Note Ph.443)

The methods used at present by the Royal Aircraft Establishment for the testing of lenses designed for air photography are given in detail. The apparatus and standard conditions for the measurement of the lens resolving power are described, and the treatment and accuracy of the experimental data discussed. Extension of the resolving power measurements to the focusing of cameras and the estimation of cine-camera performance are briefly described.

N-10288*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) A METHOD OF PERFORMANCE REDUCTION FOR HELICOPTERS. PART 2. STEADY AUTOROTATIVE FLIGHT. A. L. Oliver. June 11, 1951. 10p. diagrs. (AAEE Rept. A.A.E.E./Res/257)

A method of performance reduction for helicopters was given in AFEE Rept. Res. 26, together with charts for the estimation and reduction of performance in power-on flight. The same method has been used here to prepare charts for estimating steady autorotative performance and for determining the effect on rate of descent of changes in temperature, rotor speed, and weight.

N-10289*

Ministry of Supply (Gt. Brit.)
THE EVALUATION OF PERSPEX JOINTING TECHNIQUES. January 1951. 43p. diagrs., photos., 40 tabs. (MOS S & TM 5/51; Fairey Aviation Co., Ltd., Hayes)

Describes a program of work carried out to afford a comparison of joint strengths in Perspex when the jointing is effected by an acrylic dough and a solvent cement. It was also desired to obtain the relevant design data. Results are given for tension, bend and shear strengths at ambient temperatures, +70°C, and -70°C, for both plasticized and unplasticized Perspex. It has been shown that joints made with an acrylic dough afford higher ultimate strengths than those made with a solvent cement. It is also apparent that various imperfections in the joint produce considerable reduction in joint strength.

N-10306*

National Gas Turbine Establishment (Gt. Brit.)
THE BURNING OF SINGLE DROPS OF FUEL. PART II. EXPERIMENTAL RESULTS. G. A. E. Godsave. April 1951. 19p. photos., diagrs., 3 tabs. (NGTE R.87)

This is Part II in the series of reports describing investigations of the mechanism of the combustion of the individual drops in a liquid fuel spray. This report gives results of experimental measurements of the burning rates of single drops of various fuels suspended in still air on a fine silica filament. Over the range of drop diameter investigation (2,000-1,000μ), the burning drops decreased in size at a mass rate proportional to the first power of their diameters. The burning rate at any diameter, and hence the total drop life, may be characterized by a constant λ called the evaporation constant. Using the experimental technique described in this report, it was possible to determine the values of the evaporation constant λ for a series of pure hydrocarbons and commercial fuels.

N-10359*

Royal Aircraft Establishment (Gt. Brit.)
ON THE ERRORS INVOLVED IN MEASURING SUPERSONIC MACH NUMBERS. W. T. Lord and D. Beastall. April 1951. 43p. diagrs., tab. (RAE Aero 2100)

This note presents a method of finding the errors to be expected in deriving the Mach number at a point in a supersonic flow from the formulas which depend on the pitot, static, and stagnation pressures at that point, when the errors involved in the pressure readings can be estimated. It thus suggests the best formula to use in any given case. The method is illustrated by a series of figures covering values of Mach number from 1 to 4, when no pressure has an error more than four times greater than that of any other. Other cases may be computed as required.

N-10379*

Forest Products Research Lab. (Gt. Brit.)
TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. PRELIMINARY TESTS ON FIVE SPECIES. PROGRESS REPORT TWELVE. June 1951. 27p. 15 tabs. (Forest Products Research Lab.)

Small quantities of African timbers were tested as specified in Paper PRP5/1 - Manual for Conducting Trials of Timbers for Plywood Manufacture. The timbers were Afzelia, Danta, Greenheart, Mubura, and Muhimbi.

N-10380*

Forest Products Research Lab. (Gt. Brit.)
INVESTIGATIONS INTO GLUES AND GLUING. PROGRESS REPORT SIXTY-TWO - MAY, 1951. THE COMPARATIVE DURABILITY OF PLYWOOD GLUES IN ENGLAND AND IN NIGERIA. (SERIES IV). J. F. S. Carruthers and A. M. Thomas. 11p. photos., 3 tabs. (Forest Products Research Lab.)

The glues tested include those of the phenol, resorcinol, melamine, and fortified and normal urea formaldehyde types. Beech and gaboon plywood was made with 10 glues. The panels were exposed in two environments at Princes Risborough (panels open-piled in a normally heated workshop and fully exposed on nearly horizontal racks in the open) and in two at Port Harcourt, Nigeria (panels piled in stick under an open sided shed and fully exposed on nearly horizontal racks in the open).

UNPUBLISHED PAPERS

N-8588*

National Bureau of Standards.
CORROSION OF SURFACE TREATED ALUMINUM ALLOYS. Fred M. Reinhart. 1951. 9p. diagrs., 2 tabs. (National Bureau of Standards. Rept. 1004)

Panels of aluminum alloy 24S-T3, surface-treated by the Alrok 14 and Bonderite 170 processes, were exposed in a salt fog cabinet, tidewater and marine atmosphere, both unpainted and painted, to evaluate their protective merits in these environments. The unpainted Alrok 14 surface-treated material was more resistant to corrosive attack in the tidewater and marine atmosphere than was the Bonderite 170 treated material. The Alrok 14 treated material was susceptible to the pitting type of corrosive attack only while the Bonderite 170 treated material was susceptible to intergranular attack. Both surface treatments were good bases for paint coatings in both environments for 24 months.

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA TN 2467

THE AERODYNAMIC BEHAVIOR OF A HARMONICALLY OSCILLATING FINITE SWEPTBACK WING IN SUPERSONIC FLOW. Chieh-Chien Chang, Johns Hopkins University. October 1951. 76p. diagrs. (NACA TN 2467)

By an extension of Evvard's "diaphragm" concept outside the wing tip, two approximate methods are presented for calculating the aerodynamic behavior of harmonically oscillating, sweptback finite wings with both supersonic leading and trailing edges - one expressing the integration in terms of Fresnal integrals and the second one similar to the first except that a series expansion of the source-strength function is used. If the wing frequency parameter is small both methods give accurate results in the engineering sense without requiring undue computing skill. A number of graphs are presented to show pressure distribution of the wings at different Mach numbers, sweepback angles, and frequency parameters. Comparisons of pressure coefficients calculated from present methods and exact two dimensional solutions based on linearized theory are made.

NACA TN 2468

INVESTIGATION AT LOW SPEED OF 45° AND 60° SWEPTBACK, TAPERED, LOW-DRAG WINGS EQUIPPED WITH VARIOUS TYPES OF FULL-SPAN, TRAILING-EDGE FLAPS. John J. Harper, Georgia Institute of Technology. October 1951. 53p. diagrs., photos., 3 tabs. (NACA TN 2468)

An investigation was made to determine the low-speed aerodynamic characteristics of two sweptback, low-drag, tapered wings equipped with full-span split and slotted flaps and three special types of trailing-edge flaps. Sweep angles of 45° and 60° measured at the quarter chord were used. The results showed no appreciable gain in maximum lift coefficients for either the split flap or the special flaps on the 60° model but these same flaps did produce an increment in lift on the 45° model. The slotted flap produced the largest increase in lift on both models. The effect of the flaps on drag and pitching moment is the same as that indicated by other test data available. The slotted flap caused the largest increase in pitching moment for a given deflection angle. All flap configurations increased the stability of both wings.

NACA TN 2469

RUPTURE PROPERTIES OF LOW-CARBON N-155 TYPE ALLOYS MADE WITH A COLUMBIUM-TANTALUM FERRO-ALLOY. J. W. Freeman, E. E. Reynolds and A. E. White, University of Michigan. October 1951. 11p. diagrs., 2 tabs. (NACA TN 2469)

An experimental columbium-tantalum ferro-alloy was substituted for ferro-columbium in making laboratory heats of low-carbon N-155 alloy and an N-155 type alloy (20Cr-20Ni-20Co+2Cb). This substitution had no significant effect upon stress-rupture and creep properties of either alloy at 1200° and 1500° F. The results indicate the probable practicality of using high-tantalum ferro-columbium for making columbium-bearing heat-resistant alloys. In addition to using columbium not otherwise available, an actual reduction of the amount of columbium used is indicated.

NACA TN 2472

FUNDAMENTAL EFFECTS OF COLD-WORKING ON CREEP PROPERTIES OF LOW-CARBON N-155 ALLOY. D. N. Frey, J. W. Freeman and A. E. White, University of Michigan. October 1951. 45p. diagrs., photos. (NACA TN 2472)

Effects of cold-working under various conditions on the creep resistance at 1200° F and on the internal structure of low-carbon N-155 were determined in part by microscopic examination and X-ray diffraction. Effects of annealing at various times and temperatures on creep resistance and internal structure of the cold-worked samples were also partially evaluated. Cold-working was found to improve the creep resistance of this alloy by the introduction of residual elastic stresses into the lattice. These stresses acted to prevent the movement of the fundamental creep flow units.

NACA TN 2474

EMPIRICAL RELATION BETWEEN INDUCED VELOCITY, THRUST, AND RATE OF DESCENT OF A HELICOPTER ROTOR AS DETERMINED BY WIND-TUNNEL TESTS ON FOUR MODEL ROTORS. Walter Castles, Jr. and Robin B. Gray, Georgia Institute of Technology. October 1951. 72p. diagrs., photos., 8 tabs. (NACA TN 2474)

The empirical relation between the induced velocity, thrust, and rate of vertical descent of a helicopter rotor was calculated from wind-tunnel force tests of four model rotors by the application of blade element theory to the measured values of the thrust, torque, blade angle, and equivalent free-stream rate of descent. The tests covered the useful range of the ratio of thrust coefficient to effective solidity and the range of vertical descent from hovering to descent velocities slightly greater than those for autorotation. Possible sources of discrepancy between

previous flight and wind-tunnel test data are discussed and the principal effects of blade taper and twist on the vertical-descent characteristics are evaluated.

NACA TN 2475

SOME FEATURES OF ARTIFICALLY THICKENED FULLY DEVELOPED TURBULENT BOUNDARY LAYERS WITH ZERO PRESSURE GRADIENT. P. S. Klebanoff and Z. W. Diehl, National Bureau of Standards. October 1951. 55p. diagrs., photos. (NACA TN 2475)

Results are presented of tests to determine the feasibility of artifically thickening a turbulent boundary layer on a flat plate. It is shown that it is possible to do substantial thickening and obtain a fully developed turbulent boundary layer which is free from any distortions introduced by the thickening process. Measurements of mean velocity, spectrum of u-fluctuation, and intensity of u-fluctuation are presented. Some features of the fully developed turbulent boundary layer with zero pressure gradient are discussed. The mean flow in the boundary layer is compared with the logarithmic laws of mean-velocity distribution derived for pipes and channels, and the existing theories dealing with the shape of the spectrum in isotropic turbulence are applied to the spectrum measured in the outer portion of the boundary layer.

NACA TN 2496

FLIGHT INVESTIGATION OF A MECHANICAL FEEL DEVICE IN AN IRREVERSIBLE ELEVATOR CONTROL SYSTEM OF A LARGE AIRPLANE. B. Porter Brown, Robert G. Chilton and James B. Whitten. October 1951. 47p. diagrs., photos. (NACA TN 2496)

Data are presented showing the flight characteristics of a large airplane having a control-surface booster and mechanical feel device in the elevator-control system. The tests were made with various force gradients provided by the adjustable feel device. The booster was set to operate at a very high boost ratio throughout the tests so that the measured or apparent stick-free stability would be influenced only slightly by the aerodynamic hinge moments. The results show the effect of the feel device on the handling qualities of the test airplane and also the design features which should be incorporated in such feel devices.

NACA TN 2499

LAMINAR FRICTION AND HEAT TRANSFER AT MACH NUMBERS FROM 1 TO 10. E. B. Klunker and F. Edward McLean. October 1951. 22p. diagrs. (NACA TN 2499)

Velocity and temperature profiles and laminar boundary-layer characteristics have been computed for Mach numbers from 1 to 10, utilizing experimental values of the heat capacity, viscosity, and conductivity. The analysis shows that an effective temperature, which is a function of the surface temperature and stream conditions, arises naturally and is the proper reference temperature to be used in heat-transfer calculations. The effective temperature and the recovery temperature become identical for the condition of zero heat transfer.

NACA TN 2506

AN ANALYTIC DETERMINATION OF THE FLOW BEHIND A SYMMETRICAL CURVED SHOCK IN A UNIFORM STREAM. C. C. Lin and S. F. Shen, Massachusetts Institute of Technology. October 1951. 45p. diagrs. (NACA TN 2506)

A power-series-expansion method is used to determine the flow pattern behind a detached curved shock in a uniform stream. The limitations of the method are discussed and earlier applications are extended to include more terms and to give improved accuracy. The analysis is carried out in a manner applicable to both the two-dimensional and the axially symmetrical cases. The particular example with free-stream Mach number 1.7 is computed in the axially symmetrical case by using a fourth-degree polynomial to represent the flow and comparison is made with experimental results.

NACA TN 2509

A SELF-SYNCHRONIZING STROBOSCOPIC SCHLIEREN SYSTEM FOR THE STUDY OF UNSTEADY AIR FLOWS. Leslie F. Lawrence, Stanley F. Schmidt and Floyd W. Looschen. October 1951. 30p. diagrs., photos., tab. (NACA TN 2509)

A description and several examples of an application of a self-synchronized stroboscopic schlieren system are presented. The instrument provides for visual examination of unsteady flow phenomena occuring about aerodynamic bodies in wind tunnels. The frequency limitations of the instrument were arbitrarily selected for a particular test and may be varied by modifying electronic circuits of the system. Complete circuit diagrams are presented.

NACA TN 2510

EXPERIMENTAL VALUES OF THE SURFACE TENSION OF SUPERCOOLED WATER. Paul T. Hacker. October 1951. 20p. diagrs., photos., tab. (NACA TN 2510)

The surface tension of water has been determined experimentally for the temperature range, 0° to -22.2° C. The weak inflection point in the surface-tension - temperature relation, as indicated by the International Critical Table values for temperatures down to -8° C, was substantiated by the measurements in the temperature range, 0° to -22.2° C. The surface tension increases at approximately a linear rate from a value of 76.96 ± 0.06 dynes per centimeter at -8° C to 79.67 ± 0.06 dynes per centimeter at -22.2° C.

NACA TN 2511

CALCULATION OF HIGHER APPROXIMATIONS FOR TWO-DIMENSIONAL COMPRESSIBLE FLOW

BY A SIMPLIFIED ITERATION PROCESS. W. H. Braun and M. M. Klein. October 1951. 54p. diagrs., 10 tabs. (NACA TN 2511)

The iteration equations for a simplified solution of the nonlinear compressible-flow equation are developed and applied to two profiles, the ellipse and the Kaplan section. Limitations imposed on the solutions by simplifications in the differential equation and the boundary conditions are discussed. The velocities near the midchord, the critical and potential limit free-stream Mach numbers, and the extent of isentropic supersonic regions are calculated to four approximations for the Kaplan section and to six approximations for the ellipse. The development of the iteration equations and the presentation of the results are made in conformity with the Kármán transonic similarity law and comparisons are made with other solutions.

NACA TN 2513

EFFECTS OF SOME SOLUTION TREATMENTS FOLLOWED BY AN AGING TREATMENT ON THE LIFE OF SMALL CAST GAS-TURBINE BLADES OF A COBALT-CHROMIUM-BASE ALLOY. II - EFFECT OF SELECTED COMBINATIONS OF SOAKING TIME, TEMPERATURE, AND COOLING RATE. C. A. Hoffman and C. F. Robards. October 1951. 19p. diagrs., photos., 4 tabs. (NACA TN 2513)

An investigation was conducted to determine the effects of a number of solution and aging treatments on the life of small cast gas-turbine blades of Haynes Stellite alloy 21 (a cobalt-chromium-base alloy). Solution Treating at 2250° F followed by slow furnace cooling and subsequent aging was found to improve the mean life and the initial failure time of the blades. This improvement was confirmed by statistical analysis. Metallographic examination revealed the presence of a lamellar structure in the improved blades. Other treatments investigated did not improve blade life. The blades were operated at 1500° F and 20,000 pounds per square inch at the blade mid-span. Samples of 20 and 22 blades were used.

NACA TN 2517

AN INVESTIGATION OF AIRCRAFT HEATERS. XXXVII - EXPERIMENTAL DETERMINATION OF THERMAL AND HYDRODYNAMICAL BEHAVIOR OF AIR FLOWING ALONG A FLAT PLATE CONTAINING TURBULENCE PROMOTERS. L. M. K. Boelter, G. Young, M. L. Greenfield, V. D. Sanders and M. Morgan, University of California. October 1951. 26p. diagrs. (NACA TN 2517)

This report contains heat-transfer and pressure-drop data for air flowing over a heated flat plate containing strips of metal placed normal to the direction of air flow. The heat-transfer rates and static pressure drops are increased for this system over that for a flat plate alone because of the eddies, turbulence, and fin effect caused by the interrupters.

NACA TN 2520

EFFECTS OF PRESSURE-RAKE DESIGN PARAMETERS ON STATIC-PRESSURE MEASUREMENT FOR RAKES USED IN SUBSONIC FREE JETS. Lloyd N. Krause. October 1951. 20p. diagrs. (NACA TN 2520)

A subsonic-free-jet investigation was conducted to determine the effect of pressure-rake design parameters on static-pressure measurement. The design parameters investigated include: the location of the static orifices in relation to the tube nose and supporting strut; the proximity effects of adjacent tubes near the static orifices; and the effect of ratio of support diameter to jet diameter. The investigation covered a Mach number range of 0.3 to 0.95. Information and recommendations are provided for the design of pressure rakes to be used in subsonic free jets.

NACA TN 2521

LAMINAR BOUNDARY LAYER ON A CIRCULAR CONE IN SUPERSONIC FLOW AT A SMALL ANGLE OF ATTACK. Franklin K. Moore. October 1951. 44p. diagrs., tab. (NACA TN 2521)

The laminar boundary layer on a circular cone at angle of attack to a supersonic stream is discussed. A perturbation analysis was made to show the influence of a small angle of attack on such boundary-layer quantities as skin friction, boundary-layer thickness, viscous lift, drag, and pitching moment.

NACA RM E51H09

FLAME VELOCITIES OVER A WIDE COMPOSITION RANGE FOR PENTANE-AIR, ETHYLENE-AIR, AND PROPYNE-AIR FLAMES. Dorothy M. Simon and Edgar L. Wong. October 1951. 40p. diagrs., photos., 4 tabs. (NACA RM E51H09)

Fundamental flame velocities are reported for pentane air, ethylene-air, and propyne-air mixtures for the concentration range 60 to 130 percent of stoichiometric. A form of the Tanford and Pease equation, which includes a small constant velocity term independent of diffusion, will predict the observed changes in flame velocity.

NACA TM 1322

THEORY OF THIN-WALLED RODS. (O Teorii Tonkostennykh Sterzhnei). A. L. Goldenveizer. October 1951. 53p. (NACA TM 1322. Trans. from Prikladnaya Matematika i Mekhanika, v.13, Nov.-Dec.1949, p. 561-596).

Starting with the Love equations for bending of extensible shells, "principal stress states" are sought for a thin-walled rod of arbitrary but open cross section. Principal stress states exclude those local states arising from end conditions which damp out with distance from the ends. It is found that for rods of intermediate length, long enough to avoid local bending at a support, and short enough that elementary torsion and bending are not the most significant

stress states, four principal states exist. Three of these states are associated with the planar distribution of axial stress and are equivalent to the engineering theory of extension and bending of solid sections. The fourth state resembles that which has been called in the literature "bending stress due to torsional", except that cross sections are permitted to bend and the shear along the center line of the cross section is permitted to differ from zero.

BRITISH REPORTS

N-10613*

Royal Aircraft Establishment (Gt. Brit.)
A UNIFIED THEORY OF SUPERSONIC WING FLOW, EMPLOYING CONICAL FIELDS. H. Multhropp. April 1951. 178p. diagrs. (RAE Aero 2415)

This paper attempts to unify the supersonic wing flow theory by employing conical fields with a single transformation. The theory is applied first to the case of wings wholly inside the Mach cone and then to problems of wings which are partly outside the Mach cone. Enough partial solutions are worked out to enable the full solution to be built up for a flat plate of any practicable plan form at incidence and sideslip. The problem of a wing with supersonic curved leading edges is treated. Gives results for wings of small finite thickness at zero incidence. For calculations for wings in which the effective incidence varies as the chordwise or spanwise coordinates, the conception of conical fields of different order than that used for constant incidence is introduced.

N-10634*

Department of Supply (Australia)
AN INVESTIGATION INTO ENGINE WEAR CAUSED BY DUST. R. V. Pavia. July 1950. 19p. diagrs., photos., 5 tabs. (Department of Supply. ACA-50)

A number of wear tests have been made on an R.1830 Twin Wasp single-cylinder engine with dust introduced into the intake air, to study the effects on engine wear of dust quantity, dust concentration, and dust size. The results show that generally the wear is proportional to the weight of dust fed, but the amount of wear produced by a given weight of dust decreases as the dust concentration increases. Maximum wear was obtained with a dust size of about 15 microns, while the wear with 100-micron dust was only half as much. A simple method, which agrees well with the experimental results, has been suggested for estimating the wear caused by a mixture of dusts with known individual wear characteristics.

UNPUBLISHED PAPERS

N-3136*

INFLUENCE OF THE FLUID BOUNDARIES ON THE LONGITUDINAL STABILITY OF BODIES. (Der einfluss von flussigkeitsgrenzen auf die langsstabilität von körpern). W. Albring. August 1951. 12p. diagrs. (Trans. from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin. UM 6407, July 14, 1944).

Reports ideas on the problem of "nose-down tendency" of submarines near the surface. A marked increase in displacement at the nose has an adverse effect. If a hydrodynamically unfavorable shape is dictated by the purpose of application, the possibility of balance by a properly designed tail surface may still remain. This is confirmed by the derivation of stability equations. From these, a few rules have been derived for design. Researchers must determine the magnitude of interference by experiment.

N-9888*

ON THE USE OF LIGHT GASES FOR CLOSED-CYCLE HEAT ENGINES. (Uber die Verwendung von leichten Gasen für Wärmekraftmaschinen mit geschlossenem Kreislauf). J. Ackeret. 8p. diagr. (Trans. from Schweizerische Bauzeitung, v.127, 1946, p.51-52).

Although the conventional operating medium for closed-cycle heat engines is air, it should be of interest to see whether further progress could be achieved by the use of other gases. This report discusses the most essential points, but leaves out a number of problems, especially those of the operation. It is noted that for the cycle efficiency, without consideration of the temperature and pressure losses, the nature of the gas plays no part. It is assumed that only gases and gas mixtures of the same atomic structure are employed.

N-10759*

THE INTERFERENCE EFFECT OF A WIND TUNNEL WITH MIXED CONTOUR. (Sull'interferenza di una Galleria Aerodinamica a Contorno Misto). Enrico Pistolesi. August 1951. 33p. diagrs. (Trans. from Pontificia Accademia delle Scienze, Commentationes, v.7, no.5, p.75-100).

This report deals with the case in which the free vortex system of the wing is formed by a couple of concentric vortices or by a continuous distribution of vortices. The development is limited so that the formulas retain their generalities. The results are applied to two specific cases: (1) circulation constant along the span, and (2) elliptic circulation distribution.

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1007

HORIZONTAL TAIL LOADS IN MANEUVERING FLIGHT. Henry A. Pearson, William A. McGowan and James J. Donegan. 1951. ii, 12p. diagrs., 2 tabs. (NACA Rept. 1007. Formerly TN 2078)

A method is derived for determining the horizontal tail load following a prescribed maneuver. The tail load is broken down into various components which are examined to determine the maximum values. The method is extended to include suggestions for distributing the load across the span as well as in a chordwise direction. Equations are given for determining the maximum possible pitching angular velocity and pitching acceleration in a pull-up maneuver.

NACA TN 2451

MATHEMATICAL IMPROVEMENT OF METHOD FOR COMPUTING POISSON INTEGRALS INVOLVED IN DETERMINATION OF VELOCITY DISTRIBUTION ON AIRFOILS. I. Flügge-Lotz, Stanford University. October 1951. 84p. diagrs., 3 tabs. (NACA TN 2451)

A solution is presented of the Poisson integral involved in the determination of the change in velocity distribution resulting from a change in airfoil profile in parallel incompressible flow. Three well developed numerical methods of evaluating this integral, all based on the division of the range of integration into small equal intervals, and the difficulties involved in each method, are discussed. A new method based on the use of unequal intervals, is developed and compared with the other methods by means of several examples.

NACA TN 2465

EXPERIMENTAL AERODYNAMIC DERIVATIVES OF A SINUSOIDALLY OSCILLATING AIRFOIL IN TWO-DIMENSIONAL FLOW. Robert L. Halfman, Massachusetts Institute of Technology. November 1951. 83p. diagrs., photo., 19 tabs. (NACA TN 2465)

Experimental measurements of the aerodynamic reactions on a symmetrical airfoil oscillating harmonically in a two-dimensional flow are presented and analyzed. Harmonic motions include pure pitch and pure translation, for several amplitudes and superimposed on an initial angle of attack, as well as combined pitch and translation. Considerable consistent data for pure pitch were obtained from a search of available reference material, and several definite Reynolds number effects are evident.

NACA TN 2473

ON THE SPECTRUM OF ISOTROPIC TURBULENCE. H. W. Liepmann, J. Laufer and Kate Liepmann, California Institute of Technology. November 1951. 61p. diagrs. (NACA TN 2473)

Measurements of the spectrum and correlation functions at large Reynolds numbers were made, as well as a series of accurate spectrum measurements at lower Reynolds numbers, and the results are compared with theory. The second, fourth, and sixth moments of the spectrum were computed from the measurements and are discussed in relation to theoretical results. The significance of the number of zeros of the fluctuating velocity components was investigated and examples of measurements for the determination of the microscale of turbulence from zero counts are presented.

NACA TN 2493

ANALYSIS OF AN AXIAL COMPRESSOR STAGE WITH INFINITESIMAL AND FINITE BLADE SPACING. H. J. Reissner and L. Meyerhoff, Polytechnic Institute of Brooklyn. October 1951. 32p. diagrs. (NACA TN 2493)

A method of designing circular blade systems of finite spacing is developed. First, the theory of flow through a system of infinitesimally spaced surfaces is formulated by means of a continuous axially symmetric force field which is uniform in the circumferential direction. This force field replaces the effect of the blade system, with its hub and shroud boundary surfaces. Second, the force field in the space between the blades, hub, and shroud is replaced in the equations of finite spacing by inertia and pressure terms, which were omitted in equations of infinitesimal spacing. These terms will change values of flow variables of infinitesimal spacing.

NACA TN 2495

WIND-TUNNEL INVESTIGATION OF EFFECTS OF VARIOUS AERODYNAMIC BALANCE SHAPES AND SWEEPBACK ON CONTROL-SURFACE CHARACTERISTICS OF SEMISPAN TAIL SURFACES WITH NACA 0009, 0015, 66-009, 66(215)-014, AND CIRCULAR-ARC AIRFOIL SECTIONS. John J. Harper, Georgia Institute of Technology. October 1951. 127p. diagrs., photos., 5 tabs. (NACA TN 2495)

A summary of force data on unswept and sweptback airplane control surfaces is presented. Lift and hinge-moment characteristics were determined for

four unswept, semispan control surfaces, and lift, drag, hinge moment, and pitching moment were determined for two semispan, sweptback control surfaces. These control surfaces were of the wide-chord type suitable for use as elevators or rudders. Measured values of the various parameters are compared with those obtained from section data by application of lifting-surface and lifting-line theory.

NACA TN 2503

HYDRODYNAMIC INVESTIGATION OF A SERIES OF HULL MODELS SUITABLE FOR SMALL FLYING BOATS AND AMPHIBIANS. W. C. Hugli, Jr. and W. C. Axt, Stevens Institute of Technology. November 1951. 122p. diagrs., photos., 4 tabs. (NACA TN 2503)

Results of an investigation to obtain hydrodynamic information on a series of hull models suitable for small flying boats or amphibians of from 2000 to 5000 pounds gross weight are presented. The series of hulls consisted of a basic hull with simple lines with plus or minus variations to this design in which the beam, sternpost angle, and afterbody length were altered. Modifications were also investigated to determine the advantage of refining the hull lines. The hulls were tested for hydrodynamic resistance and main spray. On the basis of these characteristics, the best beam and sternpost angle were selected for each of the three afterbody lengths investigated. The resulting three hulls were further tested for landing and porpoising characteristics.

NACA TN 2512

STRESSES IN A TWO-BAY NONCIRCULAR CYLINDER UNDER TRANSVERSE LOADS. George E. Griffith. October 1951. 34p. diagrs., 3 tabs. (NACA TN 2512)

A method, taking into account the effects of flexibility and based on a general eighth-order differential equation, is presented for finding the stresses in a two-bay, noncircular cylinder the cross section of which can be composed of circular arcs. Numerical examples are given for two cases of ring flexibility for a cylinder of doubly symmetrical (essentially elliptic) cross section, subjected to concentrated radial, moment, and tangential loads. The results parallel those already obtained for shells with circular rings.

NACA TN 2514

RELATIVE STRUCTURAL EFFICIENCIES OF FLAT BALSA-CORE SANDWICH AND STIFFENED-PANEL CONSTRUCTION. Ralph E. Hubka, Norris F. Dow and Paul Seide. October 1951. 29p. diagrs. (NACA TN 2514)

An analysis is made and charts are presented for the determination of regions of efficient application of flat balsa-core sandwich and stiffened-panel construction for a large range of design requirements. Optimum sandwiches were found to have relatively low values of the ratio of core thickness to face thickness.

NACA TN 2515

THE LINEARIZED CHARACTERISTICS METHOD AND ITS APPLICATION TO PRACTICAL NON-LINEAR SUPERSONIC PROBLEMS. Antonio Ferri. October 1951. 65p. diagrs. (NACA TN 2515)

The method of characteristics has been linearized by assuming that the flow field can be represented as a basic flow field determined by nonlinearized methods and a linearized superposed flow field that considers small changes in boundary conditions. The method has been applied to two-dimensional rotational flow, to calculations of axially symmetric flow, to slender bodies without symmetry, and to wing problems.

NACA TN 2516

A SURVEY OF CREEP IN METALS. A. D. Schwope and L. R. Jackson, Battelle Memorial Institute. November 1951. 66p. diagrs., tab. (NACA TN 2516)

This report summarizes numerous theories relating to creep phenomena and the extent of current knowledge on the subject. Various possible mechanisms by which creep occurs both in single crystals and in polycrystals are described. An extensive bibliography of published works in this field is also included.

NACA TN 2522

A GRAPHICAL METHOD FOR PLOTTING AMPLITUDE AND PHASE ANGLE OF TRANSFER FUNCTIONS OF DYNAMIC SYSTEMS WITHOUT FACTORING POLYNOMIALS. Earl F. Smith. November 1951. 35p. diagrs., 4 tabs. (NACA TN 2522)

A method is presented for obtaining amplitude and angle plots for rational algebraic functions of an imaginary variable. The method involves the use of templets but does not require the factoring of polynomials. Application of the method is illustrated by by an example in which the frequency response of an aircraft and automatic control system is plotted.

NACA TN 2523

ROTOGENERATIVE DETECTION OF CORROSION CURRENTS. Joseph B. McAndrew, William H. Colner and Howard T. Francis, Armour Research Foundation. November 1951. 12p. photos., diagrs. (NACA TN 2523)

A new technique for studying corrosion phenomena is described which permits the detection of the presence of currents produced by local cells on the surface of a corroding metal specimen. A cylindrical specimen is rotated at several hundred revolutions per minute in the corrosion medium. A small reference electrode is positioned as near the specimen as possible, thus scanning the surface of the metal. The signal produced is amplified and applied to an oscilloscope, together with a suitably synchronized sweep voltage. A standing pattern is produced on the oscilloscope which is a reproduction of the potential fields set up in the corrosion medium by the currents flowing between the elements of local cells.

NACA TN 2524

AN INVESTIGATION OF AIRCRAFT HEATERS. XXXVIII - DETERMINATION OF THERMAL PERFORMANCE OF RECTANGULAR- AND TRAPEZOIDAL-SHAPED INNER-SKIN PASSAGES FOR ANTI-ICING SYSTEMS. L. M. K. Boelter, V. D. Sanders and F. E. Romie, University of California. November 1951. 21p. diagrs., photos. (NACA TN 2524)

An investigation was conducted to determine the thermal and hydrodynamic behavior of air in the downstream portion of two types of double-skin passages used in heated-air leading-edge anti-icing systems. The downstream average unit thermal conductance in the turbulent region was 30 to 35 percent below that given by the commonly used equations. In the laminar region, the experimental unit conductance was about 30 percent below the predicted values for rectangular ducts but for trapezoidal ducts the data were much lower than the predicted values.

NACA TN 2525

THE EFFECT OF RATE OF CHANGE OF ANGLE OF ATTACK ON THE MAXIMUM LIFT COEFFICIENT OF A PURSUIT AIRPLANE. Burnett L. Gadeberg. October 1951. 17p. diagrs., photo. (NACA TN 2525. Formerly RM A8I30)

Flight tests have been made with a pursuit airplane to determine the effect of Mach and Reynolds numbers on the variation of the rate of change of maximum lift coefficient with rate of change of angle of attack. These tests have indicated that the rate of increase of maximum lift coefficient with increasing abruptness of the stall is significantly affected by Reynolds number as well as Mach number. Both parameters reduce this rate of increase over the lower ranges tested and increase it in the higher ranges.

NACA TN 2528

A METHOD FOR PREDICTING THE UPWASH ANGLES INDUCED AT THE PROPELLER PLANE OF A COMBINATION OF BODIES WITH AN UNSWEPT WING. Paul F. Yaggy. October 1951. 24p. diagrs., photos. (NACA TN 2528)

An approximate method for predicting the upwash angles induced at the horizontal center line of the propeller disk of a twin-engine airplane is developed and is shown to be satisfactory. The applicability of the method to other airplanes is discussed.

NACA TN 2529

SECONDARY STRESSES IN THIN-WALLED BEAMS WITH CLOSED CROSS SECTIONS. Stanley Urner Benscoter, California Institute of Technology. October 1951. 104p. diagrs. (NACA TN 2529)

An accurate method of determining secondary stresses in thin-walled, uniform beams of closed cross section is presented. The cross sections are assumed to be preserved by closely spaced rigid diaphragms. In the first section of the paper the integrodifferential equation governing axial displacements is formulated and solved for a beam without longitudinal stiffeners. In the second section of the paper the corresponding summation-difference equation is developed and solved for a beam with stiffeners (flanges and stringers). The cross section, loading distribution, and end conditions are assumed to be arbitrary.

NACA TN 2531
National Advisory Committee for Aeronautics.
SIMPLIFIED METHOD FOR CALCULATION OF COMPRESSIBLE LAMINAR BOUNDARY LAYER WITH ARBITRARY FREE-STREAM PRESSURE GRADIENT. George M. Low. October 1951. 28p. diagrs., 2 tabs. (NACA TN 2531)

The Kármán-Polhausen method, as applied to compressible laminar boundary layers, is simplified by an analysis similar to the incompressible Holstein-Bohlen method. The analysis is carried out under the assumptions of a Prandtl number of 1, zero heat transfer, and a linear viscosity-temperature relation. Results are presented so that velocity and temperature profiles, momentum and displacement thicknesses, and wall shear stress can be calculated for flows over two-dimensional bodies with arbitrary free-stream velocity distributions. The results are also applicable to flows over three-dimensional bodies with axial symmetry through the use of Mangler's transformation.

NACA TN 2532
National Advisory Committee for Aeronautics.
X-RAY DIFFRACTION STUDY OF THE INTERNAL STRUCTURE OF SUPERCOOLED WATER. Robert G. Dorsch and Bemrose Boyd. October 1951. 14p. diagrs., photo. (NACA TN 2532)

X-ray diffraction data for water in the temperature range 21° to -16° C are presented. The minimum between the two main diffraction peaks deepened continuously, as the temperature was lowered. It is concluded that supercooled water apparently becomes progressively more ice-like in structure as the temperature is lowered.

NACA TN 2535
National Advisory Committee for Aeronautics.
MINIMUM WAVE DRAG OF BODIES OF REVOLUTION WITH A CYLINDRICAL CENTER SECTION. Franklyn B. Fuller and Benjamin R. Briggs. October 1951. 34p. diagrs. (NACA TN 2535)

The minimum wave-drag problem with auxiliary conditions is solved for axial flow about bodies of revolution consisting of two symmetrical ogival sections joined by a circular cylinder. The auxiliary conditions are that the total length, the length of the cylinder, the frontal area, and the volume are held constant. The results are related to similar results known for bodies of revolution without a cylindrical midsection, and it is found that the addition of small amounts of center section has little effect on the drag. The maximum thickness ratio leading to the least total of wave and friction drag is investigated briefly.

NACA TN 2545

DISCREPANCIES BETWEEN THEORETICAL AND OBSERVED BEHAVIOR OF CYCLICALLY LOADED BEARINGS. R. W. Dayton, E. M. Simons and F. A. Fend, Battelle Memorial Institute. November 1951. 27p. diagrs., photos. (NACA TN 2545)

Discrepancies between theory and the experimental behavior of a cyclically loaded shaft rotating in a sleeve bearing are analyzed. For constant loads rotating at one-half the frequency of shaft rotation, eccentricity ratios were found to be unity when kerosene was used to lubricate the test bearing. This agrees with theoretical predictions. However, when SAE 10 oil was used, the eccentricity ratios were reduced. Under the latter conditions, the eccentricity ratio decreased as the shaft speed increased. Refinements of the test conditions resulted in observed eccentricity ratios which were closer to the theoretically predicted value of unity.

NACA RM E51H31

A MULTIPLE-RANGE SELF-BALANCING THERMOCOUPLE POTENTIOMETER. I. Warshawsky and M. Estrin. November 1951. 15p. diagrs., photo., 2 tabs. (NACA RM E51H31)

A multiple-range potentiometer circuit is described that provides automatic measurement of temperatures or temperature differences with any one of several thermocouple-material pairs. Techniques of automatic reference-junction compensation, span adjustment, and zero suppression are described that permit rapid selection of range and wire material, without the necessity for restandardization, by setting of two external tap switches.

NACA TM 1308

ON MOTION OF FLUID IN BOUNDARY LAYER NEAR LINE OF INTERSECTION OF TWO PLANES. (O Dvizhenii Zhidkosti v Pogranichnom Sloe Vblizi Linii Peresechenia Dvukh Ploskostei). L. G. Loitsianskii and V. P. Bolshakov. November 1951. 27p. diagrs., 4 tabs. (NACA TM 1308. Trans. from Central Aero-Hydrodynamical Institute, Transactions, Rept.279, 1936, p.3-18).

A motion of a slightly viscous incompressible fluid that flows between two semi-infinite planes which intersect at an angle between 0° and 180° is discussed. The increase in thickness of the boundary layer near the line of intersection of the two planes, the limits of the effect of the corner, and the effect on the drag are determined. The analysis is made for both laminar and turbulent flow by using the momentum theorem and assuming suitable velocity profiles.

NACA TM 1309

ON THE THEORY OF THIN AND THIN-WALLED RODS. (K. Teorii Tonkikh i Tonkostennykh Sterzhnei). G. Y. Dzhanelidze. October 1951. 18p. tab. (NACA TM 1309. Trans. from Prikladnaya Matematika i Mekhanika, v.13, Nov.-Dec.1949, p.597-608).

An approximate theory for the torsion and bending of thin shells is developed. The theory is based on two fundamental assumptions: cross sections are unstrained in their own planes, and the longitudinal strain in the cross section can be represented by a planar distribution (the usual engineering assumption) and by a distribution proportional to the St. Venant warping. The torsion and bending problems are discussed in the light of these assumptions; the analysis is then applied to the free vibration of a thin shell in combined torsion and bending.

NACA TM 1311

CONTRIBUTIONS TO THE THEORY OF THE SPREADING OF A FREE JET ISSUING FROM A NOZZLE. (Zur Theorie der Ausbreitung eines aus einer Düse austretenden freien Strahls). W. Szablewski. November 1951. 72p. diagrs. (NACA TM 1311. Trans. from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin. UM 8003, September 1944).

For the flow field of a free jet leaving a nozzle of circular cross section in a medium with straight uniform flow field, approximate formulas are presented for the calculation of the velocity distribution and the dimensions of the core region. The agreement with experimental results is satisfactory.

NACA TM 1320

INVESTIGATIONS ON WINGS WITH AND WITHOUT SWEEPBACK AT HIGH SUBSONIC SPEEDS. (Untersuchungen an gepfeilten und ungepfeilten Flügeln bei hohen Unterschallgeschwindigkeiten). Jakob Ackeret, Max Degen and Nikolaus Rott. November 1951. 14p. diagrs., photos. (NACA TM 1320. Trans. from Zeitschrift für angewandte Mathematik und Physik, v.1, 1950, p.32-42).

Drag tests at zero lift have been made at Mach numbers from 0.7 to approximately 0.95 in the high speed wind tunnel of the Institute for Aerodynamics, ETH, Zürich, on a group of untapered wings of aspect ratio 3.25, having sweep angles of 0° and 35°. For each sweep angle, a series of geometrically similar models was tested at a constant Reynolds number to provide a verification of computed tunnel blocking corrections. Tests were also made for wings having thickness ratios of 0.09 and 0.12 and the results compared with results predicted by von Kármán's similarity law.

NACA TM 1323

INFLUENCE OF STATIC LONGITUDINAL STABILITY ON THE BEHAVIOR OF AIRPLANES IN GUSTS. (Einfluss der statischen Längsstabilität auf das Verhalten eines Flugzeuges in Böen). H. Hoene. November 1951. 26p. diagrs. (NACA TM 1323. Trans. from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin. FB 1422, December 31, 1940).

The equations of motion for an airplane penetrating a gust are derived using a few simplifying assumptions. Calculations of loads for different static longitudinal stability on two German airplane models,

HC 45 and HS 122, are compared with flight tests. Good agreement is obtained between the trend of the flight tests and the calculated values; however no absolute comparison was possible between the flight tests and calculations.

BRITISH REPORTS

N-2414*

Department of Supply (Australia)
CORROSION OF METALS. METALS UNDER STRESS: I. ALUMINIUM. P. F. Thompson. July 1950. 22p. photos., diagrs. (Department of Supply. ACA-49)

Discusses the corrosion of aluminum under stress. Gives time-potential curves determined simultaneously of stressed and unstressed electrodes of commercially pure aluminum. Test pieces of various shapes were used. Determinations were made in various liquids, including distilled water, tap water, salt solutions and sea water; and so that full assessment of the oxidizing potentials could be made, these solutions were examined under full aeration and under complete deaeration. The conclusions following on the work of this report indicate that stresses are but contributory factors in the so-called process of "stress-corrosion."

N-4904*

Department of Supply (Australia)
OBSERVATION OF THE LUBRICATING OIL FILM BETWEEN PISTON RING AND CYLINDER OF A RUNNING ENGINE. THE EFFECT OF RING GEOMETRY. R. L. Brooks and M. L. Atkin. November 1950. 13p. diagrs., photos. (Department of Supply. ACA-52)

The effect of ring geometry on lubrication between the top piston ring and cylinder wall of a single cylinder aircraft engine was studied by measuring the electrical contact resistance. Torsion rings gave better results than square section rings of corresponding designs. Tapered leading edges were effective in promoting the rapid formation and maintenance of an oil film. Chamfered edges did not effect any improvement. Rings which were tapered across the full bearing faces gave traces which had a sawtooth appearance, with severe breakdowns at the bottom centers. Two piston ring designs which might give improved performance have been suggested.

N-10881*

National Gas Turbine Establishment (Gt. Brit.)
DATA SHEETS FOR GAS TURBINE REFERENCE FUELS. III - ADMIRALTY REFERENCE FUEL OILS 'NIGHTLIGHT', 'MOTHBALL' & 'TARMAC.' J. J. Macfarlane. June 1951. 17p. diagrs., 7 tabs. (NGTE Memo. M.116)

The report lists the measured physical and chemical properties of the three Admiralty Reference fuel oils code names "Nightlight", "Mothball" and "Tarmac", together with derived data in common use in combustion work.

UNPUBLISHED PAPERS

N-10942*

THE LIFT DISTRIBUTION OVER THE WINGS OF AN AIRPLANE I - SPANWISE LIFT DISTRIBUTION. (La Distribuzione della Portanza sulla Velatura di un Valivolo. I - La Distribuzione della Portanza sull'apertura). Enrico Pistolesi. August 1951. 92p. diagrs. (Trans. from Annali del Registro Aeronautico Italiano, v. 3, no.3, September 1942. 80p.)

Presents a review of methods of calculating the spanwise lift distribution over the wings of an airplane. Includes methods producing quick, and reasonably approximate solutions by simple means, including those obtained by an elaboration in diagrams and tables from one of the theoretical methods. Gives a brief summary of special wing theories, as distinct from Prandtl's simple line vortex, which can be used for the theoretical calculation of the lift distribution along the span as well as along the chord.

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CURRENT NACA REPORTS

NACA TN 2530

WIND-TUNNEL INVESTIGATION OF SIX SHIELDED TOTAL-PRESSURE TUBES AT HIGH ANGLES OF ATTACK. SUBSONIC SPEEDS. Walter R. Russell, William Gracey, William Letko and Paul G. Fournier. November 1951. 25p. diagrs., tab. (NACA TN 2530)

Calibrations of six shielded total-pressure tubes over an angle-of-attack range of -30° to 65° at Mach numbers of 0.26, 0.50, 0.70, 0.90, and 0.95 are presented. One of these tubes was a standard Kiel design, while the other tubes were variations of this design. The design variables which were investigated included the shape of the venturi entry (conical and curved), the position of the total-pressure probe with respect to the leading edge of the shield, the internal diameter of the shield, and the shape of the leading-edge profile. The effect of these variables on the range of angle of attack over which the tubes remained insensitive to inclination is discussed.

NACA TN 2533

EVALUATION OF HIGH-ANGLE-OF-ATTACK AERODYNAMIC-DERIVATIVE DATA AND STALL-FLUTTER PREDICTION TECHNIQUES. Robert L. Halfman, H. C. Johnson and S. M. Haley, Massachusetts Institute of Technology. November 1951. 154p. diagrs., photos., 11 tabs. (NACA TN 2533)

The aerodynamic reactions on wings oscillating harmonically in pitch and translation in the stall range have been measured, evaluated, and correlated where possible with available published data. Data on the time-average values in the stall range of both lift and moment are presented. The results of numerous experimental observations of stall flutter have been reviewed and known attempts at its prediction have been examined, compared, and extended. A semi-empirical method of predicting the variations of moment in pitch with airfoil shape, reduced frequency, initial angle of attack, and amplitude of oscillation has been presented.

NACA TN 2534

EXPERIMENTAL INVESTIGATION OF THE LOW-SPEED STATIC AND YAWING STABILITY CHARACTERISTICS OF A 45° SWEPTBACK HIGH-WING CONFIGURATION WITH VARIOUS TWIN VERTICAL WING FINS. Alex Goodman and Walter D. Wolhart. November 1951. 25p. diagrs., photos., 3 tabs. (NACA TN 2534)

Results are presented of an investigation of the low-speed static and yawing stability characteristics of a 45° sweptback high-wing, low-horizontal-tail configuration with various twin vertical fins located on the wing. The static and yawing stability characteristics obtained with the various twin-fin configurations are compared with the characteristics of a similiar configuration with a single vertical tail at the rear of the fuselage. In addition, the effects of a small vertical fin at the rear of the fuselage on the characteristics of the twin-fin configurations are presented.

NACA TN 2539

APPLICATION OF VARIATIONAL METHODS TO TRANSONIC FLOWS WITH SHOCK WAVES. Chi-Teh Wang and Pei-Chi Chou, New York University. November 1951. 32p. diagrs., 4 tabs. (NACA TN 2539)

By modifying Bateman's variational principle for irrotational flows, it is shown that a variational principle for flows with rotation and variable entropy can be obtained. By applying this variational principle to the regions of flow behind shock waves and Bateman's original principle to the other regions in the fluid, shock equations can be directly obtained. A procedure for computing numerical solutions for such flows is suggested, and a numerical example is carried out. The results show that when the Mach number increases to a certain limiting value without allowing for shock waves the variational method does not have a solution. This probably indicates the breakdown of the irrotational flow. By allowing shock waves to occur, solution again exists.

NACA TN 2540

APPLICATION OF RESPONSE FUNCTION TO CALCULATION OF FLUTTER CHARACTERISTICS OF A WING CARRYING CONCENTRATED MASSES. H. Serbin and E. L. Costilow, Purdue University. November 1951. 52p. diagrs., 3 tabs. (NACA TN 2540)

Concepts involved in the harmonic-response-function method, such as the direct or conjugate characteristic modes, are illustrated by application of the method to the calculation of the change in flutter characteristics of a wing due to adding concentrated masses. The rigid body is first idealized as a point mass, then as a distributed mass. The main purpose of the numerical procedures which are given is to illustrate the scope of the method and to make some of its abstract formulations more specific. An appendix is given which contains some of the essential theoretical background.

NACA TN 2541

STUDIES OF VON KÁRMÁN'S SIMILARITY THEORY AND ITS EXTENSION TO COMPRESSIBLE FLOWS. A CRITICAL EXAMINATION OF SIMILARITY THEORY FOR INCOMPRESSIBLE FLOWS. C. C. Lin and S. F. Shen, Massachusetts Institute of Technology. November 1951. 24p. (NACA TN 2541)

Von Kármán's similarity theory for incompressible flows is examined critically by using modern concepts in order to provide a basis for extending the theory to compressible flows. It is found that the original form of the theory is supported by modern concepts.

NACA TN 2544

HYDRODYNAMIC LUBRICATION OF CYCLICALLY LOADED BEARINGS. R. W. Dayton and E. M. Simons, Battelle Memorial Institute. November 1951. 76p. diagrs., photos. (NACA TN 2544)

Results are presented of an experimental investigation conducted in order to check the validity of analytical studies of simple cases of cyclic loading and to determine the effect of the loading conditions on hydrodynamic lubrication when the load diagram is so complex that analytical treatment is difficult or impossible. A precise test bearing was set up to which constant or varying unidirectional loads or constant rotating loads could be applied, singly or together, and the effect of the load diagram on hydrodynamic lubrication was measured from the attitude of the journal in the bearing.

NACA TN 2546

VISCOSITIES OF AIR AND NITROGEN AT LOW PRESSURES. Herrick L. Johnston, Robert W. Mattox and Robert W. Powers, Ohio State University. November 1951. 22p. diagrs., 6 tabs. (NACA TN 2546)

Information is presented of the results of an investigation to measure the viscosities of nitrogen and air at 306° and 273° K at pressures from 500 to 0.0005 millimeter of mercury and at 194° and 79° K at pressures down to 0.3 millimeter of mercury.

NACA TN 2555
National Advisory Committee for Aeronautics.
EFFECT OF TAPER RATIO ON THE LOW-SPEED ROLLING STABILITY DERIVATIVES OF SWEPT AND UNSWEPT WINGS OF ASPECT RATIO 2.61. Jack D. Brewer and Lewis R. Fisher. November 1951. 17p. diagrs., photo. (NACA TN 2555. Formerly RM L8H18)

Results of tests conducted in the 6-foot-diameter rolling-flow test section of the Langley stability tunnel to determine the effects of varying taper ratio on the rolling and static stability characteristics of a swept wing are presented; results are also given for the effects of varying taper ratio on an unswept wing and for the effects of sweep on a tapered wing. All the models were of aspect ratio 2.61 and had NACA 0012 sections normal to the quarter-chord line. Taper ratios of 1.00, 0.50, and 0.25 and sweep angles of 0° and 45° were investigated.

NACA TN 2564
National Advisory Committee for Aeronautics.
PROPERTIES OF HONEYCOMB CORES AS AFFECTED BY FIBER TYPE, FIBER ORIENTATION, RESIN TYPE, AND AMOUNT. R. J. Seidl, D. J. Fahey and A. W. Voss, Forest Products Laboratory. November 1951. 36p. diagrs., photos., 6 tabs. (NACA TN 2564)

An investigation was conducted to determine the effect of fiber type, fiber orientation, resin type, and resin content on the strength properties of honeycomb core structures. The structures examined were made from nonwoven cotton, nonwoven rayon, and paper. Some cores had the principal fiber grain parallel to and others had it perpendicular to the cells of the honeycomb. One or more resins in varying amounts were used to impregnate or bond the three materials.

BRITISH REPORTS

N-11054*

National Gas Turbine Establishment (Gt. Brit.)
A NOTE ON RADIATION HEAT TRANSFER. G. A. E. Godsave. March 1951. 21p. diagrs. (NGTE Memo. M.111)

The majority of previous discussions of radiation heat transfer between surfaces have been restricted to the case where the surfaces are considered to be grey and opaque. In this paper the case of interchange of radiation between surfaces that may partly absorb, reflect and transmit the incident radiation is considered. The surfaces are considered to be selective emitters. Expressions for calculating radiation heat transfer under these conditions are derived in particular for parallel plane surfaces, concentric spherical surfaces and concentric cylindrical surfaces. Both regularly reflecting and diffusely reflecting surfaces are discussed. For the special case of grey opaque surfaces these expressions all reduce to those previously published by other authors for this case.

N-11077*

Ministry of Supply (Gt. Brit.)
FATIGUE TESTS ON SHOT PEENED 64 TON CAST STEEL. 9p. photos., diagrs. (MOS S & TM 7/51; Metropolitan-Vickers Electrical Co., Ltd., Manchester. Research Dept. C.651, December 1947)

Fatigue tests on cast 64-ton steel "T" specimens have shown that shot peening following the normal "scurfing" (shot-blasting) process given to castings carries no additional advantage. Increasing the fillet radius shows a small definite improvement although

the general level of the fatigue i.e. 30-35 percent of the U.T.S. is low.

N-11078*

Ministry of Supply (Gt. Brit.)
FATIGUE TESTS ON SHOT PEENED 74/78-TON, CR-MO CAST STEEL. 8p. diagrs. (MOS S & TM 11/51; Metropolitan-Vickers Electrical Co., Ltd., Manchester. Research Dept. C.688, December 1948)

Fatigue tests on 74/78-ton Cr-Mo "T" shaped steel castings indicates that shot peening machined surfaces improves the fatigue resistance by about 27 percent.

N-11080*

Royal Aircraft Establishment (Gt. Brit.)
APPARATUS FOR THE LABORATORY INVESTIGATION OF THE HIGH ALTITUDE WEAR OF CARBON BRUSHES. R. F. Sims, J. G. Carr and C. Algar. May 1951. 37p. photos., diagrs. (RAE Tech. Note EL.25)

Apparatus for the laboratory investigation of high altitude brush wear and the testing of brushes intended for use at high altitudes is described. Some account of the precautions necessary to ensure reproducible results is given and it is shown that experimental errors are small compared with the variations in performance between nominally similar brushes.

UNPUBLISHED PAPERS

N-9948*

EXPERIMENTAL INVESTIGATIONS ON AN AXIAL BLOWER STAGE. (Experimentelle Untersuchungen an einer axialen Geblasestufe). Ernst Muhlemann. July 1951. 96p. diagrs., photos., 5 tabs. (Trans. from Eidgenössische Technische Hochschule Zürich. Institut für Aerodynamik. Mitteilungen 12, 1946).

A single stage consisting of a stator and rotor was investigated by means of a two-blower test setup for use in a multistage axial compressor. The various losses, particularly friction losses, were analyzed. A rotating pitot tube for wake measurements was developed.

N-10941*

COMPUTATION OF ONE-DIMENSIONAL GAS FLOWS. (Raschet odnoragmernik gazovik techenii). B. M. Kiselev. 29p. diagrs. (Trans. from Prikladnaia Matematika i Mekhanika, v.11, 1947, p.177-192).

Problems of one-dimensional gas flow are solved by means of three equations: the equation of continuity or conservation of mass, the equation of mechanics, and the equation of energy. In a number of papers, the solution is considerably simplified by the application of the initial or stagnation parameters p_0, ρ_0, and T_0, and the introduction of the nondimensional velocity $\lambda = W/a$. The solution of the problems can be still further simplified if these equations are applied in a somewhat modified form. In the present paper, the transformed equations of gas dynamics are given and the effectiveness of the application of these equations is illustrated with the aid of a number of examples. The computation of an ejector is considered in greater detail.

N-11158*

EFFECT OF VELOCITY ON RESISTANCE OF METALS TO PLASTIC DEFORMATION. (Vlianie Skorosti na Soprotivlenie Metallov Blasticheskomu Deformirovaniu). L. D. Sokolov. 12p. diagrs., tab. (Trans. from Zhurnal Tekhnicheskoi Fiziki, v.16, no.4, 1946, p.437-442).

Static (with velocities of 0.01 and 1 mm/sec) and dynamic (with mean velocity of 2000 mm/sec) compression tests were carried out on lead, copper, and steel (with varying carbon content) cylinders 20 millimeters in height in the cold state and at high temperatures. The true stress curves were constructed. A relation was established between the resistance coefficient, the temperature, and the carbon content of the steel.

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CURRENT NACA REPORTS

NACA Rept. 1013

EFFECT OF WING FLEXIBILITY AND VARIABLE AIR LIFT UPON WING BENDING MOMENTS DURING LANDING IMPACT OF A SMALL SEAPLANE. Kenneth F. Merten and Edgar B. Beck. 1951. 7p. diagrs., 2 tabs. (NACA Rept. 1013. Formerly TN 2063)

Comparisons of theoretical and experimental wing bending moments during landing impacts of a small seaplane are presented in the form of time-history curves. The effects of air-load change during impact on the bending moments in the wing are included in the theoretical calculations. Good agreement between measured and computed wing bending moments was obtained when the three components of the wing moment (static water-load moment, dynamic water-load moment, and air-load moment) were included in the calculations.

NACA TN 2452

FLEXURAL FATIGUE STRENGTHS OF RIVETED BOX BEAMS - ALCLAD 14S-T6, ALCLAD 75S-T6, AND VARIOUS TEMPERS OF ALCLAD 24S. I. D. Eaton and Marshall Holt. Aluminum Company of America. November 1951. 25p. diagrs., photos., 3 tabs. (NACA TN 2452)

Results are given of tests made to determine and compare the flexural fatigue strengths of built-up riveted box beams made from 14S-T6, 75S-T6, and various tempers of 24S alclad aluminum-alloy sheet.

NACA TN 2482

STABILITY AND CONTROL CHARACTERISTICS OF A COMPLETE AIRPLANE MODEL HAVING A WING WITH QUARTER-CHORD LINE SWEPT BACK 40°, ASPECT RATIO 2.50, AND TAPER RATIO 0.42. Marvin Schuldenfrei, Paul Comisarow and Kenneth W. Goodson. December 1951. 86p. photos., diagrs. (NACA TN 2482. Formerly RM L7B25)

An investigation has been made of a complete airplane model having a wing with the quarter-chord line swept back 40°, aspect ratio 2.50, and taper ratio 0.42 to determine its low-speed stability and control characteristics. The longitudinal stability investigation included stabilizer and tail-off tests with different wing dihedral angles ($\Gamma = 0^\circ$ and $\Gamma = -10^\circ$) over an angle-of-attack range for the cruising and landing configurations and tests with a high horizontal-tail location ($\Gamma = -10^\circ$) for the cruising configuration. Tests were made of the wing alone and to determine the effect of wing end plates in pitch. Lateral stability characteristics were determined for the airplane with different geometric wing dihedrals, with end plates, and with several dorsal modifications. Tests were made with ailerons and spoilers to determine control characteristics.

NACA TN 2518

CRITERIONS FOR CONDENSATION-FREE FLOW IN SUPERSONIC TUNNELS. Warren C. Burgess, Jr. and Ferris L. Seashore. December 1951. 39p. diagrs., photos., tab. (NACA TN 2518. Formerly RM E9E02)

The results of an investigation of water-vapor condensation shocks in the air passing through supersonic tunnels are presented. Criterions for condensation free flow are established by correlating experimental observations with the Volmer theory of nuclei formation. Experimental observations were made at Mach numbers up to 2.01. The criterions are presented in a form independent of tunnel-inlet stagnation pressure and are extended theoretically to a Mach number of 4.0. Preliminary evidence of the effect of tunnel size on the criterions is presented.

NACA TN 2527

A VELOCITY-CORRECTION FORMULA FOR THE CALCULATION OF TRANSONIC MACH NUMBER DISTRIBUTIONS OVER DIAMOND-SHAPED AIRFOILS. H. Reese Ivey and Keith C. Harder. November 1951. 28p. diagrs. (NACA TN 2527)

A velocity-correction formula is proposed for the purpose of calculating, from the known Mach number distribution for a diamond-shaped airfoil, at a stream Mach number of 1.0, Mach number distributions on the same airfoil at speeds from a Mach number of about 0.8 to shock-attachment Mach number. An expression for the rate of change of local Mach number with stream Mach number is derived and an explicit equation for the drag coefficient as a function of stream Mach number and thickness ratio is given.

NACA TN 2536

CRITICAL COMBINATIONS OF BENDING, SHEAR, AND TRANSVERSE COMPRESSIVE STRESSES FOR BUCKLING OF INFINITELY LONG FLAT PLATES. Aldie E. Johnson, Jr. and Kenneth P. Buchert. December 1951. 40p. diagrs., 3 tabs. (NACA TN 2536)

Three-dimensional interaction surfaces are presented for the computation of elastic buckling stresses for an infinitely long flat plate subjected to combinations of bending, shear, and transverse compression in its plane - a loading approximating that occurring in a shear web. Surfaces are presented for two sets of edge conditions: both edges simply supported, and lower edge simply supported, upper edge clamped. Present results are in good agreement with data for one-load and two-load limiting cases previously published.

NACA TN 2537

HEAT CAPACITY LAG IN GASES. Richard Walker, Iowa State College. November 1951. 40p. diagrs., tab. (NACA TN 2537)

A review is presented of the literature on the sonic studies of the problem of the excitation of molecular vibrations by collision and the theory on which the interpretation of almost all the sonic work has been based is discussed. The principal experimental programs are described and most of the available results are included in a table.

NACA TN 2542

STUDIES OF VON KÁRMÁN'S SIMILARITY THEORY AND ITS EXTENSION TO COMPRESSIBLE FLOWS. A SIMILARITY THEORY FOR TURBULENT BOUNDARY LAYER OVER A FLAT PLATE IN COMPRESSIBLE FLOW. C. C. Lin and S. F. Shen, Massachusetts Institute of Technology. November 1951. 37p. (NACA TN 2542)

As an application of the concepts in NACA TN 2541, the problem of turbulent boundary layer over a flat plate in compressible flow is treated. The dissipation term in the energy equation, usually neglected, is first studied and found to be of importance. In the differential equations governing the fluctuations, the lower-frequency components of all quantities are regarded to participate in an equilibrium in accordance with similarity. After proper linearization, a set of differential equations containing only the lower order frequency fluctuations is obtained. In parallel with Von Kármán's theory in incompressible flow, similarity scales for all the flow variables are derived. Two possible length scales are found and the significance of this possibility is discussed.

NACA TN 2543

STUDIES OF VON KÁRMÁN'S SIMILARITY THEORY AND ITS EXTENSION TO COMPRESSIBLE FLOWS. INVESTIGATION OF TURBULENT BOUNDARY LAYER OVER A FLAT PLATE IN COMPRESSIBLE FLOW BY THE SIMILARITY THEORY. S. F. Shen, Massachusetts Institute of Technology. November 1951. 43p. (NACA TN 2543)

The turbulent-boundary-layer flow over a flat plate in compressible flow is considered on the basis of the scheme established in NACA TN 2542. It is shown how the influence of the Mach number (e.g., on the velocity and temperature distribution) can be predicted from the theory after the constant coefficients in the theory are determined by one set of experimental measurements.

NACA TN 2547

AN INVESTIGATION BY THE HODOGRAPH METHOD OF FLOW THROUGH A SYMMETRICAL NOZZLE WITH LOCALLY SUPERSONIC REGIONS. F. Edward Ehlers and Hirsh G. Cohen, Brown University. November 1951. 61p. diagrs., 2 tabs. (NACA TN 2547)

To study the flow of a compressible fluid through a channel having locally supersonic regions, the Tricomi equation is used in the hodograph variables as an approximation in the sonic region to the equation of flow of an irrotational, inviscid gas. A one-parameter family of solutions of the Tricomi equation is used which provides symmetrical accelerated-decelerated flows. Variation of this parameter alters the Mach number at the center of the throat, the velocity distribution and gradient along the center streamline, as well as the shape of the channel, that is the curvature of the bounding streamline. Other solutions to the Tricomi equation are discussed which may be used to formulate channel flows.

NACA TN 2550

DETERMINATION OF SHAPES OF BOATTAIL BODIES OF REVOLUTION FOR MINIMUM WAVE DRAG. Mac C. Adams. November 1951. 20p. diagrs. (NACA TN 2550)

By use of an approximate equation for the wave drag of slender bodies of revolution in a supersonic flow field, the optimum shapes of certain boattail bodies are determined for minimum wave drag. The properties of three specific families of bodies are determined, the first family consisting of bodies having a given length and base area and a contour passing through a prescribed point between the nose and base, the second family having fixed length, base area, and maximum area, and the third family having given length, volume, and base area.

NACA TN 2551

EFFECT OF VARIOUS PARAMETERS INCLUDING MACH NUMBER ON THE SINGLE-DEGREE-OF-FREEDOM FLUTTER OF A CONTROL SURFACE IN POTENTIAL FLOW. Harry L. Runyan. December 1951. 33p. diagrs. (NACA TN 2551)

Calculations demonstrating the existence of single-degree-of-freedom flutter of a control surface are presented. The effect of various parameters such as Mach number, aerodynamic balance, structural damping, and inertia ratio are shown. Even though the calculations are based on potential-flow theory, the results should provide a logical basis or framework with which to examine oscillations of a control surface believed due to separated flow phenomena.

NACA TN 2552

CONSIDERATIONS ON THE EFFECT OF WIND-TUNNEL WALLS ON OSCILLATING AIR FORCES FOR TWO-DIMENSIONAL SUBSONIC COMPRESSIBLE FLOW. Harry L. Runyan and Charles E. Watkins. December 1951. 18p. diagrs. (NACA TN 2552)

This paper treats the effect of wind-tunnel walls on the oscillating two-dimensional air forces in a compressible medium. The walls are simulated by the usual method of placing images at appropriate distances above and below the wing. An important result shown is that, for certain conditions of wing frequency, tunnel height, and Mach number, the tunnel and wing may form a resonant system so that the forces on the wing are greatly changed from the condition of no tunnel walls.

NACA TN 2554

THEORETICAL AERODYNAMIC CHARACTERISTICS OF A FAMILY OF SLENDER WING-TAIL-BODY COMBINATIONS. Harvard Lomax and Paul F. Byrd. November 1951. 75p. diagrs., 2 tabs. (NACA TN 2554)

The aerodynamic characteristics of an airplane configuration composed of a swept-back, nearly constant chord wing and a triangular tail mounted on a cylindrical body are presented. The analysis is based on the assumption that the free-stream Mach number is near unity or that the configuration is slender. The calculations for the tail are made on the assumption that the vortex system trailing back from the wing is either a sheet lying entirely in the plane of the flat tail surface or has completely "rolled up" into two point vortices that lie either in, above, or below the plane of the tail surface.

NACA TN 2557

INFRARED SPECTRA OF 59 DICYCLIC HYDROCARBONS. K. T. Serijan, I. A. Goodman and W. J. Yankauskas. November 1951. 37p. diagrs., 4 tabs. (NACA TN 2557)

The infrared spectra are presented for 59 dicyclic hydrocarbons consisting of some diphenylalkanes, dicyclohexylalkanes, alkylbiphenyls, and alkylbicyclohexyls ranging from C_{12} to C_{18}. The physical properties of these compounds, which were available in a high state of purity, are tabulated for reference purposes.

NACA TN 2558

SOME EFFECTS OF VARIATIONS IN SEVERAL PARAMETERS INCLUDING FLUID DENSITY ON THE FLUTTER SPEED OF LIGHT UNIFORM CANTILEVER WINGS. Donald S. Woolston and George E. Castile. December 1951. 40p. diagrs., 10 tabs. (NACA TN 2558)

An experimental investigation has been made of some effects of variations in several parameters, including fluid density, on the flutter characteristics of light uniform cantilever wings. Special emphasis has been placed on low values of the relative-density parameter $1/\sqrt{\kappa}$, where κ is the ratio of fluid density to wing mass. The experimental investigation has been supplemented by an analytical investigation. In general, the theoretical results followed the trends indicated by experiment except at low values of the relative density parameter and, in this region, additional analytical investigation seems necessary.

NACA TN 2559

THEORETICAL AND EXPERIMENTAL INVESTIGATION OF CONDENSATION OF AIR IN HYPERSONIC WIND TUNNELS. H. Guyford Stever and Kenneth C. Rathbun, Massachusetts Institute of Technology. November 1951. 79p. diagrs., photos. (NACA TN 2559)

Presents results of theoretical and experimental investigation of condensation of air in hypersonic wind tunnels. The experimental work was done in a tunnel with Mach number of approximately 7. Condensation was detected and measured by condensation-fog light-scattering, static-pressure measurements, and changes in wedge shock angle at degrees of supersaturation considerably lower than those predicted by existing condensation theory. Effects of varying supply pressures and temperatures were also measured. The nucleation theory of condensation was modified to take account of a postulated variation of surface tension with decrease in size of spontaneously formed drops which act as nuclei of condensation. The modified theory was applied to pure oxygen and nitrogen and its predictions were compared with those of the unmodified theory.

NACA TN 2560

AN EXPERIMENTAL INVESTIGATION OF TRANSONIC FLOW PAST TWO-DIMENSIONAL WEDGE AND CIRCULAR-ARC SECTIONS USING A MACH-ZEHNDER INTERFEROMETER. Arthur Earl Bryson, Jr., California Institute of Technology. November 1951. 97p. diagrs., photos. (NACA TN 2560)

Interferometer measurements are given of the flow fields near two-dimensional wedge and circular-arc sections at zero angle of attack. Pressure distributions and drag coefficients as functions of Mach number were obtained and the wedge data are compared with theory. It is shown that the local Mach number at any point on the surface of a finite three dimensional body or an unswept two-dimensional body, moving through an infinite fluid, has a stationary value at Mach number 1 and, in fact, remains nearly constant for a range of speeds below and above Mach number 1. On the basis of this concept and the experimental data, pressure distributions and drag coefficients for the wedge and circular-arc sections are presented throughout the entire transonic range of velocities.

NACA TN 2562

NUMERICAL DETERMINATION OF INDICIAL LIFT OF TWO-DIMENSIONAL AIRFOILS AT SUBSONIC MACH NUMBERS FROM OSCILLATORY LIFT COEFFICIENTS WITH CALCULATIONS FOR MACH NUMBER 0.7. Bernard Mazelsky. December 1951. 38p. diagrs., tab. (NACA TN 2562)

The indicial lift and moment on an airfoil experiencing a sudden acquisition of vertical velocity is calculated for Mach number 0.7 from the available flutter coefficients for an oscillating airfoil. An approximate calculation is also made for the indicial-lift function due to penetration of a sharp-edged gust.

NACA TN 2565

A THEORETICAL ANALYSIS OF THE EFFECT OF SEVERAL AUXILIARY DAMPING DEVICES ON THE LATERAL STABILITY AND CONTROLLABILITY OF A HIGH-SPEED AIRCRAFT. Ordway B. Gates, Jr. December 1951. 39p. diagrs., 6 tabs. (NACA TN 2565)

An investigation has been made to determine the effect of several auxiliary damping devices on the lateral stability and controllability of a present-day high-speed airplane. The results are presented in the form of aircraft motions subsequent to applied yawing or rolling moments, comparisons of the time to damp to half amplitude and the period of the lateral modes of motion, rudder motion required for zero sideslip subsequent to an aileron deflection, and combinations of rudder and aileron deflection necessary to perform steady turning maneuvers for each of the investigated damping devices.

NACA TN 2566

A STUDY OF ELASTIC AND PLASTIC STRESS CONCENTRATION FACTORS DUE TO NOTCHES AND FILLETS IN FLAT PLATES. Herbert F. Hardrath and Lachlan Ohman. December 1951. 23p. diagrs. (NACA TN 2566)

Six large 24S-T3 aluminum-alloy-sheet specimens containing various notches or fillets were tested in tension to determine their stress concentration factors in the elastic and plastic ranges. The elastic stress concentration factors were found to be slightly higher than those predicted by other methods. A generalization of a relation presented by Stowell gave good agreement with the plastic stress concentration factors as they decreased with increasing plastic strain.

NACA TN 2569

A SUMMARY OF METEOROLOGICAL CONDITIONS ASSOCIATED WITH AIRCRAFT ICING AND A PROPOSED METHOD OF SELECTING DESIGN CRITERIONS FOR ICE-PROTECTION EQUIPMENT. Paul T. Hacker and Robert G. Dorsch. November 1951. 35p. diagrs. (NACA TN 2569)

Data on the meteorological parameters pertinent to the aircraft icing problem are so summarized as to give the frequency of occurrence of observed icing situations according to two of the parameters. The summarized data indicate that statistical relations exist between some of the parameters. A method, based upon the collection efficiency of an airfoil and the frequency of occurrence of icing situations with various liquid-water contents and mean-effective droplet sizes, is proposed for the selection of design criterions for ice-protection equipment. The method provides a convenient means of calculating the percentage of icing encounters in which the water collection rate exceeds the design rate.

NACA TN 2578

A COMPARISON OF PREDICTED AND EXPERIMENTALLY DETERMINED LONGITUDINAL DYNAMIC RESPONSES OF A STABILIZED AIRPLANE. Louis H. Smaus, Marvin R. Gore and Merle G. Waugh. December 1951. 53p. diagrs., photos. (NACA TN 2578)

The dynamic stability in pitch of an aircraft with autopilot was predicted by combining ground measured autopilot transfer functions to obtain open-loop and closed-loop frequency responses and transient responses for the combination. These predicted responses for three airspeeds and for various amounts of displacement and rate-of-displacement feedback are compared with corresponding frequency and transient responses of the stabilized airplane as measured in flight.

NACA TN 2579

APPROXIMATE METHODS FOR CALCULATING THE FLOW ABOUT NONLIFTING BODIES OF REVOLUTION AT HIGH SUPERSONIC AIRSPEEDS. A. J. Eggers, Jr. and Raymond C. Savin. December 1951. 40p. diagrs. (NACA TN 2579)

Explicit expressions are developed which yield the Mach number and pressure distributions on the surfaces of pointed nonlifting bodies of revolution operating at high supersonic airspeeds and at values of the hypersonic similarity parameter (ratio of free-stream Mach number to slenderness ratio) greater than 1. Very simple explicit expressions are obtained for these distributions in the special case of slender bodies. In the case of cones, the analytic solutions accurately define the entire flow field over a wide range of free-stream Mach numbers and apex angles.

NACA TN 2580

AN ANALYSIS OF AN X-RAY ABSORPTION METHOD FOR MEASUREMENT OF HIGH GAS TEMPERATURES. Ruth N. Weltmann and Perry W. Kuhns. December 1951. 35p. diagrs., photos., 2 tabs. (NACA TN 2580)

An analysis is presented of an X-ray absorption method for determining high gas temperatures. The

indicated temperature represents the mean density of the gas. Correction factors for dissociation and air-gas mixture are calculated as a function of temperature for stoichiometric mixtures of hydrocarbons and air. Design suggestions for a practical instrument are given on the basis of a theoretical analysis, which is corroborated by a few experimental data.

NACA RM E51I05

COMPARISON OF HIGH-SPEED OPERATING CHARACTERISTICS OF SIZE 215 CYLINDRICAL-ROLLER BEARINGS AS DETERMINED IN TURBO-JET ENGINE AND IN LABORATORY TEST RIG. E. Fred Macks and Zolton N. Nemeth. November 1951. 33p. diagrs., photos., tab. (NACA RM E51I05)

Inner- and outer-race cooling-correlation curves were obtained for the turbojet-engine turbine-roller bearing with the same inner- and outer-race cooling-correlation parameters and exponents as those determined for the test-rig bearing. The inner- and outer-race turbine roller-bearing temperatures may be predicted from a single curve regardless of variations in speed, load, oil flow, oil inlet temperatures, oil inlet viscosity, oil-jet diameter, or any combination of these parameters.

NACA RM E51I10

ELEVATED TEMPERATURE PROPERTIES OF TITANIUM CARBIDE BASE CERAMALS CONTAINING NICKEL OR IRON: A. L. Cooper and L. E. Colteryahn. December 1951. 47p. photos., diagrs., 5 tabs. (NACA RM E51I10)

Elevated-temperature properties of titanium carbide base ceramals containing nickel or iron were determined in oxidation, modulus of rupture, tensile strength, and thermal-shock resistance. Metallographic structure was studied. These materials followed the general growth law and exhibited two stages in oxidation. The following tensile strengths were found at 2000° F; 13.3 weight percent nickel, 16,150 pounds per square inch; 11.8 weight percent iron, 12,500 pounds per square inch; unalloyed titanium carbide, 16,450 pounds per square inch. Nickel or iron additions to titanium carbide improved the thermal-shock resistance, nickel more. The path of fracture in tensile and thermal-shock specimens was found to progress approximately 50 percent intergranularly and 50 percent transgranularly.

NACA RM E51I18

FORCED-CONVECTION HEAT TRANSFER TO WATER AT HIGH PRESSURES AND TEMPERATURES IN THE NONBOILING REGION. S. J. Kaufman and R. W. Henderson. November 1951. 16p. diagrs., photos. (NACA RM E51I18)

Forced-convection heat-transfer data have been obtained for water flowing in an electrically heated tube of circular cross section at water pressures of 200 and 2000 pounds per square inch, and temperatures in the nonboiling region, for water velocities ranging between 5 and 35 feet per second. The results indicate that conventional correlations can be used to predict heat-transfer coefficients for water at pressures up to 2000 pounds per square inch and temperatures in the nonboiling region.

NACA RM E51J05

FUNDAMENTAL FLAME VELOCITIES OF PURE HYDROCARBONS. III - EXTENSION OF TUBE METHOD TO HIGH FLAME VELOCITIES - ACETYLENE-AIR MIXTURES. Oscar Levine and Melvin Gerstein. December 1951. 21p. diagrs. (NACA RM E51J05)

The tube method of measuring flame velocities has been extended to fundamental flame velocities of 141 centimeters per second. This extension was accomplished by reducing the flame-tube diameter from 25 to 12.5 millimeters. The reduction in flame-tube diameter decreased the Reynolds number of the unburned gas ahead of the flame from a turbulent to a laminar region. The gas-velocity correction in the 12.5-millimeter flame tube fits the empirical linear relation between gas velocity and spatial flame velocity previously obtained in the 25-millimeter flame tube. The ratio of the flame tube cross sectional area to the flame surface area was found to be the same constant in the 25- and the 12.5-millimeter flame tubes. A simplified equation for calculating the flame surface area from flame photographs is presented.

NACA RM E51J09

VARIATION OF THE PRESSURE LIMITS OF FLAME PROPAGATION WITH TUBE DIAMETER FOR PROPANE-AIR MIXTURES. Frank E. Belles and Dorothy M. Simon. December 1951. 17p. diagrs., tab. (NACA RM E51J09)

An investigation was made of the variation of the pressure limits of flame propagation with tube diameter for quiescent propane-air mixtures. Pressure limits were measured in glass tubes of six different inside diameters, with a precise apparatus. Critical diameters for flame propagation were calculated and the effect of pressure was determined. The critical diameters depended on the pressure to the -0.97 power for stoichiometric mixtures. The pressure dependence decreased with decreasing propane concentration. Critical diameters were related to quenching distance, flame speeds, and minimum ignition energy.

NACA TM 1316

RESISTANCE OF A PLATE IN PARALLEL FLOW AT LOW REYNOLDS NUMBERS. (Odpor podélne obtékané desky pri malých Reynoldsových číslech). Zbynek Janour. November 1951. 40p. diagrs., tab. (NACA TM 1316. Trans. from Letecký Vyzkumný Ústav, Praha, Rept. 2, 1947).

The present paper gives the results of measurements of the resistance of a plate placed parallel to the flow in the range of Reynolds numbers from 10 to 2300; in this range the resistance deviates from the formula of Blasius. The lower limit of validity of the Blasius formula is determined and also the increase

in resistance at the edges parallel to the flow in the case of a plate of finite width.

NACA TM 1319

TORSION AND BENDING OF PRISMATIC RODS OF HOLLOW RECTANGULAR SECTION. (Kruchenie i Izgib Prismaticheskikh Sterzhnei s Polym Pryamougol'nym Secheniem). B. L. Abramyan. November 1951. 24p. diagrs., 2 tabs. (NACA TM 1319. Trans. from Prikladnaya Mathematika i Mekhanika, v.14, no.3, 1950, p.265-276).

The torsion and bending of hollow rectangular beams was investigated without the requirement that the wall thickness be small compared with the transverse dimensions. The limits of applicability of the usual Bredt formula are indicated for the case of a square hollow tube in torsion. Formulas are given for bending stresses at different parts of the cross section of a hollow rectangular beam.

NACA TM 1321

RELATIONS BETWEEN THE MODULUS OF ELASTICITY OF BINARY ALLOYS AND THEIR STRUCTURE. (Beziehungen zwischen dem Elastizitatsmodul von Zweistofflegierungen und ihrem Aufbau). Werner Köster and Walter Rauscher. November 1951. 49p. diagrs. (NACA TM 1321. Trans. from Zeitschrift für Metallkunde, v.39, 1948, p.111-120. Dissertation Technische Hochschule Stuttgart, 1942).

A comprehensive survey of the elastic modulus of binary alloys as a function of the concentration is presented. Alloys that form continuous solid solutions, limited solid solutions, eutectic alloys, and alloys with intermetallic phases are investigated. Systems having the most important structures have been examined to obtain criteria for the relation between lattice structure, type of binding, and elastic behavior.

NACA TM 1326

CONCERNING THE FLOW ABOUT RING-SHAPED COWLINGS. PART II - ANNULAR BODIES OF INFINITE LENGTH WITH CIRCULATION FOR SMOOTH ENTRANCE. (Über die Strömung an ringförmigen Verkleidungen. II. Mitteilung: Ringkörper unendlicher Tiefe mit Zirkulation bei stossfreiem Eintritt). Dietrich Küchemann and Johanna Weber. November 1951. 41p. diagrs. (NACA TM 1326. Trans. from Zentrale für wissenschaftliches Berichtswesen über Luftfahrtforschung, Berlin. FB 1236/2, November 11, 1940).

The investigations carried out in a previous report (NACA TM 1325) concerning the flow about ring-shaped cowlings were extended by taking a circulation about the cowling into consideration. The present second report treats bodies of infinite length with approximately smooth entrance. The circulation was caused by distributing vortex rings of constant density over a stream surface extending to infinity. Furthermore, the influence of a hub body on such cowlings was dealt with. The examples treated are meant to give to the designer a basis for his design.

BRITISH REPORTS

N-11151*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) VARSITY T. MK.1 VX.835 (2 x HERCULES 265). MEASURED LANDINGS. August 14, 1951. 6p. curves, tab. (AAEE Rept. A.A.E.E./873, pt.15)

Using a glide approach with full flap at 85 knots I.A.S., the landing distances were 365 yards from 50 feet to touchdown, and a further 600 yards from touchdown to stop, the values being corrected to an aircraft weight of 36,000 pounds to I.C.A.N. sea-level conditions, on a level tarmac runway. It was considered, however, that the use of full braking during these landing runs was to some extent prejudiced by the harshness of the brake control combined with the need to minimize the occurrence of tire slip (or wheel locking).

N-11236*

Royal Aircraft Establishment (Gt. Brit.) THE THEORETICAL WAVE DRAG OF SOME BODIES OF REVOLUTION. L. E. Fraenkel. May 1951. 41p. diagrs., tab. (RAE Aero 2420)

The results of linearized theory for the wave drag of bodies of revolution are applied to bodies whose profiles (meridian sections) are either straight or parabolic arcs. Forebody and afterbody drag are examined; a reversibility theorem is established; and the interference effect of the forebody on the afterbody is investigated. Two different types of approximation are considered and their results are compared.

N-11238*

Royal Aircraft Establishment (Gt. Brit.) GUST ALLEVIATION FACTOR. J. Zbrozek. May 1951. 45p. diagrs. (RAE Aero 2421)

Presents theoretical calculations of gust alleviation factor made for rigid aircraft and with one degree of freedom only (that is, vertical motion). It is shown that for average gust lengths and for orthodox (tailed) aircraft the influence of the second degree of freedom (that is, pitching) on the value of the gust alleviation factor is negligibly small, providing the pitching moment of inertia is not unduly small. The influence of aspect ratio, the importance of the mass parameter, and the gust shape on the values of the gust alleviation factor are shown. The large influence of the gust shape on the value of the alleviation factor makes the gust analysis by simple measurements of maximum aircraft acceleration inadequate, and the full records of the time history of the aircraft are necessary. An alternative, more direct method of gust measurements is suggested.

N-11396*

Royal Aircraft Establishment (Gt. Brit.)
FATIGUE TESTS ON SPECIMENS FROM DTD.364 'Z' SECTION EXTRUSIONS. M. S. Binning and J. T. Ballett. May 1951. 21p. photos., diagrs., 3 tabs. (RAE Tech. Note Met.138)

Fatigue tests were made of extruded "Z" section stringers in fluctuating tension in order to ascertain the effect of surface finishes and stress raisers. The material was made to the specification DTD.364.

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NACA TN 2445

WIND-TUNNEL TESTS AT LOW SPEED OF SWEPT AND YAWED WINGS HAVING VARIOUS PLAN FORMS. Paul E. Purser and M. Leroy Spearman. December 1951. 82p. diagrs., photos., 2 tabs. (NACA TN 2445. Formerly RM L7D23)

Results are presented of wind-tunnel tests made at low speed of various small-scale models of sweptback, sweptforward, and yawed wings. The tests covered changes in aspect ratio, taper ratio, and tip shape. Some data were obtained with high-lift devices on sweptback wings and with ailerons on sweptforward wings. The data have been briefly analyzed and some comparisons have been made with the available theory.

NACA TN 2553

PITCHING-MOMENT DERIVATIVES C_{m_q} AND $C_{m_{\dot{\alpha}}}$ AT SUPERSONIC SPEEDS FOR A SLENDER-DELTA-WING AND SLENDER-BODY COMBINATION AND APPROXIMATE SOLUTIONS FOR BROAD-DELTA-WING AND SLENDER-BODY COMBINATIONS. Arthur Henderson, Jr. December 1951. 29p. diagrs. (NACA TN 2553)

The pitching-moment derivatives C_{m_q} and $C_{m_{\dot{\alpha}}}$ for supersonic speeds are developed for a slender-delta-wing and slender-body combination having no afterbody. By drawing an analogy between the aerodynamics of the wing-body section of the configuration and the aerodynamics of a delta wing alone, the results for the slender-delta-wing and slender-body combination are modified to the extent that approximate solutions for C_{m_q} and $C_{m_{\dot{\alpha}}}$ for broad-delta-wing and slender-body combinations can be obtained.

NACA TN 2563

EXPERIMENTAL INVESTIGATION OF ROLLING PERFORMANCE OF STRAIGHT AND SWEPTBACK FLEXIBLE WINGS WITH VARIOUS AILERONS. Henry A. Cole, Jr. and Victor M. Ganzer, University of Washington. December 1951. 45p. diagrs., photos., 2 tabs. (NACA TN 2563)

An experimental investigation was conducted to determine the performance in roll of two flexible wings, one swept back 45° and the other unswept. Rolling moments due to aileron deflection, damping derivatives in roll, and free-rolling angular velocities due to aileron deflection were obtained at various speeds including, when possible, the aileron reversal speed.

NACA TN 2568

EFFECT OF SLIP ON FLOW NEAR A STAGNATION POINT AND IN A BOUNDARY LAYER. T. C. Lin and S. A. Schaaf, University of California. December 1951. 28p. diagrs. (NACA TN 2568)

Theoretical analyses are presented of the effect of slip on the flow of a rarefied gas near a stagnation point and in a boundary layer on a flat plate. The results indicate that the stagnation pressure is increased because of the effect of slip but that there is a negligible effect on the flat-plate skin-friction coefficient in the range of application of the analysis.

NACA TN 2572

CERAMIC COATINGS FOR PREVENTION OF CARBON ABSORPTION IN FOUR HEAT-RESISTANT ALLOYS. Joseph W. Pitts and Dwight G. Moore, National Bureau of Standards. December 1951. 14p. diagr., photos., 3 tabs. (NACA TN 2572)

Three ceramic coatings were applied to four heat-resistant alloys (three types of 18-8 stainless steel and Inconel) and then tested for their effectiveness in preventing carbon absorption after box carburizing for 4 hours at 1350° to 1650° F. Carbon absorption that occurred on uncoated specimens at these conditions was inhibited by the application of a ceramic coating. The coating apparently seals the surface of the alloy from carburizing gases and thus prevents carbon pickup and resulting precipitation of carbides at or near the grain boundaries.

NACA TN 2576

A STUDY OF SLIP FORMATION IN POLYCRYSTALLINE ALUMINUM. Aldie E. Johnson, Jr. and S. B. Batdorf. December 1951. 18p. photos., diagr., tab. (NACA TN 2576)

Experimental results are presented which shed light on the assumptions that have been made in several attempts to bridge the gap between the physical and mathematical theories of plasticity. The experimental results are compatible with, but do not necessarily verify, the conception that plastic deformation in strain-hardening materials is primarily due to slip. Slip was observed to occur first in a few iso-

lated grains and to spread gradually to adjacent grains as the stress level increased. The occurrence and spread of the slip lines suggested independent behavior of randomly oriented grains at low stress levels with interaction among grains increasing as the stress level increased.

NACA TN 2577

ON THE ANGULAR DISTRIBUTION OF SLIP LINES IN POLYCRYSTALLINE ALUMINUM ALLOY. John M. Hedgepeth, S. B. Batdorf and J. Lyell Sanders, Jr. December 1951. 18p. photos., diagrs., tab. (NACA TN 2577)

A rather wide distribution in the angular orientation of slip lines is generally observed in various grains of a metal subjected to plastic deformation. The relative frequency of occurrence of any given slip line angle for the case of simple tension has been derived on the basis of a model of a plastically deforming polycrystal that was recently used as the basis of a theory of polyaxial stress-strain relations (the so-called slip theory of plasticity). The results are compared with experiment and conclusions are drawn as to the limitations of the model.

NACA TN 2583

A SEMIEMPIRICAL PROCEDURE FOR COMPUTING THE WATER-PRESSURE DISTRIBUTION ON FLAT AND V-BOTTOM PRISMATIC SURFACES DURING IMPACT OR PLANING. Robert F. Smiley. December 1951. 28p. diagrs. (NACA TN 2583)

A semiempirical procedure is presented for computing the water-pressure distribution on flat and V-bottom prismatic surfaces during planing or landings. For the rectangular flat plate, calculated and experimental pressure distributions are in good agreement for trims below 30° and for wetted-length-beam ratios at least up to 3.3. For the case of a V-bottom prismatic surface with appreciable chine immersion, the pressures on chine-immersed sections of a model having an angle of dead rise of 30° are similar to those on the corresponding flat plate so that a simple modification of the flat-plate procedure can be used to predict approximately the pressures on V-bottom surfaces.

NACA TN 2584

AN ANALYSIS OF THE FLOW IN THE ROTATING PASSAGE OF LARGE RADIAL-INLET CENTRIFUGAL COMPRESSOR AT A TIP SPEED OF 700 FEET PER SECOND. Vasily D. Prian and Donald J. Michel. December 1951. 46p. diagrs., photo., tab. (NACA TN 2584)

An analysis of the flow in the rotating passage of a 48-inch diameter radial-inlet centrifugal impeller at a tip speed of 700 feet per second indicated that a region of low efficiency generally existed along the trailing face as a result of a combination of shifting of low energy air toward the trailing face and losses arising from the decelerations along the trailing face. Because of the comparatively large viscous losses along the trailing face, and with the unloading of the blades, the velocity at the driving face tip was higher than the trailing face tip. This velocity difference would be expected to result in mixing losses upon diffusion of the air. The theoretically predicted eddy on the driving face was not found experimentally. Modification of the theoretical entrance angle of flow for the first 15 percent of the passage gave fair agreement between the theoretical and experimental static pressures at off-design conditions except for the maximum flow conditions.

NACA RM E51J12

SPARK IGNITION OF FLOWING GASES. II - EFFECT OF ELECTRODE PARAMETERS ON ENERGY REQUIRED TO IGNITE A PROPANE-AIR MIXTURE. Clyde C. Swett, Jr. December 1951. 26p. diagrs., photos. (NACA RM E51J12)

The effect of electrode spacing, configuration, and material on the energy required for ignition of a propane-air mixture at a pressure of 3 inches mercury absolute was determined. The energy required decreased and then increased as the spacing was increased; a minimum occurred at a spacing of 0.65 inch. Small-diameter electrodes required less energy than large-diameter electrodes if the spacing was less than optimum; at the spacing of 0.65 inch no differences were observed. Glow discharges required more energy for ignition than the arc-glow discharges; with glow discharges the effect of electrode material was negligible. A determination of the energy distribution along the discharge showed one-third to one-half of the energy to be concentrated in a small region near the cathode and the remainder uniformly distributed across the spark gap. Long-duration (600-microsec) sparks required much less energy than the short-duration (1-microsec) sparks.

BRITISH REPORTS

N-11394*

Royal Aircraft Establishment (Gt. Brit.) COMPARATIVE CORROSION TESTS ON MAGNESIUM ALLOY PARTS AND ALUMINUM ALLOY PARTS OF ELECTRICAL EQUIPMENT IN SALT FOG, AND CORROSION TESTS ON MAGNESIUM ALLOY CASTINGS IN A HUMIDITY CHAMBER. R. F. Sims and E. C. Railton. January 1951. 11p. photos. (RAE Tech. Note EL. 20)

Comparative tests under severe salt-fog conditions show that corrosion of properly treated magnesium alloys is no worse than that of aluminum alloys. Since aluminum has been widely used for parts of electrical equipment in sea-going aircraft, it should be possible to use magnesium alloy parts for similar purposes and so save weight. Points at which other metals contact the magnesium will need careful protection, however, if corrosion is to be avoided.

N-11395*

Royal Aircraft Establishment (Gt. Brit.)
GRAPHITE LUBRICATION AND THE WEAR OF CARBON BRUSHES AT HIGH ALTITUDES. R. F. Sims. April 1951. 19p. diagrs. (RAE Tech. Note EL. 24)

The lubricity of graphite in normal atmospheric conditions is shown to be due to absorbed films of water. In dry atmospheres the water films are not maintained and where graphite brushes are running on commutators, seizure occurs, with resultant high rates of wear. Brushes may be treated with substances e. g. some metallic halides, which partly replace the water film, but their performance in extremely dry conditions depends critically on previous running of the bursh with the commutator in moist conditions.

N-11439*

Forest Products Research Lab. (Gt. Brit.)
STRAY FIELD HEATING. P. M. C. Lacey, H. A. Howe and G. E. Soane. (Progress Rept. 8.) June 1951. 16p. diagrs., photo. (Forest Products Research Lab.)

The object of the present investigation was to assess the relative effectiveness of the basic electrode patterns, and where possible, to determine the most efficient relative conditions.

N-11475*

Forest Products Research Lab. (Gt. Brit.)
RADIO FREQUENCY AND OTHER HEATING PROCESSES. A CALORIMETRIC METHOD OF ASSESSMENT OF THE R. F. CONDUCTIVITY OF GLUES. P. M. C. Lacey and G. E. Soane. (Progress Rept. 9.) August 1951. 8p. diagrs. (Forest Products Research Lab.)

The radio frequency conductivity of a number of synthetic resin glues has been determined over a wide range of temperature, to an accuracy of about ±15 percent by a calorimetric method, and compared with the voltages needed to set the same glues in wood joints. It is concluded that conductivity is not a reliable guide to set voltage.

N-11511*

Aeronautical Research Council (Gt. Brit.)
NOTES ON DEFINITIONS OF AND NOMENCLATURE FOR AIR SPEEDS. Staff of the Aeroplane and Armament Experimental Establishment. November 22, 1950. 7p. (ARC CP 49; ARC 13, 570, app.)

Definitions and nomenclature for air speeds adopted by the British Standard Glossary of Aeronautical Terms, the Royal Aeronautical Society, the Air Ministry, the United States (NACA TR 837), and the International Civil Aviation Organization are discussed and comment is made on the possibility of confusion between them.

N-11512*

Aeronautical Research Council (Gt. Brit.)
DATA ON FLIGHT LOADS OBTAINED WITH MILLER RECORDING EQUIPMENT, WITH PARTICULAR REFERENCE TO TEST FLIGHTS IN LANCASTER PD. 119. Anne Burns. 1951. 34p. diagrs., tab. (ARC CP 48; ARC 12, 796)

A technique is presented for using Miller recording equipment to obtain satistical data on flight loads. The technique includes modifying the equipment and taking sample records of the flight loads. Considerable labor is required to extract statistical data from the records, and Miller recording equipment should only be used until more suitable equipment has been developed.

N-11513*

Aeronautical Research Council (Gt. Brit.)
DYNAMIC STABILITY OF THE HELICOPTER: THE EQUATIONS OF MOTION. A. H. Yates. 1951. 7p. 2 tabs. (ARC CP 47; ARC 13, 682)

The equations of motion, as used in calculations of the dynamic stability of the helicopter, are stated here. They are reduced to dimensionless form and the expanded forms of the coefficients of the determinatal equations are given.

N-11514*

Aeronautical Research Council (Gt. Brit.)
CALCULATION OF THE DAMPING FOR ROLLING OSCILLATIONS OF A SWEPT WING. Doris E. Lehrian. 1951. 10p. diagrs., tab. (ARC CP 51; ARC 13, 448)

The damping derivative for rolling oscillations of a swept and an unswept wing, each of aspect ratio 6 is calculated for a range of frequency parameter values. Good agreement with experiment is obtained for the larger values of the frequency parameter. For the lower values the results diverge slightly; this difference may be partly due to the approximations made in the calculation, and partly due to the greater importance of tunnel wall interference effects as the frequency parameter tends to zero.

N-11515*

Aeronautical Research Council (Gt. Brit.)
THE MEASUREMENT OF THE DERIVATIVE Z_W FOR AN OSCILLATING AEROFOIL. A. L. Buchan, K. D. Harris and P. M. Somervail. 1951. 32p. diagrs. (ARC CP 52; ARC 13, 548)

This report presents the results of experimental measurements of the damping coefficient z_w for constant-chord rigid wings of various aspect ratios having sweepback angles of zero and 45°.

N-11516*

Aeronautical Research Council (Gt. Brit.)
LIST OF CURRENT PAPERS. (NOS. 1-50) July 1951. 5p. (ARC CP 50)

Contains a list of the current papers published by the Aeronautical Research Council.

N-11517*

Aeronautical Research Council (Gt. Brit.)
OBSERVATIONS OF THE INTERACTION BETWEEN THE SHOCK WAVES AND BOUNDARY LAYERS AT THE TRAILING EDGES OF AEROFOILS IN SUPERSONIC FLOW. D. W. Holder and R. J. North. December 28, 1950. 12p. photos., diagrs. (ARC CP 53; ARC 13,621)

Photographs have been taken of the flow at the trailing edges of three unyawed, two-dimensional airfoils placed in an airstream moving with a Mach number of 1.6 and giving a Reynolds number (based on chord) of 0.8×10^6. It is found that the conditions close to the trailing edge depend on the strength of the trailing-edge shock, particularly if the boundary layer is laminar ahead of the shock.

UNPUBLISHED PAPERS

N-3221*

Guggenheim Airship Institute.
DROPLET INTERCEPTION INVESTIGATION UPON VARIOUS AIRFOIL SECTIONS AT ABOVE FREEZING TEMPERATURES. Clarence Hofelt, Jr. and George Batiuk. June 1949. vi, 100p. diagrs., photos., 14 tabs. (Guggenheim Airship Inst. Rept. 159)

A whirling-arm technique and a calorimetric method for measuring droplet interception were investigated. Representative models varying section and aspect ratio were used. The test data indicated the effect of change in pitch angle, lift coefficient and velocity. The tests furnished data which can later be compared with wind tunnel test data. The cylinder test data can be compared with previously made theoretical studies.

N-5558*

Calif. Inst. of Tech. Guggenheim Aeronautical Lab.
MEAN-SPEED MEASUREMENTS IN TWO-DIMENSIONAL, INCOMPRESSIBLE, FULLY-DEVELOPED TURBULENT CHANNEL FLOW. George T. Skinner. 1950. 44p. diagrs. (Calif. Inst. of Tech. Guggenheim Aeronautical Lab.)

Mean velocity profiles were measured in a 5-inch by 60-inch wind channel by the use of a hot-wire anemometer. Repeatability of results was established and accuracy of the instrumentation was estimated. A little scatter may have been caused by humidity variations and slight flow unsteadiness. Irregularities of a hot-wire in close proximity to a solid boundary at low speeds were observed. It was found that Kármán's logarithmic law holds reasonably well. The values of the constants for the law for the best over-all agreement were determined and compared with those obtained by others.

N-6783*

Harvard U.
INVESTIGATION OF THE STRUCTURAL CHARACTERISTICS OF TAPERED SWEPTBACK WINGS. Phrixos J. Theodorides. (Final rept.) February 10, 1951. 133p. diagrs., photos., 6 tabs. (Harvard U.)

Tests to determine the structural characteristics of tapered sweptback wings are compared here with theory. The models were symmetrical wing boxes of semimonocoque riveted construction. They differed only in sweep angles which were 0°, 40°, and 60° of the quarter-chord line. All results are reported in tables. Some results are plotted and discussed.

N-12273*

GENERAL THEORY OF APPROXIMATION METHODS OF ANALYSIS. (K obshchei teorii priblizhennykh metodov analiza). L. V. Kantorovich. 8p. (Trans. from Akademiia Nauk SSSR, Doklady, v. 60, no. 6, May 1949, p. 957-960).

This is a general approach to the divising of methods of the solution of various problems of analysis associated with differential equations, ordinary and partial integral equations, or infinite algebraic systems. A general theory of approximation methods of analysis which arises from this study is presented.

N-12274*

ON INTEGRATION IN QUADRATURES OF EQUATION OF PLANE UNIFORM PROBLEM OF THEORY OF PLASTICITY WITH ACCOUNT TAKEN OF HARDENING OF MATERIAL. (Ob integrirovanii v kvadraturakh uravnenii ploskoi odnomernoi zadachi teorii plastichnosti s uchentom uprochneniya materiala). G. S. Shapiro. 7p. diagrs. (Trans. from Prikladnaia Matematika i Mekhanika, v. 13, Nov.-Dec., 1949, p. 659-662).

It is shown that the equations of the plane uniform problem of the theory of plasticity with account taken of the hardening of the material for the plane stress state and for plane deformation can be integrated in quadratures if the material is assumed to be incompressible. In the first case the result is obtained with the aid of approximate expressions for the intensity of the stresses and deformations.

National Advisory Committee for Aeronautics

Research Abstracts

NO. 15 JANUARY 15 , 1952

CURRENT NACA REPORTS

NACA Rept. 1012

INVESTIGATION OF THE NACA 4-(5)(08)-03 AND NACA 4-(10)(08)-03 TWO-BLADE PROPELLERS AT FORWARD MACH NUMBERS TO 0.725 TO DETERMINE THE EFFECTS OF CAMBER AND COMPRESSIBILITY ON PERFORMANCE. James B. Delano. 1951. 31p. photos., diagrs. (NACA Rept. 1012. Formerly ACR L5F15)

The effects of blade section and camber and compressibility on propeller characteristics are presented for forward Mach numbers from 0.165 to 0.725 for blade angles from 20° to 60°. The camber-range investigated corresponds to section design lift coefficients of 0.3, 0.5, and 1.0.

NACA TN 2508

LANDING CHARACTERISTICS IN WAVES OF THREE DYNAMIC MODELS OF FLYING BOATS. James M. Benson, Robert F. Havens and David R. Woodward. January 1952. 41p. diagrs., photo., 2 tabs. (NACA TN 2508. Formerly RM L6L13)

Powered models of three different flying boats were landed in oncoming waves of various heights and lengths. The effects of varying the trim at landing, the deceleration after landing, and the size of the waves were determined. Data are presented on the motions and accelerations obtained during landings in rough water.

NACA TN 2538

MECHANICAL AND CORROSION TESTS OF SPOT-WELDED ALUMINUM ALLOYS. Fred M. Reinhart, National Bureau of Standards, and W. F. Hess, R. A. Wyant, F. J. Winsor and R. R. Nash, Rensselaer Polytechnic Institute. December 1951. 74p. diagrs., photos., 19 tabs. (NACA TN 2538)

Corrosion behavior of spot-welded aluminum-alloy (alclad 24S-T3, 24S-T3, alclad XB75S-T6, XB75S-T6, and R-301-T6) panels of varying weld quality was determined. Tidewater and weather exposure tests were made and the results were evaluated largely in terms of distribution of corrosion products and effects on weld strength. Metallographic examinations of several of the alloys were also made to determine the extent and type of corrosion attack associated with various welding and exposure conditions.

NACA TN 2573

DEVELOPMENT OF AUXILIARY CYCLOTRON EQUIPMENT FOR USING TRITIUM AS BOMBARDING PARTICLES IN A CYCLOTRON. D. N. Kundu, F. G. Boyle and M. L. Pool, Ohio State University. December 1951. 19p. diagrs. (NACA TN 2573)

A circulating system for radioactive tritium was constructed, assembled, and tested. The results showed that the pumping speed of the system was too low for use. With a sufficiently increased pumping speed, it is believed that the circulating system would provide satisfactory operation.

NACA TN 2574

THEORETICAL ANALYSIS OF SOME SIMPLE TYPES OF ACCELERATION RESTRICTORS. William H. Phillips. December 1951. 35p. diagrs., 2 tabs. (NACA TN 2574)

Acceleration restrictors which work on the principle of stopping the upward motion of the elevator when the signal from an acceleration-sensing device reaches a certain value have been analyzed for representative fighter and transport airplanes over a range of altitude and center-of-gravity positions.

NACA TN 2575

A FLIGHT INVESTIGATION OF THE EFFECT OF CENTER-OF-GRAVITY LOCATION ON GUST LOADS. Jack Funk and Earle T. Binckley. December 1951. 18p. diagrs., 3 tabs. (NACA TN 2575)

Two jet-propelled airplanes were flown in rough air to investigate the effects of center-of-gravity location on gust loads. Data were obtained at centers of gravity of 20.9 and 27.5 percent mean aerodynamic chord for incremental load factor up to 1 g. The results indicate that a 6.6-percent forward movement of center of gravity decreases the gust loads by approximately 10 percent. The most frequently occurring distance from 1 g to peak acceleration was 17.5 chords. Calculations of the change in normal acceleration for a center-of-gravity movement from 20.9 to 27.5 percent mean aerodynamic chord for a single triangular gust having a gradient distance of 17.5 chords were in good agreement with the test results.

NACA TN 2581

DEFLECTIONS OF A SIMPLY SUPPORTED RECTANGULAR SANDWICH PLATE SUBJECTED TO TRANSVERSE LOADS. Kuo Tai Yen, Sadettin Gunturkun and Frederick V. Pohle, Polytechnic

*AVAILABLE ON LOAN ONLY.

ADDRESS REQUESTS FOR DOCUMENTS TO NACA, 1724 F ST., NW., WASHINGTON 25, D. C., CITING CODE NUMBER, TITLE AND AUTHOR.

Institute of Brooklyn. December 1951. 39p. curves, diagrs., 3 tabs. (NACA TN 2581)

The differential equations of the bending of sandwich plates were integrated to obtain the deflections when the four edges of the plate are simply supported and the loading consists of either a uniformly distributed transverse load or a concentrated load applied at the center of the panel. The deflection patterns are shown in diagrams and the maximum deflection of the plate is presented in a number of graphs.

NACA TN 2582

GENERAL CONSIDERATION OF PROBLEMS IN COMPRESSIBLE FLOW USING THE HODOGRAPH METHOD. Chieh-Chien Chang, Johns Hopkins University. January 1952. 113p. diagrs. (NACA TN 2582)

This is an investigation of the hodograph method as it is applied in general to the problem of compressible flow. The hodograph equations are given in various canonical forms convenient for obtaining solutions in the different flow regimes. However, since the coefficients of the canonical differential equations are implicit functions and therefore exact solutions are difficult to find, different approximations are chosen so that simpler differential equations can be obtained. The detailed development is concentrated on Chaplygin's second equation. The first-order approximation is well known as the Tricomi equation; the second- and third-order approximations follow the exact gas law closely in the neighborhood of sonic velocity. The flow through an aperture is reexamined by comparing the present approximate relation with the exact Chaplygin solutions.

NACA TN 2586

FUNDAMENTAL EFFECTS OF COLD-WORK ON SOME COBALT-CHROMIUM-NICKEL-IRON BASE CREEP-RESISTANT ALLOYS. D. N. Frey, J. W. Freeman and A. E. White, University of Michigan. January 1952. 12p. diagrs. (NACA TN 2586)

The influence of cold-working on creep properties of an alloy containing 20-percent cobalt, 20-percent chromium, 20-percent nickel, and the balance iron and on the same alloy modified by small additions of tungsten alone or tungsten, molybdenum, and columbium in combination was studied. Effects of cold-working on creep resistance were the same for all alloys studied for temperatures up to 1600° F and reductions between 15 and 40 percent. Conclusions were reached by studying creep properties and also internal stress relaxation at test temperatures which previous work had shown to be the controlling factor in response of such alloys to cold-working.

NACA TN 2587

INFLUENCE OF WING AND FUSELAGE ON THE VERTICAL-TAIL CONTRIBUTION TO THE LOW-SPEED ROLLING DERIVATIVES OF MIDWING AIRPLANE MODELS WITH 45° SWEPTBACK SURFACES. Walter D. Wolhart. December 1951. 55p. diagrs., photo., 3 tabs. (NACA TN 2587)

Results are presented of an investigation to determine the influence of the wing and fuselage on the vertical-tail contribution to the rolling derivatives of midwing airplane models with 45° sweptback surfaces. Comparisons are also made between measured and calculated vertical-tail contributions to the rolling derivatives which include corrections for the effect of fuselage and wing sidewash due to roll.

NACA TN 2589

AN ANALYTICAL INVESTIGATION USING AERODYNAMIC LIMITATIONS OF SEVERAL DESIGNS OF HIGH STAGE PRESSURE RATIO MULTISTAGE COMPRESSORS. Charles H. Voit and Arthur R. Thomson. December 1951. 56p. diagrs., 2 tabs. (NACA TN 2589)

An analysis of the effect of the principal design variables on the stagewise design-point characteristics of axial-flow compressors having high average stage pressure ratios was made. The investigation considered certain design limits and the manner in which they are affected by the principal design variables. Optimum stagewise variations of axial velocity and relative inlet-air angle were determined. An estimate was made of the obtainable over-all total pressure ratio by the use of several stagewise distributions of these variables.

NACA TN 2595

DESIGN OF TWO-DIMENSIONAL CHANNELS WITH PRESCRIBED VELOCITY DISTRIBUTIONS ALONG THE CHANNEL WALLS. II - SOLUTION BY GREEN'S FUNCTION. John D. Stanitz. January 1952. 35p. diagrs., 2 tabs. (NACA TN 2595)

Methods of solution by Green's function are developed for the design of two-dimensional unbranched channels with prescribed velocities as a function of arc length along the channel walls. The methods apply to incompressible and linearized compressible, nonviscous irrotational flow. One numerical example is presented for an accelerating elbow with linearized compressible flow. The elbow shape obtained from the solution by Green's function is the same as that obtained from a solution by relaxation methods for the same prescribed conditions. The time required for the calculations is considerably less for solutions by Green's function.

NACA TM 1327

CONCERNING THE FLOW ABOUT RING-SHAPED COWLINGS. PART VI - FURTHER MEASUREMENTS ON INLET DEVICES. (Uber die Strömung an ringförmigen Verkleidungen. VI. Mitteilung: Weitere Messungen an Einlaufgeräten). Dietrich Kuchemann and Johanna Weber. December 1951. 21p. diagrs. (NACA TM 1327. Trans. from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin. FB 1236/6, March 30, 1942).

The present report presents as a supplement to the fourth report (available as ATI 50545, Air Materiel Command) in the series of investigations concerning the flow about ring-shaped cowlings further wind-

tunnel measurements on inlet devices which are to show the influence of the radius of the nose of the cowling on the flow conditions. Moreover, a simple rule for the design of such arrangements, containing a hub in the interior, is suggested.

UNPUBLISHED PAPERS

N-1873*

A THEORETICAL AND EXPERIMENTAL INVESTIGATION OF PLATES REINFORCED BY RIBS. (Di una ricerca teoricosperimentale sulle piastre con nervature). Elio Giangreco. August 1951. 24p. diagrs., photos. (Trans. from Ingegnere, no.3, March 1950, 8p.).

An experimental investigation of the static reaction of plates reinforced by ribs was made. Results were compared with the theoretical method of Tolotti and Grioli in which several simplifying empirical assumptions of the load distribution were eliminated. Further comparisons were made with a theoretical method usually employed by engineers in which the appraisal of the load transmitted by the plate on the ribs is made by concentrating on the point of intersection of the beams the load acting on a square of equal sides to those of the mesh of the grid and therefore independent of the assumedly effective flange width.

N-3875 *

CERTAIN FUNDAMENTAL PROBLEMS IN THE THEORY OF PLASTICITY. (Nekotorie Osnovnye Zadachi Teorii Plastichnosti). A. A. Ilyushin. THE PROBLEM OF STRENGTH IN MACHINE CONSTRUCTION. (Problema Prochnosti v Mashinostroenii). I. A. Oding. 48p. (Trans. from Akademiia Nauk SSSR, Izvestiia, Otdelenie Tekynicheskikh Nauk, no. 12, December 1949, p. 1753-1787).

The first paper considers the methods for investigating plasticity and critiques the theory of plasticity and the basic problems of plasticity. The second paper discusses the problem of strength in machine design. It includes information on the strength of metals under conditions of cyclic loading and conditions of high temperature.

N-10899*

THIRD APPROXIMATION OF THIN-WING EXPANSION METHOD FOR COMPRESSIBLE FLUIDS. (Chijimu Ryūtai ni Okeru Hakyuokudenkaiho no Dai San Kinji). Isao Imai and Seiichi Oyama. 7p. (Trans. from Tokyo (Imperial) Univ., Institute of Science and Technology, Reports, v. 2, no. 3-4, Mar. -Apr., 1948, p. 37-39).

In a previous paper the thin-wing expansion method was developed with the object of perfecting the two-dimensional wing theory and at that time the computation was carried only to the second approximation. In the present paper the computation is carried to the third approximation and the reader is referred to the previous report for the details of the method. As a concrete example, the flow past a sine-wave shaped wall was investigated and the results are presented herein.

N-10900*

APPROXIMATE SOLUTION TO VISCOUS FLOW AT LOW SPEEDS. I. FLOW PAST CIRCULAR CYLINDER. (Nenseiryutai No Osoi Nagare Ni Taisuru Hitotsu No Kinji Kaiho). Mitsutoshi Kawaguchi. 12p. diagrs., 2 tabs. (Trans. from Tokyo (Imperial) Univ., Institute of Science and Technology, Reports, v. 2, no. 3-4, Mar. -Apr., 1948, p. 33-37).

The stream function for $R = 10$ to $R = 20$ is analytically studied by developing it into a finite number of terms in order to approximately satisfy the Navier-Stokes equation. The results thus obtained may be considered to agree fairly well with experimental results. In the second approximation there was added the condition that the derivative of the equation of motion is satisfied at $r = 1$ but the approximation became impaired for $R > 20$.

Recd. from H. Cross 5/25/53

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National Advisory Committee for Aeronautics

Research Abstracts

NO.17 FEBRUARY 19, 1952

CURRENT NACA REPORTS

NACA Rept. 1010

A RECURRENCE MATRIX SOLUTION FOR THE DYNAMIC RESPONSE OF AIRCRAFT IN GUSTS. John C. Houbolt. 1951. ii, 31p. diagrs., 7 tabs. (NACA Rept. 1010. Formerly NACA TN 2060)

Through the use of different equations and matrix notation a systematic procedure is developed for the calculation of the structural response of an aircraft flying through a gust. The method takes into account wing bending and twisting flexibilities, fuselage flexibility, vertical and pitching motion of the airplane, and some tail forces. Strip theory is used, but approximate three-dimensional and compressibility corrections can be made without difficulty. Either sharp-edge or arbitrary gusts may be treated.

NACA Rept. 1021

ANALYSIS OF PLANE-PLASTIC-STRESS PROBLEMS WITH AXIAL SYMMETRY IN STRAIN-HARDENING RANGE. M. H. Lee Wu. 1951. ii, 23p. diagrs. (NACA Rept. 1021. Formerly NACA TN 2217)

A method, based on the deformation theory and employing the finite-strain concept, was developed to solve plane-stress problems in the strain-hardening range of circular membrane, rotating disk, and infinite plate with circular hole. Distributions of octahedral shear strain, as well as principal stresses and strains, were obtained. Results show that: (1) Ratios of principal stresses remain essentially constant during loading; (2) distributions of strain in the plastic case are less uniform than in the elastic case, although distributions of stress are more uniform; (3) the deformation that can be accepted by the member depends mainly on the maximum octahedral shear strain of the material; and (4) the added load that the member can sustain between the onset of yielding and failure depends on octahedral shear stress-strain relation of the material.

NACA Rept. 1022

TEMPERATURE DISTRIBUTION IN INTERNALLY HEATED WALLS OF HEAT EXCHANGERS COMPOSED OF NONCIRCULAR FLOW PASSAGES. E. R. G. Eckert and George M. Low. 1951. ii, 14p. diagrs. (NACA Rept. 1022. Formerly TN 2257)

A method for the determination of circumferential temperature distributions and heat-transfer characteristics of heat exchangers composed of polygonal flow passages is developed. The passage walls are heated uniformly by internal heat sources and the coolant flow within the passages is turbulent. Applications of the method to heat exchangers with rectangular and triangular passages are presented.

NACA Rept. 1023

DIFFUSION OF CHROMIUM IN ALPHA COBALT-CHROMIUM SOLID SOLUTIONS. John W. Weeton. 1951. ii, 15p. diagrs., photos., tab. (NACA Rept. 1023. Formerly TN 2218)

Diffusion of chromium in α coblat-chromium solid solutions was investigated in the range of 0 to 40 atomic percent at temperatures of 1360°, 1300°, 1150°, and 1000° C. The activation heat of diffusion was determined to be 63,600 calories per mole and the equation relating diffusion D and temperature T is $D = 0.443\, e^{-\frac{63,600}{RT}}$ where R is the gas constant. When compared with most alloy systems for which diffusion data have been previously obtained, the diffusion rates of chromium in α colbalt-chromium solid solutions were found to be low.

NACA TN 2435

DIRECT-READING DESIGN CHARTS FOR 75S-T6 ALUMINUM-ALLOY FLAT COMPRESSION PANELS HAVING LONGITUDINAL EXTRUDED Z-SECTION STIFFENERS. William A. Hickman and Norris F. Dow. February 1952. 60p. diagrs., photos., 8 tabs. (NACA TN 2435)

Direct-reading design charts are presented for 75S-T6 aluminum-alloy flat compression panels having longitudinal extruded Z-section stiffeners. These charts, which cover a wide range of proportions, make possible the direct determination of the stress and all panel dimensions required to carry a given intensity of loading with a given skin thickness and effective length of panel.

NACA TN 2459

SOME EFFECTS OF VARYING THE DAMPING IN PITCH AND ROLL ON THE FLYING QUALITIES OF A SMALL SINGLE-ROTOR HELICOPTER. John P. Reeder and James B. Whitten. January 1952. 23p. diagrs., photos., 4 tabs. (NACA TN 2459)

Flight-test measurements and pilots' opinions of the

longitudinal flying qualities and lateral control characteristics of a small single-rotor helicopter are presented in which the damping of the helicopter in pitch and roll was varied by means of a rate sensitive automatic-control device from the amount present in the helicopter with the device inoperative to nearly three times that amount.

NACA TN 2481

HYDRODYNAMIC CHARACTERISTICS OF A LOW-DRAG, PLANING-TAIL FLYING-BOAT HULL. Henry B. Suydam. January 1952. 20p. diagrs., photo., tab. (NACA TN 2481. Formerly RM L7I10)

The hydrodynamic characteristics, as determined from model tests of a planing-tail, flying-boat hull that was found to have very low air drag, are described and these characteristics are compared with the hydrodynamic characteristics of a comparable conventional type of hull. The planing-tail hull was found to have generally greater take-off stability than the conventional type of hull, as well as having improved landing stability. The hydrodynamic resistance was lower for the planing-tail hull than for the conventional type of hull, and the load-resistance ratio was higher for the planing-tail hull.

NACA TN 2483

EFFECT OF FUSELAGE AND TAIL SURFACES ON LOW-SPEED YAWING CHARACTERISTICS OF A SWEPT-WING MODEL AS DETERMINED IN CURVED-FLOW TEST SECTION OF LANGLEY STABILITY TUNNEL. John D. Bird, Byron M. Jaquet and John W. Cowan. October 1951. 19p. diagrs., photo. (NACA TN 2483. Formerly RM L8G13)

Results are presented of a wind-tunnel investigation made to determine the influence of the fuselage and tail surfaces on the rotary derivatives in yawing flight of a transonic-airplane configuration having 45° sweptback wing and tail surfaces. The tests were run in the curved-flow test section of the Langley stability tunnel at a Reynolds number of 1.07×10^{6} and consisted of balance measurements throughout the angle-of-attack range for several flight-path radii of curvature. The results are compared with data from forced-oscillation and free-oscillation tests, and a description of testing techniques used is included.

NACA TN 2485

PILOT ESCAPE FROM SPINNING AIRPLANES AS DETERMINED FROM FREE-SPINNING-TUNNEL TESTS. Stanley H. Scher. October 1951. 36p. diagrs., photos., 4 tabs. (NACA TN 2485. Formerly RM L8D28)

Procedure for pilot escape from spinning airplanes has been determined by means of tests in which pilot escape was simulated from 21 airplane models spinning in the Langley 20-foot free-spinning tunnel. The results in general indicated that the pilot should bail out of the outboard side. Calculated centripetal accelerations acting on the pilot during a spin are presented.

NACA TN 2486

THEORETICAL CHARACTERISTICS OF TWO-DIMENSIONAL SUPERSONIC CONTROL SURFACES. Robert R. Morrissette and Lester F. Oborny. October 1951. 74p. diagrs., tab. (NACA TN 2486. Formerly RM L8G12)

The "Busemann second-order-approximation theory" for the pressure distribution over a two-dimensional airfoil in supersonic flow was used to determine some of the aerodynamic characteristics of uncambered symmetrical parabolic and double-wedge airfoils with leading-edge and trailing-edge flaps. The characteristics presented and discussed in this paper are: flap effectiveness factor, rate of change of hinge-moment coefficient with flap deflection, rate of change of the pitching-moment coefficient about the midchord with flap deflection, and the location of the center of pressure of the airfoil-flap combination.

NACA TN 2488

WIND-TUNNEL INVESTIGATION OF THE CONTRIBUTION OF A VERTICAL TAIL TO THE DIRECTIONAL STABILITY OF A FIGHTER-TYPE AIRPLANE. Alfred A. Marino and N. Mastrocola. January 1952. 41p. diagrs., photo., 4 tabs. (NACA TN 2488. Formerly RM L7K03)

Contributions of vertical tail and fuselage to directional stability are determined from pressure distributions measured over wide ranges of angle of attack and angle of yaw with stabilizer in each of three vertical positions, with stabilizer removed, and with both stabilizer and vertical tail removed. Results point out inadequacies of current design methods and show that more accurate methods must treat separately contributions of vertical tail, fuselage area above stabilizer, and fuselage area below stabilizer.

NACA TN 2504

EFFECTS OF WING POSITION AND HORIZONTAL-TAIL POSITION ON THE STATIC STABILITY CHARACTERISTICS OF MODELS WITH UNSWEPT AND 45° SWEPTBACK SURFACES WITH SOME REFERENCE TO MUTUAL INTERFERENCE. Alex Goodman. October 1951. 58p. diagrs., photos., 4 tabs. (NACA TN 2504)

Results are presented of an investigation made to determine the effects of wing position and horizontal-tail position on the low-speed static lateral and static longitudinal stability characteristics of airplane models having unswept and 45° sweptback surfaces. Interference increments between the various components are evaluated, and efficiency factors of the vertical tail as a function of wing position are presented.

NACA TN 2505

ON THE ATTACHED CURVED SHOCK IN FRONT OF A SHARP-NOSED AXIALLY SYMMETRICAL BODY PLACED IN A UNIFORM STREAM: S. F. Shen and C. C. Lin, Massachusetts Institute of Technology. October 1951. 66p. diagrs. 2 tabs. (NACA TN 2505)

The flow behind the attached curved shock near the nose of an axially symmetrical body placed in a uniform stream is investigated by perturbation from the Taylor-Maccoll conical solution. The first-order perturbation yields the ratio of the initial radii of curvature of the shock and the body. Numerical results are presented for initial semivertex angles of 10°, 20°, and 30°, up to a Mach number around 5. A negative ratio of curvatures is again obtained at low Mach number, as in the two-dimensional case. Higher-order perturbations indicate that a regular shock shape might lead to a logarithmic singularity at the nose of the body.

NACA TN 2507

EXPERIMENTAL INVESTIGATION OF OIL FILM PRESSURE DISTRIBUTION FOR MISALINED PLAIN BEARINGS. G. B. DuBois, H. H. Mabie and F. W. Ocvirk, Cornell University. October 1951. 89p. diagrs., photos., tab. (NACA TN 2507)

Effect of axial and twisting misalining couples on oil film pressure distribution of a loaded bearing was determined. Test data were obtained with a 1.62-by 1.62-inch bearing at a shaft speed of 5000 rpm, a centrally applied load giving 833 pounds per square inch on projected area, and with or without misalining couples. Five three-dimensional plaster models were made to represent the test data obtained under the various conditions. Profile curves of oil film pressure distribution as well as curves showing distribution of bearing temperature are included.

NACA TN 2549

INVESTIGATION OF HYDROCARBON IGNITION. Charles E. Frank and Angus U. Blackham, University of Cincinnati. January 1952. 33p. diagrs., 5 tabs. (NACA TN 2549)

Accurate spontaneous ignition temperatures were determined for over 50 pure organic compounds including paraffins, olefins, aromatic hydrocarbons, alcohols, ethers, and esters. The effects of a wide variety of additives and of eight selected metals on the spontaneous ignition temperatures of these compounds were observed. Results are correlated with chemical structure and with antiknock characteristics where known; the more fundamental aspects of the possible chain-breaking and chain-branching reactions involved are also considered.

NACA TN 2561

A STUDY OF POISSON'S RATIO IN THE YIELD REGION. George Gerard and Sorrel Wildhorn, New York University. January 1952. 30p. diagrs., photos. (NACA TN 2561)

The variation in Poisson's ratio from the elastic to the plastic value was studied experimentally by a systematic series of tests on several aluminum alloys. The tests were conducted under simple tensile and compressive loading along three orthogonal axes. A theoretical variation of Poisson's ratio for an orthotropic solid was obtained from dilatational considerations. The assumptions used in deriving the theory were examined by use of the test data and were found to be in reasonable agreement with experimental evidence.

NACA TN 2570

COMPARISON OF AIRSPEED CALIBRATIONS EVALUATED BY THE ACCELEROMETER AND RADAR METHODS. Lindsay J. Lina and James P. Trant, Jr. January 1952. 16p. diagrs., photos., tab. (NACA TN 2570)

Airspeed calibration of the pitot-static installation on a jet fighter airplane was made to compare the accelerometer method of determining the static-pressure error with the radar method. The tests included shallow dives up to a Mach number of about 0.80 with pull-ups of about 4, 3, and 2g normal acceleration. The results of the test indicated that, for vertical plane maneuvers, the accelerometer method may be used as an alternate to the radar method.

NACA TN 2588

TRANSONIC FLOW PAST A WEDGE PROFILE WITH DETACHED BOW WAVE - DETAILS OF ANALYSIS. Walter G. Vincenti and Cleo B. Wagoner. December 1951. 48p. diagrs., tab. (NACA TN 2588)

Details are given of the calculations of the flow with detached bow wave past a doubly symmetrical, double-wedge profile at zero angle of attack. The results of these calculations have been previously described in NACA TN 2339.

NACA TN 2593

DESIGN OF TWO-DIMENSIONAL CHANNELS WITH PRESCRIBED VELOCITY DISTRIBUTIONS ALONG THE CHANNEL WALLS. I - RELAXATION SOLUTIONS. John D. Stanitz. January 1952. 69p. diagrs., 6 tabs. (NACA TN 2593)

A general method of design is developed for two-dimensional unbranched channels with prescribed velocities as a function of arc length along the channel walls. The method is developed for both incompressible and compressible, irrotational, nonviscous flow. Two types of compressible flow are considered: the general type, with the ratio of specific heats γ equal to 1.4, for example, and the linearized type in which γ is equal to -1.0. The design method gives complete information concerning the flow throughout the channel. Five numerical examples are given including three elbow designs with the same prescribed velocity as a function of arc length along the channel walls but with incom-

pressible, linearized compressible, and compressible flow.

NACA TN 2596

AN IMPULSE-MOMENTUM METHOD FOR CALCULATING LANDING-GEAR CONTACT CONDITIONS IN ECCENTRIC LANDINGS. Robert T. Yntema and Benjamin Milwitzky. January 1952. 60p. diagrs., 3 tabs. (NACA TN 2596)

An impulse-momentum method for determining impact conditions for landing gears in eccentric landings is presented. The analysis is primarily concerned with the determination of landing-gear contact velocities for impacts subsequent to initial touchdown in eccentric landings and with the determination of the effective mass acting on each landing gear. Calculated results are presented which indicate the effects of such factors as landing-gear configuration and location, wing lift, side drift, angle of roll, and initial rolling velocity. A brief study of the effects of variable aerodynamic lift and damping in roll is also presented.

NACA TN 2599

EXPERIMENTAL DETERMINATION OF TIME CONSTANTS AND NUSSELT NUMBERS FOR BARE-WIRE THERMOCOUPLES IN HIGH-VELOCITY AIR STREAMS AND ANALYTIC APPROXIMATION OF CONDUCTION AND RADIATION ERRORS. D. Scadron and Isidore Warshawsky. January 1952. 81p. diagrs., 4 tabs. (NACA TN 2599)

The relations among Nusselt, Reynolds, and Mach numbers for cylinders mounted in cross flow to an air stream, in the ranges $250 <$ Reynolds number $< 30,000$ and $0.1 <$ Mach number < 0.9, have been obtained from experimental determinations of the time constants of bare-wire thermocouples. This information has been used to prepare nomographs for ready computation of approximate values of time constants, radiation errors, and conduction errors for bare cylindrical-wire thermocouples in high-temperature, high-velocity gas streams.

NACA TN 2601

COMPRESSIVE BUCKLING OF SIMPLY SUPPORTED CURVED PLATES AND CYLINDERS OF SANDWICH CONSTRUCTION. Manuel Stein and J. Mayers. January 1952. 34p. diagrs. (NACA TN 2601)

Theoretical solutions are presented for the buckling in uniform axial compression of two types of simply supported curved sandwich plates: the corrugated-core type and the isotropic type. Results are given in the form of equations and curves.

NACA TN 2604

A GENERAL THEORY OF THREE-DIMENSIONAL FLOW IN SUBSONIC AND SUPERSONIC TURBOMACHINES OF AXIAL-, RADIAL-, AND MIXED-FLOW TYPES. Chung-Hua Wu. January 1952. 93p. diagrs., tab. (NACA TN 2604)

Presents a general theory of steady three-dimensional flow of a nonviscous fluid in turbomachines having arbitrary hub and casing shapes and a finite number of blades. Solution of the three-dimensional direct and inverse problem is obtained by investigating an appropriate combination of two-dimensional flows on relative stream surfaces whose intersections with a z-plane either upstream of or somewhere inside the blade row form a circular arc or a radial line. The theory is applicable to both irrotational and rotational absolute flow at the inlet of the blade row and at both design and off-design operations.

NACA TN 2606

SPECTRUM OF TURBULENCE IN A CONTRACTING STREAM. H. S. Ribner and M. Tucker. January 1952. 54p. diagrs., tab. (NACA TN 2606)

Spectrum concepts are employed to study the selective effect of a stream contraction on longitudinal and lateral turbulent velocity fluctuations. By consideration of the effect of stream contraction on a single plane wave, the effect on spectrum and correlation tensors of the turbulence is determined. Weak turbulence and an inviscid fluid are postulated; compressibility of mean flow only is taken into account. For axisymmetric contraction and isotropic initial turbulence, explicit results are obtained. The one dimensional longitudinal spectrum is found to be markedly distorted. The selective effect of contraction on longitudinal and lateral components of turbulence is found to be given uniquely, regardless of details of the isotropic spectrum; comparison with experiment is made.

NACA TN 2609

ESTIMATE OF SLIP EFFECT ON COMPRESSIBLE LAMINAR-BOUNDARY-LAYER SKIN FRICTION. Harold Mirels. January 1952. 22p. diagrs. (NACA TN 2609)

A solution to Rayleigh's problem for a compressible fluid, with slip boundary conditions, has been obtained and related to the flow past a semi-infinite flat plate. The results have been interpreted to define the border region between continuum and slip flow and to estimate the effect of slip.

NACA TN 2610

ONE-DIMENSIONAL COMPRESSIBLE FLOW IN VANELESS DIFFUSERS OF RADIAL- AND MIXED-FLOW CENTRIFUGAL COMPRESSORS, INCLUDING EFFECTS OF FRICTION, HEAT TRANSFER AND AREA CHANGE. John D. Stanitz. January 1952. 61p. diagrs., photo. (NACA TN 2610)

An analysis method and a design method are developed for one-dimensional, compressible flow with friction, heat transfer, and area change in vaneless diffusers with arbitrary profiles in the axial-radial plane. In the analysis method the variations in fluid

properties are determined as a function of radius for a prescribed variation in diffuser wall spacing with radius. In the design method the variation in effective diffuser wall spacing is determined as a function of radius for an arbitrary prescribed variation in one fluid property. As a result of numerical examples it is concluded that: (1) The friction losses in most vaneless diffuser designs are considerable and these losses result from the usually large ratios of wetted surface to flow area in vaneless diffusers. (2) Vaneless diffuser efficiencies can be improved by increased compressor flow rates for a given impeller tip radius.

NACA TN 2611

EXPERIMENTAL INVESTIGATION OF BASE PRESSURE ON BLUNT-TRAILING-EDGE WINGS AT SUPERSONIC VELOCITIES. Dean R. Chapman, William R. Wimbrow and Robert H. Kester. January 1952. 53p. diagrs., photos., tab. (NACA TN 2611)

The pressures acting on the base of blunt-trailing-edge airfoils have been measured at Mach numbers of 1.25, 1.5, 2.0, and 3.1 and at Reynolds numbers from 0.2 to 3.8 million. Data are presented for 29 profiles both with laminar and with turbulent boundary layers approaching the trailing edges of the wings. The base pressure is found to be a function primarily of Mach number and the ratio of the boundary layer thickness at the trailing edge to the trailing-edge thickness.

NACA TN 2615

THE CALCULATED AND MEASURED PERFORMANCE CHARACTERISTICS OF A HEATED-WIRE LIQUID-WATER-CONTENT METER FOR MEASURING ICING SEVERITY. Carr B. Neel, Jr. and Charles P. Steinmetz. January 1952. 59p. diagrs., photos., 6 tabs. (NACA TN 2615)

Initial development has been made of an instrument which could be used to obtain statistical flight data on the liquid-water content of icing clouds and to provide a direct indication of icing severity. The sensing element of the instrument consists of a wire of known temperature-resistance characteristics which is heated by passing electrical current through it. The wire is mounted in the air stream and the degree of cooling resulting from evaporation of impinging water droplets is a measure of the liquid-water content of the cloud. Comparisons are made of the liquid-water content as measured with heated wires and absorbent cylinders in an artificially produced cloud. Performance characteristics of a heated-wire instrument are presented.

NACA TN 2621

DEFLECTION AND STRESS ANALYSIS OF THIN SOLID WINGS OF ARBITRARY PLAN FORM WITH PARTICULAR REFERENCE TO DELTA WINGS. Manuel Stein, J. Edward Anderson and John M. Hedgepeth. February 1952. 53p. photo., diagrs. (NACA TN 2621)

The structural analysis of arbitrary solid cantilever wings by thin-plate theory is reduced to the solution of linear ordinary differential equations by use of the assumption that the chordwise deflections may be expressed in the form of a power series. With the series limited to the first two and the first three terms, the differential equations are solved exactly for several examples of solid delta wings. For cases for which exact solutions to the differential equations cannot be obtained, a numerical procedure is derived. Some experimental data are presented and are found to compare favorably with the present theory.

NACA RM E51J29

PRELIMINARY RESULTS OF CYCLICAL DE-ICING OF A GAS-HEATED AIRFOIL. V. H. Gray, D. T. Bowden and U. von Glahn. January 1952. 38p. photos., diagrs., tab. (NACA RM E51J29)

An NACA 65_1-212 airfoil of 8-foot chord was provided with a gas-heated leading edge for investigations of cyclical de-icing. De-icing was accomplished with intermittent heating of airfoil segments that supplied hot gas to chordwise passages in a double-skin construction. Ice removal was facilitated by a spanwise leading-edge parting strip which was continuously heated from the gas-supply duct. Preliminary results demonstrate that satisfactory cyclical ice removal occurs with ratios of total cycle time to heat-on period from 10 to 26.

NACA RM E51K07

EXPERIMENTAL STUDY OF ISOTHERMAL WAKE-FLOW CHARACTERISTICS OF VARIOUS FLAME-HOLDER SHAPES. George G. Younger, David S. Gabriel and William R. Mickelsen. January 1952. 45p. diagrs., photos., 2 tabs. (NACA RM E51K07)

An investigation of the effects of flame-holder-shape changes on the strength and the shedding frequency of the Kármán vortices was conducted in isothermal flow. Because the characteristics of the stable vortex trail are related to the recirculation zones which influence the combustion process, these results may furnish a basis of correlation of combustion efficiency and stability in combustion studies. Appreciable changes in strength and frequency were obtained by varying flame-holder shape. Changing shape and size provides many schedules of variation of strength and frequency not obtainable by changing size only and may provide theoretical maximum strength for a given frequency.

BRITISH REPORTS

N-11930*

Royal Aircraft Establishment (Gt. Brit.)
DEVELOPMENT OF ALUMINUM ALLOYS HAVING A HIGH YOUNG'S MODULUS. G. Meikle, J. Thompson and M. E. Whillans. August 1951. 11p. photos., diagr., 4 tabs. (RAE Tech. Note Met.149)

Aluminum alloys containing about 10.5 percent silicon and other elements, having a high Young's modulus have been successfully rolled into sheets (20 SWG - 0.036 in.) under production conditions. Examination of one of the alloys was made at RAE and it was found that the suggested target values of 21 tons/in.^{2}, 0.1 percent proof stress, 28 tons/in.^{2} ultimate tensile stress and 4 percent minimum elongation were met after solution treatment and aging. The average "E" value just fell short of the expected value of 12 x 10^6 lb/in.^{2}, which is 20 percent above that of the normal aircraft aluminum alloys.

N-11999*

Royal Aircraft Establishment (Gt. Brit.)
THE EIGENSOLUTIONS OF THE FINITE SEGMENTS OF THE HILBERT MATRIX. P. F. Jordan. August 1951. 59p. diagrs., 6 tabs. (RAE Structures 115)

The eigensolutions of the finite segments of a generalized Hilbert matrix are discussed by means of a new approach on the basis of the solutions of the associated integral equation. Many new and detailed results are given. The eigenvectors and the overtone solutions are also described.

N-13051*

Royal Aircraft Establishment (Gt. Brit.)
DEVELOPMENT OF A HIGH EFFICIENCY AIR LUBRICATED JOURNAL BEARING. E. C. Brown. June 1951. 13p. photos., diagrs. (RAE Tech. Note Aero 2107)

Modifications to the air lubricated drag and side-force bearings of the virtual center balance in the RAE No. 2 (11-1/2 feet by 8-1/2 feet) wind tunnel have resulted in a very substantial increase in their load carrying capacity. A total of eight bearings were affected and all are now working at load coefficients (maximum load carried/projected area of bearing x air supply pressure) of between 0.77 and 0.86, compared with the normally accepted values of 0.3 to 0.4 to this type of bearing. An appendix contains some suggestions for the applications of the principles involved to the design of complete journal bearings.

N-13060*

Aeronautical Research Council (Gt. Brit.)
THE EXPERIMENTAL APPROACH TO THE PROBLEMS OF SHAFT WHIRLING. E. Downham. 1951. 9p. photos. (ARC CP 55; ARC 13,416. Formerly RAE Structures 70)

The theoretical and practical aspects of shaft whirling are discussed and a brief survey is given of past work. A new experimental approach to the problem is suggested and discussed. A detailed program of experiments is outlined. The design of model test rigs is also considered and a description is given of a rig built at the RAE for investigating the theory of shaft whirling.

N-13061*

Aeronautical Research Council (Gt. Brit.)
THE INCOMPRESSIBLE POTENTIAL FLOW PAST TWO-DIMENSIONAL AEROFOILS WITH ARBITRARY SURFACE SUCTION. W. T. Lord. June 20, 1950. 44p. diagrs., tab. (ARC CP 56; ARC 13,196)

The problem of incompressible potential flow past a conventional airfoil which has an arbitrary distribution of normal velocity across its surface is solved by the application of conformal transformation to the solution derived for the corresponding problem for the unit circle. Several simple examples are given. Although it is theoretically possible to obtain any desired tangential velocity distribution on an airfoil by the correct choice of suction velocity distribution, the quantities of suction required are considered large for immediate practical use.

N-13062*

Aeronautical Research Council (Gt. Brit.)
FREE FLIGHT MEASUREMENTS AT SUPERSONIC SPEEDS OF THE DRAG OF A PARTICULAR DELTA WING HAVING A SIMPLE PRESSURE DISTRIBUTION. P. J. Herbert. 1951. 11p. diagrs., photo. (ARC CP 57; ARC 14,008. Formerly RAE Aero 2406)

Squire has drawn attention to a family of delta wings, having airfoil-like sections with a rounded leading edge, whose supersonic wave drag at zero incidence is theoretically determinable, so long as the leading edge is subsonic. Drag measurements have been made, at a Reynolds number of 7 x 10^6, on one member of this family using the ground-launched rocket-boosted model technique. The experimental wave drag is in good agreement with tunnel measurements on another wing of the family, both methods giving values less than theory.

N-13123*

Forest Products Research Lab. (Gt. Brit.)
TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. PROGRESS REPORT THIRTEEN. July 1951. 6p. 3 tabs. (Forest Products Research Lab.)

Tests were made on Ramin (Gonystylus bancanus) as outlined in Paper PRP5/1 "Manual for Conducting Trials of Timber for Plywood Manufacture." The test specimens came from Sarawak but the species also occurs in Borneo and Malaya.

N-13124 *

Forest Products Research Lab. (Gt. Brit.)
TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. PRELIMINARY TESTS ON TWO SPECIES. PROGRESS REPORT FOURTEEN. October 1951. 9p. 6 tabs. (Forest Products Research Lab.)

Tests were made on Red Birch (Bursera simaruba) and Hog Plum (Spondias mombin) as outlined in Paper PRP5/1 "Manual for Conducting Trials of Timber for Plywood Manufacture" except that the yield measurements were not made. The test specimens came from Jamaica.

N-13125 *

Forest Products Research Lab. (Gt. Brit.)
TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. PROGRESS REPORT FIFTEEN. November 1951. 14p. 8 tabs. (Forest Products Research Lab.)

Tests were made on African Mahogany (Khaya ivorensis) as outlined in Paper PRP5/1 "Manual for Conducting Trials of Timber for Plywood Manufacture." The specimens tested came from the Gold Coast.

N-13128*

Forest Products Research Lab. (Gt. Brit.)
THE MIXING OF CASEIN GLUES. P. M. C. Lacey. November 1951. 8p. diagrs., 2 tabs. (Forest Products Research Lab., AMP 20/2)

In the mixing of prepared casein glues with water, in quantity, difficulties of lump-formation and air-entrainment arise from difficulties experienced by the particles in penetrating the water surface. It is shown that this problem can be solved by carrying out the operation on a continuous basis, and using centrifugal forces to surmerge the particles. A machine has been built in which correctly proportioned streams of casein powder are passed into a specially designed centrifuge cup, continuously discharged at the top through a scoop-tube. A scraper provides reflux near the base, and air is removed centripetally as the materials ascend the divergent walls.

N-13210 *

Royal Aircraft Establishment (Gt. Brit.)
THE DEFORMATION OF SILVER WIRE AT HIGH TEMPERATURE. A. P. Greenough. October 1951. 18p. diagrs., photos., 4 tabs. (RAE Tech. Note Met. 151)

The deformation of silver wires at high temperatures and low stresses has been investigated experimentally. Observations of the behavior of single crystal wires, and on the rate of strain and the development of kinks and necks in polycrystalline wires, provide strong support for Herrig's theory of the mechanism by which the deformation proceeds. Offsetting, or the sliding of grains on their boundaries, takes place in wires subject to low applied stresses, and an explanation of this is proposed. The surface energy of solid silver was estimated from the results obtained.

UNPUBLISHED PAPERS

N-12357*

BRIEF EMPIRICAL REPORT ON THE ELIMINATION OF OSCILLATORY YAW. PART I. W. Stender. BRIEF EMPIRICAL REPORT ON THE ELIMINATION OF OSCILLATORY YAW. PART II. O. Bubenzer. BRIEF EMPIRICAL REPORT ON THE ELIMINATION OF OSCILLATORY YAW. PART III. H. Motzfeld. (Erfahrungskurzbericht über die Beseitigung von Gierschwingungen). November 1951. 12p. diagrs. (Trans. from Lilienthal-Gesellschaft für Luftfahrtforschung, Berlin, Bericht 143, November 6-7, 1941, p. 24-26, 29)

The balance of control surfaces apparently increases the susceptibility to oscillatory yaw. This problem and means of eliminating it is discussed. These means include varying the trailing-edge shape of the rudder, varying the thickness of the rudder, mass over-balancing, addition of fins under the nose of the fuselage, addition of a screening plate, and force or spring control of the rudder.

N-12430 *

THEORY OF FATIGUE STRENGTH IN THE COMPLEX STRESSED STATE. (Teoria ustallostnoi prochnosti pri slozhnom napryazhennom sostoyanii). N. N. Afanasiev. 18p. diagrs. (Trans. from Zhurnal Tekhnicheskoi Fiziki, v. 16, no. 4, 1946, p. 443-454).

Discusses a proposed theory of fatigue strength in the complex stressed state which agrees with experimental data and provides them with a physically underlying basis.

N-12447*

Princeton U.
A METHOD OF SOLVING THE NONLINEAR DIFFERENTIAL EQUATIONS OF ATMOSPHERIC TIDES WITH APPLICATION TO AN ATMOSPHERE OF CONSTANT TEMPERATURE. C. L. Pekeris. July 24, 1951. 28p. (Princeton U.)

The purpose of this investigation is to develop a method of including the quadratic terms of the differential equations in the theory of atmospheric tides. The method is illustrated by applying it to the problem of determining the effect of the quadratic terms on the free period of oscillation of an atmosphere of constant temperature.

National Advisory Committee for Aeronautics

Research Abstracts

NO.18 FEBRUARY 27, 1952

CURRENT NACA REPORTS

NACA TN 2519

A COMPARISON OF THE EXPERIMENTAL SUBSONIC PRESSURE DISTRIBUTIONS ABOUT SEVERAL BODIES OF REVOLUTION WITH PRESSURE DISTRIBUTIONS COMPUTED BY MEANS OF THE LINEARIZED THEORY. Clarence W. Matthews. February 1952. 52p. diagrs., tab. (NACA TN 2519. Formerly RM L9F28)

A comparison is made of the theoretical and experimental subsonic compressible pressure-coefficient distributions about several bodies of revolution. The results show that the linearized theory predicts the subsonic pressure coefficients over the central portion of the body. An extrapolation of the theory into the supercritical range does not predict the rearward shift of the negative pressure peak which occurs after the flow becomes critical. Two equations are presented for approximately determining the subsonic compressible pressure-coefficient distributions from the incompressible pressure-coefficient distributions.

NACA TN 2548

EQUAL-STRENGTH DESIGN OF TENSION-FIELD WEBS AND UPRIGHTS. Ralph H. Upson, George M. Phelps and Tung-Sheng Liu, University of Minnesota. January 1952. 46p. diagrs., photos., 4 tabs. (NACA TN 2548)

A method is hereby presented for proportioning thin-web beams to attain equal strength of web and uprights which may in turn be employed toward optimum design of these components. Improved empirical formulas for this purpose are developed and the results checked by experimental loading of six beams. The empirical formulas developed are subject to the limitations of the imposed conditions of this investigation and proportions of uprights as brought out in the experimental results and conclusions.

NACA TN 2602

SURVEY OF THE CHROMIUM-COBALT-NICKEL PHASE DIAGRAM AT 1200° C. W. D. Manly and Paul A. Beck, University of Notre Dame. February 1952. 45p. diagrs., photos., 9 tab. (NACA TN 2602)

A survey of the chromium-cobalt-nickel ternary phase diagram at 1200° C was made by means of microscopic and X-ray diffraction studies on 110 vacuum melted alloys prepared from commercial metals of the highest purity available. At 1200° C, the following phases occur: (1) very extensive face centered cubic solid solutions, based on the binary cobalt-nickel solid solutions; (2) body-centered cubic chromium-base solid solutions; and (3) brittle sigma solid solutions, based on the chromium-cobalt sigma phase which is isomorphous with the iron-chromium sigma phase.

NACA TN 2603

SURVEY OF PORTIONS OF THE COBALT-CHROMIUM-IRON-NICKEL QUATERNARY SYSTEM. E. L. Kamen and Paul A. Beck. February 1952. 62p. photos., diagrs., 13 tabs. (NACA TN 2603)

An isothermal survey was made of certain portions of the chromium-cobalt-nickel-iron quaternary system at 1200° C. The iron content was varied up to 30 percent to include the range of commercial chromium-cobalt-nickel alloys. The component cobalt-chromium-iron ternary system was also studied.

NACA TN 2607

ELECTRICAL PRESSURE INTEGRATOR. Arleigh P. Helfer. January 1952. 44p. photos., diagrs., 2 tabs. (NACA TN 2607)

The design of an instrument that is capable of integration of airfoil pressures into a quantity representative of normal force and pitching moment acting on an airfoil is presented. Flight and wind-tunnel versions of this instrument are described along with samples of test data obtained from them.

NACA TN 2608

CHARTS AND APPROXIMATE FORMULAS FOR THE ESTIMATION OF AEROELASTIC EFFECTS ON THE LOADING OF SWEPT AND UNSWEPT WINGS. Franklin W. Diederich and Kenneth A. Foss. February 1952. 98p. diagrs., 3 tabs. (NACA TN 2608)

Charts are presented for the estimation of aeroelastic effects on spanwise lift distribution, lift-curve slope, aerodynamic center, and damping in roll of swept and unswept wings at subsonic and supersonic speeds. Some design considerations brought out by the results of this paper are discussed.

*AVAILABLE ON LOAN ONLY.

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NACA TN 2616

THE ACHIEVEMENT OF CONTINUOUS WALL CURVATURE IN DESIGN OF TWO-DIMENSIONAL SYMMETRICAL SUPERSONIC NOZZLES. J. C. Evvard and Lawrence R. Marcus. January 1952. 8p. diagrs. (NACA TN 2616)

Auxiliary boundary conditions were derived to assure continuity of wall curvature in applying the method of characteristics to the design of two-dimensional supersonic nozzles.

NACA TN 2617

RELATIVE IMPORTANCE OF VARIOUS SOURCES OF DEFECT-PRODUCING HYDROGEN INTRODUCED INTO STEEL DURING APPLICATION OF VITREOUS COATINGS. Dwight G. Moore, Mary A. Mason and William N. Harrison, National Bureau of Standards. February 1952. 31p. photos., diagrs., 5 tabs. (NACA TN 2617)

The purpose of this investigation was to study and to determine experimentally the relative importance of various sources of defect-producing hydrogen introduced into steel during the application of vitreous-type ceramic coatings. Under the conditions investigated, the principal source of defect-producing hydrogen was the dissolved water present in the enamel frit of the coating. Acid pickling, milling water, chemically combined water in the clay, and quenching water were all minor sources. Test results indicate that fishscaling, reboil, and possibly primary boil may be eliminated by using a coating prepared with a water-free frit.

NACA TN 2618

CREEP IN METALS. A. D. Schwope, F. R. Shober and L. R. Jackson, Battelle Memorial Institute. February 1952. 52p. diagrs., photos., tab. (NACA TN 2618)

This report covers phases of an investigation of the fundamentals of creep in metals. Results of a study of creep in single crystals of high-purity aluminum are presented and discussed. It is shown that at low stresses the creep phenomenon appears to be consistent with Mott and Nabarro's theory of exhaustion creep while at higher stresses results appear to be more in accord with ideas expressed by Andrade.

NACA TN 2622

A DESCRIPTION AND A COMPARISON OF CERTAIN NONLINEAR CURVE-FITTING TECHNIQUES, WITH APPLICATIONS TO THE ANALYSIS OF TRANSIENT-RESPONSE DATA. Marvin Shinbrot. February 1952. 41p. diagrs., 5 tabs. (NACA TN 2622)

Several least-squares methods for curve fitting a set of data to a nonlinear function are described and compared. Each of the methods is applied to fit data, obtained from a flight test of an actual airplane, to a sum of two exponentials, thus illustrating the use of the methods for the calculation of aircraft stability parameters.

NACA TN 2627

COINCIDENCE METHOD APPLIED TO ION BEAM MEASUREMENT. Stanley Fultz and M. L. Pool. Ohio State University. February 1952. 13p. diagrs. (NACA TN 2627)

A coincidence Geiger counter system was constructed for the absolute measurement of the activity of radioactive substances made in a cyclotron. The average beam current in the cyclotron can be calculated from the number of disintegrations per second observed, the half-life of the radioactive substance, and the reaction cross section.

NACA TN 2628

BONDING OF MOLYBDENUM DISULFIDE TO VARIOUS MATERIALS TO FORM A SOLID LUBRICATING FILM. I - THE BONDING MECHANISM. Douglas Godfrey and Edmond E. Bisson. February 1952. 16p. photos., 4 tabs. (NACA TN 2628)

The use of molybdenum disulfide MoS_2 as a solid film lubricant in applications where designs or temperatures preclude liquid lubricants is dependent upon successful bonding of MoS_2 to the surface. An experimental investigation was conducted to determine the basic mechanism of bonding MoS_2 and extend application of the bonding to a variety of materials. When MoS_2 was applied to a surface as a mixture of MoS2 powder and some liquid vehicles, the liquid vehicle decomposed and polymerized to a resin which bound the particles of MoS_2 together and to the surface to be lubricated. MoS_2 can be bonded by resin-forming viscous liquid vehicles, such as asphalt- and silicone-base varnishes, glycerine, ethylene glycol, polyglycol ether, and corn syrup to a variety of materials, such as steel, aluminum, brass, stainless steel, and glass. The reduction of Fe_2O_3, formed by preheating steel in air, to Fe_3O_4 by one of the liquid vehicles (syrup) improves the frictional properties of the solid lubricating film. Rubbing of MoS_2 whether dusted, built-up, or bonded by a resin to a surface produced distinct preferred orientation.

NACA TN 2629

ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF FULLY DEVELOPED TURBULENT FLOW OF AIR IN A SMOOTH TUBE WITH HEAT TRANSFER WITH VARIABLE FLUID PROPERTIES. R. G. Deissler and C. S. Eian. February 1952. 43p. diagrs. (NACA TN 2629)

A previous analysis of turbulent flow and heat transfer in smooth tubes with variable fluid properties was modified in order to be applicable to air which has a Prandtl number slightly less than unity (0.73). In order to verify the analysis, tests were conducted to determine local heat-transfer coefficients and friction factors for fully developed turbulent flow of air in a smooth electrically heated tube having an inside diameter of 0.87 inch and a length of 87 inches. The tests were conducted at high ratios of wall to fluid bulk temperature. Velocity and temperature

profiles were measured for some conditions. The analytically predicted results were found to agree closely with the experimental results.

NACA TN 2631

THE SIMILARITY LAW FOR NONSTEADY HYPERSONIC FLOWS AND REQUIREMENTS FOR THE DYNAMICAL SIMILARITY OF RELATED BODIES IN FREE FLIGHT. Frank M. Hamaker and Thomas J. Wong. February 1952. 24p. diagrs. (NACA TN 2631)

The hypersonic similarity law for steady flow is extended to include nonsteady flows. The aerodynamic forces are correlated by this law and this correlation is used to derive conditions for dynamical similarity of the motions of related bodies in free flight. The correlation of flight paths was achieved on this basis.

NACA TN 2634

EVALUATION OF THREE METHODS FOR DETERMINING DYNAMIC CHARACTERISTICS OF A TURBOJET ENGINE. Gene J. Delio. February 1952. 56p. diagrs., 6 tabs. (NACA TN 2634)

Data resulting from approximate step and sinusoidal disturbances of fuel flow of a turbojet engine were analyzed by three methods: approximate indicial responses were used in determining the coefficients of differential equations, Fourier analysis was performed on the transient data, and AC analysis was performed using steady-state frequency response data. Transfer functions are derived from functional relationships describing turbojet engine dynamic behavior resulting from changes of several manipulated variables. Engine nonlinearities and supply source regulation are considered.

NACA RM E51J30

PRELIMINARY INVESTIGATION OF CYCLIC DE-ICING OF AN AIRFOIL USING AN EXTERNAL ELECTRIC HEATER. James P. Lewis and Dean T. Bowden. February 1952. 43p. photos., diagrs. (NACA RM E51J30)

An investigation was conducted in the NACA Lewis icing research tunnel to determine the characteristics and requirements of cyclic de-icing of an airfoil by use of an external electric heater. The present investigation was limited to an airspeed of 175 miles per hour. Data are presented to show the effects of variations in heat-on and heat-off periods, ambient air temperature, liquid-water content, angle of attack and heating distribution on the requirements for cyclic de-icing. The external heat flow at various icing and heating conditions is also presented. A continuously heated parting strip at the airfoil leading edge was found necessary for quick, complete, and consistent ice removal. The cyclic power requirements were found to be primarily a function of the datum temperature and heat-on time, with the other operating and meteorological variables having a second-order effect. Short heat-on periods and high power densities resulted in the most efficient ice removal, the minimum energy input, and the minimum runback ice formations.

NACA TM 1300

WIND-TUNNEL CORRECTIONS AT HIGH SUBSONIC SPEEDS PARTICULARLY FOR AN ENCLOSED CIRCULAR TUNNEL. (Windkanalkorrekturen bei hohen Unterschallgeschwindigkeiten unter besonderer Berücksichtigung des geschlossenen kreiskanals). B. Göthert. February 1952. 43p. diagrs., 3 tabs. (NACA TM 1300. Trans. from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin. FB 1216; Deutsche Versuchsanstalt für Luftfahrt E. V., Berlin. Institut für Aerodynamik, May 16, 1940).

A review of existing publications on wind-tunnel corrections is followed by an approximate method for determining the corrections due to model and wake displacement and to lift. Relations are investigated for fuselages and wings of various spans in closed circular tunnels. A comparison is made between the computations and the tests in the DVL high-speed wind tunnel.

NACA TM 1328

CONCERNING THE FLOW ABOUT RING-SHAPED COWLINGS. PART VIII - FURTHER MEASUREMENTS ON ANNULAR PROFILES. (Über die Strömung an ringförmigen Verkleidungen. VIII Mitteilung: Weitere Messungen an Ringprofilen). Dietrich Küchemann and Johanna Weber. February 1952. 11p. diagrs. (NACA TM 1328. Trans from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin. FB 1236/8, March 25, 1943).

The measurements of part V (reference 1) of this series of reports, which concerned comparatively long ring profiles, are supplemented by measurements on shorter rings as they are used for shrouded propellers and cowlings of ring-shaped radiators. Mass-flow coefficients and profile drags are given. Furthermore, it has to be determined how far the potential theory describes the flow phenomenon with sufficient accuracy and whether the present theory for the calculation of thin annular profiles yields useful profile forms and is suitable for determination of the mass flow for thick profiles.

BRITISH REPORTS

N-11515A*

College of Aeronautics, Cranfield (Gt. Brit.)
THE MEASUREMENT OF THE DERIVATIVE Z_w FOR AN OSCILLATING AEROFOIL. A. L. Buchan, K. D. Harris and P. M. Somervail. June 1950. 32p. diagrs. (College of Aeronautics, Cranfield. Rept. 40)

Presents results of experimental measurements of the damping derivative coefficient for constant chord rigid wings of various aspect ratios having sweepback angles of zero and 45°. The results for the rectangular wings show substantial agreement with the unsteady airfoil theory developed by W. P. Jones. The dependence of W_z upon frequency parameter is as given by theory and is much less than for two-dimensional flow, but the numerical results are approximately 10 percent below the theoretical. The effect of sweepback is to decrease the numerical value, but this effect is more pronounced for low than for high aspect ratios.

N-11533*

Aeronautical Research Council (Gt. Brit.)
CREEP TESTS ON SOME CAST MAGNESIUM ALLOYS. PARTS I, II AND III. A. E. Johnson and H. J. Tapsell. 1951. 22p. diagrs., tabs. (ARC R & M 2675; ARC 8281; ARC 8306. Formerly ARC 7595; ARC A.459)

Results of creep tests of 150 hours duration at 100°, 150° and 200° C on some heat-treated sand cast magnesium alloys are presented. A comparison of the creep properties of three cast magnesium alloys based on tests of 1000 hours duration is made. Finally results are presented of short-time creep tests at 3 tons/sq in. of four cast magnesium alloys having different heat treatments.

N-13037*

Aeronautical Research Council (Gt. Brit.)
SANDWICH CONSTRUCTION - A PRACTICAL APPROACH FOR THE USE OF DESIGNERS. D. Williams. 1951. 25p. diagrs. (ARC R & M 2466; ARC 10,384. Formerly RAE Structures 2)

Formulas for the design of sandwich panels are derived. The approximations used reduce the accuracy of the results to only a negligible degree. The qualities both of stiffness and strength desirable in core materials (homogeneous or grained) are discussed, and suggestions for future developments are made. It is shown that very high efficiencies are obtainable with a core material having elastic moduli some 500 less than those of dural, even though the density may be as much as 1/100 that of duralumin.

N-13039*

Aeronautical Research Council (Gt. Brit.)
STRAIN GAUGE INVESTIGATION OF PROPELLER FLUTTER. L. H. G. Sterne, H. G. Ewing and J. Kettlewell. 1951. 7p. diagrs. (ARC R & M 2472; ARC 10,567. Formerly RAE SME 3399)

This report describes strain-gage tests on a fluttering propeller. The tests were made on the No. 3 spinning tower and also in the large wind tunnel at the Royal Aircraft Establishment. The propeller blades were made of compressed wood. Both low incidence and stalling flutter were detected, and examples of the wave forms recorded by an oscilloscope and corresponding to each type of flutter are given.

N-13041*

Aeronautical Research Council (Gt. Brit.)
AN INVESTIGATION IN FLIGHT OF THE INDUCED VELOCITY DISTRIBUTION UNDER A HELICOPTER ROTOR WHEN HOVERING. P. Brotherhood. 1951. 16p. photos., diagrs. (ARC R & M 2521. Formerly RAE Aero 2212; ARC 10,838; ARC H58)

Flight tests have been made on a Sikorsky R-4B helicopter to determine the distribution of the velocity induced by the rotor in hovering flight. Measurements in the fully developed slipstream were referred back to their appropriate disk positions by means of smoke visualization of the streamlines. The experimental distribution agrees very well with that predicted by propeller strip theory, provided the tip loss is taken into account.

N-13043*

Aeronautical Research Council (Gt. Brit.)
PHOTO-ELASTIC EXAMINATION OF A CYLINDRICAL STRUT INTENDED FOR RECORDING COMPRESSIVE LOADS. W. A. P. Fisher. 1951. 4p. photos., diagrs. (ARC R & M 2532; ARC 11,485. Formerly RAE SME 3400)

Photoelastic methods are used to establish how much of a cylindrical steel strut, mounted for measurement of compressive force by strain gages, has uniform stress distribution, even when the end load is concentrated near the axis of the strut. It is found that a strut 16 inches long, and 6-inch diameter has virtually uniform stress distribution over the middle 2-1/2 inches.

N-13044*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE EFFECT OF BOUNDARY-LAYER SUCTION ON SEPARATION. E. J. Watson. 1951. 2p. diagrs. (ARC R & M 2538. Formerly ARC 10,606; FM 1107)

Presents a discussion of the general character of flow near the separation point. It shows the main disadvantage of the proposed separation condition in applying it to boundary-layer calculations.

N-13045*

Aeronautical Research Council (Gt. Brit.)
THE BEHAVIOUR IN COMPRESSION OF ALUMINIUM ALLOY PANELS HAVING A FLAT SKIN WITH CORRUGATED REINFORCEMENT. E. A. Brook. 1951. 33p. diagrs., photos., 8 tabs. (ARC R & M 2598; ARC 9013. Formerly RAE SME 3333)

This describes tests on 36 panels. Each panel consisted of a flat skin reinforced with continuous corrugations, and the object of the test was to investigate the effect of rivet pitch and arrangement, corrugation width, and skin and corrugation thickness on the buckling and failing loads of the panels. The results indicate that for the thickness of skin and corrugations considered, the interrivet buckling stress

is considerably less than the stress at which the skin between rivets would buckle, when considered as an Euler strut with encastre ends.

N-13046*

Aeronautical Research Council (Gt. Brit.)
STRESS DIFFUSION ADJACENT TO GAPS IN THE INTER-SPAR SKIN OF A STRESSED-SKIN WING. M. Fine and H. G. Hopkins. 1951. 13p. diagrs. (ARC R & M 2618; ARC 5941. Formerly RAE SME 3208)

This report gives, subject to certain simplifications, a theoretical analysis of the problem of stress concentrations due to cut-outs and gaps in the wing surface. Approximate formulas are found for the direct stress in the flanges and the shear stress in the skin at the flanges and at the chordwise gap. A numerical example to illustrate the application to design is given. Although various factors are likely to reduce the stress concentration if the present calculations predict it to be high, some reinforcement of the skin is likely to be necessary.

N-13047*

Aeronautical Research Council (Gt. Brit.)
A NOTE ON A ROTATING BENDING-FATIGUE MACHINE FOR TESTS AT 200 DEG. C. C. E. Phillips and R. C. A. Thruston. 1951. 4p. diagrs., photos. (ARC R & M 2674; ARC 8592)

An experimental adaptation of an air temperature rotating bending-fatigue testing machine has been made for tests on light alloys at temperatures up to 200° C. The machine is described and results of preliminary tests are discussed.

N-13059*

Aeronautical Research Council (Gt. Brit.)
FOCUSSING SCHLIEREN SYSTEMS. R. W. Fish and K. Parnham. 1951. 17p. diagrs. (ARC CP 54; ARC 13, 865. Formerly RAE Tech. Note IAP 999)

The substitution of grids for the usual knife edges in a Schlieren apparatus confers focusing properties on the system. Three possible systems are described and their optical limitations discussed. Achromatic lenses are used in place of mirrors because of the excessive off-axis aberrations of the mirrors. Some practical suggestions for the construction of the grid and the adjustment of the system are given.

N-13322*

Royal Aircraft Establishment (Gt. Brit.)
EVAPORATION FROM THE SURFACE OF A BODY IN AN AIRSTREAM. (WITH PARTICULAR REFERENCE TO THE CHEMICAL METHOD OF INDICATING BOUNDARY LAYER TRANSITION.) P. R. Owen and A. O. Ormerod. September 1951. 61p. diagrs. (RAE Aero 2431)

The problem of predicting the rate of transport of a gas from or into the surface of a two-dimensional body in an air stream is discussed. The principal object of the investigation is to provide a means of estimating the time required to obtain an experimental record of boundary layer transition when a chemical technique is used. The methods evolved should, however, find an application to other forced diffusion phenomena. Experimental results are compared with theoretical ones. A calculation of the effect of altitude is made.

N-13323*

Royal Aircraft Establishment (Gt. Brit.)
CALCULATION OF THE PRESSURE DISTRIBUTION OVER A WING AT SONIC SPEEDS. K. W. Mangler. September 1951. 94p. diagrs., 3 tabs. (RAE Aero 2439)

A method is developed for the calculation of the pressure distribution and the aerodynamic forces and moments acting on a wing at incidence, in steady roll, and in steady pitch. The calculation assumes an inviscid potential flow and is restricted to small incidence and thickness ratio. Calculations indicate the plan form is as important to pressure distribution at sonic speeds as the chordwise section is at subsonic speeds for wings of larger aspect ratios. Although the calculation is based in the assumption of an inviscid flow without shock waves, the results are thought to be useful for showing the main trends of the behavior of a wing near sonic speed.

N-13369*

Royal Aircraft Establishment (Gt. Brit.)
SOME OBSERVATIONS ON THE CREEP OF SINGLE CRYSTALS OF AN ALUMINIUM-SILVER ALLOY. L. Rotherham, A. R. Sollars and N. H. G. Daniels. July 1951. 27p. photos., diagrs. (RAE Tech. Note Met.148)

Creep tests have been carried out, at 300° C, 400° C, and 450° C, under constant load conditions, on single crystals of aluminum - 0.5 percent silver solid solution. Breakdown into substructure has been conclusively demonstrated, together with slip lines, step bands and deformation bands.

UNPUBLISHED PAPERS

N-9479*

CONTRIBUTION TO THE NONSTEADY LAMINAR BOUNDARY LAYER ON PLANE WALLS. (Beitrag zur instationären laminaren Grenzschicht an ebenen Wänden). W. Wuest. January 1952. 14p. diagrs. (Trans from Ingenieur-Archiv, v. 17, no. 3, 1949, p. 193-198).

The development of a laminar boundary layer is investigated in the neighborhood of plane walls or at the contact surface of two fluids. Aside from dependence

on time, a dependence on distance from the wall is assumed. Also investigated is a nonsteady analogue to the boundary layer suction in the steady case which is dependent upon distance along the wall. The flow at the contact surface between two fluids of different density and velocity is discussed. The results show that the ratio of the contact-surface velocity and the velocity outside of the boundary layer is independent of time.

N-10898*

APPLICATION OF THIN-WING EXPANSION METHOD TO GAS FLOW ALONG SINUSOIDAL WALL. (Seigempakei no Kabe ni Ou Kosokikiryu ni Tsuite). Isao Imai and Seiichi Oyama. 16p. diagrs. (Trans. from Tokyo (Imperial) Univ., Institute of Science and Technology, Reports, v. 2, no. 3-4, Mar.-Apr., 1948, p. 39-44).

To investigate a high velocity fluid the thin-wing expansion method carried to the third approximation was applied to flow along a sinusoidal wall. By varying ϵ and M the flow conditions could be studied. Because the factor μ^3 is involved as the approximation is carried further, it is difficult to predict anything definite for the case M near 1. According to numerical results a continuous solution exists for the case of a supersonic zone; but the curvature of the velocity distribution curves at the points of maximum velocity becomes infinite, shock waves arise, and the convergence of the solution is disrupted.

N-12506*

National Advisory Committee for Aeronautics. THE ROLE OF PHYSICS IN AERONAUTICAL DEVELOPMENT. Hugh L. Dryden. 56p. photos., diagrs. (Presented before American Association for the Advancement of Science, at conference on Applied Physics, Municipal Auditorium, Philadelphia, December 27, 1951).

In order to stimulate the physicist's interest in the field of aeronautics a few examples are given of the applications of existing physical knowledge, of problems in physics arising from the resolution of engineering problems into their component subproblems, and of the great indebtedness of aeronautics to physics for its tools of measurement. For security reasons and to fulfill better the aims of the paper, emphasis has been placed on the longer range problems.

DECLASSIFIED NACA REPORTS

NACA RM E8A29a

INTERNAL-FILM COOLING OF ROCKET NOZZLES. J. L. Sloop and George R. Kinney. June 8, 1948. 40p. diagrs., photos. (NACA RM E8A29a) (Declassified from Restricted, 1/3/52)

Experiments were conducted with a 1000-pound-thrust rocket engine to determine the feasibility of cooling convergent-divergent nozzles by internal film of water introduced at nozzle entrance. Water flow of 3 percent of propellant flow reduced heat flow into nozzle to 55 percent of uncooled heat flow. Introduction of water by porous ring before the nozzle resulted in more uniform coverage of nozzle than water introduced by single arrangement of 36 jets directed along nozzle wall. Water flow through a porous ring of 3.5 percent of propellant flow stabilized wall temperature in convergent section but did not adequately cool throat or divergent sections.

NACA RM E8F01

PHOTOGRAPHIC STUDY OF COMBUSTION IN A ROCKET ENGINE. I - VARIATION IN COMBUSTION OF LIQUID OXYGEN AND GASOLINE WITH SEVEN METHODS OF PROPELLANT INJECTION. Donald R. Bellman and Jack C. Humphrey. August 26, 1948. 51p. photos., diagrs., tab. (NACA RM E8F01) (Declassified from Restricted, 1/3/52)

Motion pictures up to 3000 frames per second were taken of the combustion of liquid oxygen and gasoline in a 100-pound thrust rocket engine. The effect of seven methods of propellant injection on the uniformity of combustion was investigated. The flame front was generally found to extend to the injector faces and all the injection systems showed considerable nonuniformity of combustion. Pressure vibration records indicated combustion vibrations that corresponded to resonant-chamber frequencies.

NACA RM E50F19

INTERNAL-FILM-COOLING EXPERIMENTS IN 4-INCH DUCT WITH GAS TEMPERATURES TO 2000° F. George R. Kinney and John L. Sloop. September 21, 1950. 34p. diagrs., tab. (NACA RM E50F19) (Declassified from Restricted, 1/3/52)

An investigation of film cooling was conducted in a 4-inch-diameter duct at gas temperatures from 600° to 2000° F and Reynolds numbers from 400,000 to 1,400,000. The coolants were water and ethylene glycol at flows of 1 to 6 percent of the gas flow. During vaporization of the liquid film, coolants kept the duct wall below the boiling temperature of the liquid; little additional duct cooling was obtained from coolant vapor alone. Data were generalized over part of the coolant-flow range by use of heat-transfer relations in a form that facilitates prediction of coolant flow required to film-cool a duct for a desired length when temperature and flow of the hot gas are known.

NACA RM E51C13

INVESTIGATION OF ANNULAR LIQUID FLOW WITH COCURRENT AIR FLOW IN HORIZONTAL TUBES. George R. Kinney and Andrew E. Abramson. May 25, 1952. 33p. diagrs., photos., 2 tabs. (NACA RM E51C13) (Declassified from Restricted, 1/3/52)

Visual observations and flow analyses were made of annular liquid flow with cocurrent air flow in horizontal tubes. Experiments were conducted with air temperatures of 80°, 475°, and 800° F, air-stream Reynolds numbers from 410,000 to 2,900,000, and liquid flows from 0.3 to 21 percent of air flows. Annular liquid films were approximately 0.0005 to 0.005 inch thick. Film surface changed from relatively smooth with the liquid annulus in the region where viscous forces are appreciable to disturbed where turbulent forces are predominant. Change in cooling effectiveness of liquid films in film-cooling experiments was related to film-surface change; surface condition could be predicted approximately knowing liquid flow and viscosity.

NACA RM L8D01

AERODYNAMIC CHARACTERISTICS OF A TWO-BLADE NACA 10-(3)(12)-03 PROPELLER. W. H. Gray and A. E. Allis. August 30, 1948. 27p. diagrs., tab. (NACA RM L8D01) (Declassified from Restricted, 12/28/51)

Contains results of wind-tunnel tests of the NACA 10-(3)(12)-03 propeller. The particular blade design, the tests of which are described, was one necessary to the investigation of the effect of differences in blade-thickness ratios. A maximum efficiency of 0.91 was attained at a constant rotational speed of 1140 rpm. Peak efficiency, at a blade angle of 45°, was decreased 26 percent by a helical tip Mach number increase from 0.81 to 1.10.

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1015

ANALYSIS OF TURBULENT FREE-CONVECTION BOUNDARY LAYER ON FLAT PLATE. E. R. G. Eckert and Thomas W. Jackson. 1951. 7p. diagrs. (NACA Rept. 1015. Formerly TN 2207)

A calculation was made for the flow and heat transfer in the turbulent free-convection boundary layer on a vertical flat plate. Formulas for the heat transfer coefficient, boundary layer thickness, and the maximum velocity in the boundary were obtained.

NACA Rept. 1017

INVESTIGATION OF FREQUENCY-RESPONSE CHARACTERISTICS OF ENGINE SPEED FOR A TYPICAL TURBINE-PROPELLER ENGINE. Burt L. Taylor, III and Frank L. Oppenheimer. 1951. 11p. diagrs., 2 tabs. (NACA Rept. 1017. Formerly TN 2184)

Experimental frequency-response characteristics of engine speed for a typical turbine-propeller engine are presented. Correlation is made between these experimental data and analytical frequency-response characteristics. Results of this investigation indicate that engine speed is a linear function of fuel flow and propeller-blade angle for small variations of these parameters. Approximate frequency-response characteristics may be calculated from solutions of a linear differential equation and equilibrium torque characteristics of the engine and the propeller.

NACA TN 2526

DETERMINATION OF RAM-JET COMBUSTION-CHAMBER TEMPERATURES BY MEANS OF TOTAL-PRESSURE SURVEYS. I. Irving Pinkel. December 1951. 10p. diagrs., tab. (NACA TN 2526. Formerly RM E7C03)

A method is described by which the total temperature of the gases at the combustion-chamber outlet of a ram-jet engine may be determined from the loss in total pressure measured across the combustion chamber. A working chart is presented by means of which the ratio of the total temperature of the gases at the combustion-chamber outlet to the total temperature of the gases at the combustion-chamber inlet may be determined from the measured loss of total pressure across the combustion chamber and the known values of air flow, total pressure, and total temperature at the combustion-chamber inlet.

NACA TN 2571

APPLICATION OF THE VON KÁRMÁN MOMENTUM THEOREM TO TURBULENT BOUNDARY LAYERS. Jerold M. Bidwell. December 1951. 25p. diagrs. (NACA TN 2571)

A study is made of the Von Kármán momentum theorem with respect to its application to turbulent boundary layers in a positive pressure gradient. Data were obtained from Schubauer and Klebanoff (NACA TN 2133) and Ludwieg and Tillman (NACA TM 1285) with which both the terms due to the mean flow and the terms due to the fluctuating flow could be evaluated.

NACA TN 2585

CALCULATION OF AERODYNAMIC FORCES ON A PROPELLER IN PITCH OR YAW. John L. Crigler and Jean Gilman, Jr. January 1952. 33p. diagrs. (NACA TN 2585. Formerly RM L8K26)

An analysis was made to determine the applicability of existing propeller theory and the theory of oscillating airfoils to the problem of determining the magnitude of the forces on propellers in pitch or yaw. Strip calculations using compressible airfoil characteristics were first made as though steady-state conditions existed successively at several blade positions of the propeller blades during one revolution. A theory of oscillating airfoils in pulsating incompressible potential flow was then considered from which it was possible to determine factors which would modify the steady-state forces.

NACA TN 2590

CALCULATIONS ON THE FORCES AND MOMENTS FOR AN OSCILLATING WING-AILERON COMBINATION IN TWO-DIMENSIONAL POTENTIAL FLOW AT SONIC SPEED. Herbert C. Nelson and Julian H. Berman. January 1952. 36p. diagrs., 2 tabs. (NACA TN 2590)

The linearized theory for compressible unsteady flow is used, as suggested in recent contributions to the subject, to obtain the velocity potential and the lift and moment for a thin, harmonically oscillating, two-dimensional wing-aileron combination moving at

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E REPORT TITLE AND AUTHOR.

sonic speed. The velocity potential is derived by considering the sonic case as the limit of the linearized supersonic theory. The paper provides extensive tables of numerical values for the coefficients contained in the expressions for lift and moment, for various values of the reduced frequency $k(0 < k \leq 3.5)$ and aileron hinge position (from 10 to 90 percent of the wing chord).

NACA TN 2591

THE EFFECTS OF REYNOLDS NUMBER ON THE APPLICATION OF NACA 16-SERIES AIRFOIL CHARACTERISTICS TO PROPELLER DESIGN. Harold E. Cleary. January 1952. 15p. diagrs. (NACA TN 2591. Formerly RM L7H12)

An analysis has been made of airfoil data taken on several NACA 16-series propeller airfoils. This analysis has shown that the combined effects of Reynolds number changes and variations in airfoil characteristics resulting from differences in models and tunnels are such that when 5-inch-chord and 12-inch-chord data are applied to full-scale propeller design at or near the design condition, differences of less than 1 percent in efficiency are involved.

NACA TN 2592

ORIENTATION OF ORIFICES ON BODIES OF REVOLUTION FOR DETERMINATION OF STREAM STATIC PRESSURE AT SUPERSONIC SPEEDS. Morton Cooper and Clyde V. Hamilton. January 1952. 26p. diagrs., photo., tab. (NACA TN 2592)

Experimental pressures obtained on a parabolic body of revolution of large fineness ratio at a Mach number of 1.59 and a Reynolds number of 3.6×10^6 have been analyzed in order to locate positions at which static-pressure orifices will indicate the stream static pressure independent of the pitch-yaw attitude of the body.

NACA TN 2594

INVESTIGATION OF THE STRUCTURAL DAMPING OF A FULL-SCALE AIRPLANE WING. Dwight O. Fearnow. February 1952. 11p. diagrs., photo., tab. (NACA TN 2594. Formerly RM L51A04)

An investigation to determine the structural damping characteristics of a full-scale airplane wing was conducted by the shock-excitation method wherein the wing was loaded to a predetermined deflection and the load suddenly released. The test specimen vibrated at its fundamental bending frequency of 1.69 cycles per second. Only the first 2 or 3 cycles showed any indication of a higher frequency being superimposed upon the fundamental bending frequency. The damping was found to increase from about 0.002 of critical at an amplitude of vibration of ±0.05 inch to approximately 0.006 of critical at an amplitude of ±5 inches.

NACA TN 2600

STRESSES AND DEFORMATIONS IN WINGS SUBJECTED TO TORSION. B. F. Ruffner and Eloise Hout, Oregon State College. February 1952. 79p. diagrs., 23 tabs. (NACA TN 2600)

Basic equations of Kármán and Chien are solved by representing the shape of a torsion box by means of a Fourier series. Coefficients of the series are determined by conventional methods. Angles of twist, longitudinal stresses, and shear stresses are determined in terms of the series coefficients. The method is applied to the calculation of angles of twist and stresses in torsion boxes of rectangular, elliptical, and airfoil cross section. Results obtained for angles of twist and normal stresses are in good agreement with results of Kármán and Chien except at sharp corners. Results obtained for shear stresses indicate the necessity for use of a large number of terms of the series for satisfactory accuracy.

NACA TN 2619

SOME REMARKS ON AN APPROXIMATE METHOD OF ESTIMATING THE WAVE DRAG DUE TO THICKNESS AT SUPERSONIC SPEEDS OF THREE-DIMENSIONAL WINGS WITH ARBITRARY PROFILE. Kenneth Margolis. February 1952. 9p. (NACA TN 2619)

A semiempirical profile-correction factor is discussed which enables the estimation of the wave-drag coefficient due to thickness at supersonic speeds for three-dimensional wings with arbitrary airfoil section (subject to restrictions of the thin airfoil theory) through use of previously calculated or known drag coefficients.

NACA TN 2620

PRINCIPLE AND APPLICATION OF COMPLEMENTARY ENERGY METHOD FOR THIN HOMOGENEOUS AND SANDWICH PLATES AND SHELLS WITH FINITE DEFLECTIONS. Chi-Teh Wang, New York University. February 1952. 33p. diagrs. (NACA TN 2620)

The principle of complementary energy in the nonlinear elasticity theory is shown to be derivable from the principle of potential energy by a Legendre type of transformation. In particular, the expression of the complementary energy is derived for homogeneous and sandwich plates and shells with large deflections. By the method of complementary energy, the stress-strain relations are derived for homogeneous shells, sandwich plates, and sandwich shells.

NACA TN 2626

AN INVESTIGATION OF BENDING-MOMENT DISTRIBUTION ON A MODEL HELICOPTER ROTOR

BLADE AND A COMPARISON WITH THEORY. John R. Meyer, Jr., Massachusetts Institute of Technology. February 1952. 91p. diagrs., photos., 12 tabs. (NACA TN 2626)

Bending-moment distributions were measured on a model helicopter rotor blade under hovering and simulated forward-flight conditions. The hinged-blade configuration was tested up to an advance ratio μ of 0.50; the fixed-at-root configuration, up to $\mu = 0.90$. Curves of maximum-bending-moment distribution are presented for all test conditions. Harmonic bending moments were found from a harmonic analysis of data for $\mu = 0.22$ and 0.47. Theoretical calculations at $\mu = 0.22$ and 0.47 for hinged- and fixed-at-root conditions, respectively, are compared with experimental results and the agreement is reasonable. Experimentally determined resonance peaks are compared with those indicated by theory for three sets of blades of different stiffnesses. Aerodynamic-loading expressions which include the effect of elastic flapping are developed for the fixed-at-root blade and are used in the Goodyear method which is modified for the fixed-at-root condition.

NACA TN 2630

A SOLUTION OF THE NAVIER-STOKES EQUATION FOR SOURCE AND SINK FLOWS OF A VISCOUS HEAT-CONDUCTING COMPRESSIBLE FLUID. Robert V. Hess. February 1952. 60p. diagrs., tab. (NACA TN 2630)

A solution of the Navier-Stokes equation for source and sink flows of a viscous, heat-conducting, compressible fluid is given for the case of constant total flow energy. For the satisfaction of the condition of constant total flow energy, a certain Prandtl number is required. Aside from this more obvious requirement, the selection of a certain ratio of the first and second viscosity coefficient is necessary. The nature of the general solutions for flow with arbitrary Prandtl number and with heat addition is discussed. Furthermore, the manner is discussed in which the familiar heat-conduction effects combined with the peculiar viscous effects solely due to compressibility, sometimes called the longitudinal viscous effects, influence the flow through a curved minimum section joined to a sink flow. A discussion of the second viscosity coefficient from the gas-dynamic approach is also given.

NACA TN 2633

ESTIMATION OF THE MAXIMUM ANGLE OF SIDESLIP FOR DETERMINATION OF VERTICAL-TAIL LOADS IN ROLLING MANEUVERS. Ralph W. Stone, Jr. February 1952. 46p. diagrs., 4 tabs. (NACA TN 2633)

This paper presents the results of a study, by a step-by-step integration of the equations of motion, of the variations of angle of sideslip and angle of attack in rolling maneuvers, particularly for airplanes with mass distributed mainly along the fuselage. The results are compared with those of existing methods for estimating angles of sideslip for determining vertical-tail loads in rolling maneuvers.

NACA TN 2635

AN ANALYSIS OF LAMINAR FREE-CONVECTION FLOW AND HEAT TRANSFER ABOUT A FLAT PLATE PARALLEL TO THE DIRECTION OF THE GENERATING BODY FORCE. Simon Ostrach. February 1952. 47p. diagrs., tab. (NACA TN 2635)

A formal and general analysis of the free-convection flow about a flat plate parallel to the direction of the generating body force is made, and velocity and temperature distributions for Prandtl numbers of 0.01, 0.72, 0.733, 1, 2, 10, 100, 1000, and large Grashof numbers are computed. The distributions for Prandtl number of 0.72 compare favorably with experimental values. It is shown that velocities and Nusselt numbers of the same order of magnitude as those associated with forced-convection flows can be obtained under free-convection conditions. A flow and a heat-transfer parameter are derived from which the important physical quantities can be computed. Reasonable agreement is obtained among values of the heat-transfer parameter obtained from an approximate theoretical development, experiments, and the present development.

NACA TN 2636

INFLUENCE OF LUBRICANT VISCOSITY ON OPERATING TEMPERATURES OF 75-MILLIMETER-BORE CYLINDRICAL-ROLLER BEARING AT HIGH SPEEDS. E. Fred Macks, William J. Anderson and Zolton N. Nemeth. February 1952. 47p. diagrs., photo., 3 tabs. (NACA TN 2636)

Oil viscosity (five oils were used) was found to have a significant effect on bearing operating temperature. Minimum bearing temperatures result when a low viscosity, low viscosity-index oil is used. Minimum power rejection to the oil (at a constant bearing temperature) results when a low viscosity oil is introduced at high inlet temperatures. The cooling correlation previously developed was extended to include fully the effect of varying viscosity. It is therefore possible to predict either inner-race or outer-race bearing temperature from single curves regardless of whether speed, load, oil flow, oil inlet temperature, oil inlet viscosity, oil-jet diameter or any combination of these parameters is varied.

NACA TN 2637

COMPRESSIVE BUCKLING OF FLAT RECTANGULAR METALITE TYPE SANDWICH PLATES WITH SIMPLY SUPPORTED LOADED EDGES AND CLAMPED UNLOADED EDGES. (Revised) Paul Seide. February 1952. 27p. diagrs., 3 tabs. (NACA TN 2637) (Superseded TN 1886, May 1949)

A theoretical solution is obtained for the problem of

the compressive buckling of flat rectangular Metalite-type sandwich plates with simply supported loaded edges and clamped unloaded edges. The solution is based upon the general small-deflection theory for flat sandwich plates developed in NACA Rep. 899.

NACA TN 2639

FATIGUE STRENGTHS OF AIRCRAFT MATERIALS. AXIAL-LOAD FATIGUE TESTS ON NOTCHED SHEET SPECIMENS OF 24S-T3 AND 75S-T6 ALUMINUM ALLOYS AND OF SAE 4130 STEEL WITH STRESS-CONCENTRATION FACTOR OF 1.5. H. J. Grover, W. S. Hyler and L. R. Jackson, Battelle Memorial Institute. February 1952. 22p. diagrs., 9 tabs. (NACA TN 2639)

Results are given of axial-load fatigue tests on notched specimens of 24S-T3 and 75S-T6 aluminum alloys and of normalized SAE 4130 steel. Each specimen was notched by edge notches designed to have a theoretical stress-concentration factor of 1.5. Tests were run at nominal mean stresses of 0, 10,000, 20,000, and 30,000 psi. Results extend previously reported data on unnotched specimens and specimens more severly notched afford data on the variation of fatigue strength reduction with notch severity.

NACA TN 2642

APPLICATION OF LINEAR ANALYSIS TO AN EXPERIMENTAL INVESTIGATION OF A TURBOJET ENGINE WITH PROPORTIONAL SPEED CONTROL. Marcel Dandois and David Novik. February 1952. 38p. diagrs., photos. (NACA TN 2642)

Results of analytical and experimental investigations of a turbojet engine with proportional speed control are compared. Linear analysis and description of the engine as a first-order linear system were found adequate for analytical prediction of the response and stability of the controlled engine. Characteristics of proportional speed control determined from the effect of loop gain on response, speed error, and stability are presented.

NACA TN 2646

INVISCID FLOW ABOUT AIRFOILS AT HIGH SUPERSONIC SPEEDS. A. J. Eggers, Jr. and Clarence A. Syvertson. March 1952. 65p. diagrs., tab. (NACA TN 2646)

The flow about curved airfoils is investigated analytically at high supersonic speeds assuming air behaves first as an ideal, and then as a calorically imperfect gas. For ideal gas flows it is shown that the shock-expansion method accurately predicts pressure distributions on curved airfoils at arbitrarily high Mach numbers provided the flow deflection angles are not too close to those corresponding to shock detachment. Forms of the shock-expansion method and the method of characteristics, generalized to consider the caloric imperfections of air and applicable for local air temperatures up to 5000° R are obtained and investigated. This shock-expansion method also exhibits a wide range of applicability and is shown to be useful in calculating the entire flow field about an airfoil. High Mach number approximations to both shock-expansion methods are investigated and presented in forms suitable for application to engineering problems.

NACA TN 2654

TWO-DIMENSIONAL FLOW ON GENERAL SURFACES OF REVOLUTION IN TURBOMACHINES. John D. Stanitz and Gaylord O. Ellis. March 1952. 44p. diagrs., tab. (NACA TN 2654)

A method of analysis is developed for two dimensional flow on general surfaces of revolution in turbomachines with arbitrary blade shapes. The method of analysis is developed for steady, compressible, nonviscous, irrotational flow that is assumed uniform normal to the surfaces of revolution. Incompressible solutions on a mean surface of revolution between the hub and shroud are presented for four flow rates through each of two centrifugal impellers with the same hub-shroud contours but with different blade spacings. In addition, correlation equations are developed whereby the velocity components and the stream function distribution can be predicted for compressible or incompressible flow in straight-bladed impellers only, with any tip speed, flow rate, area variation, blade spacing, and for any flow surface of revolution.

NACA RM E51L17

A PHOTOGRAPHIC STUDY OF FREEZING OF WATER DROPLETS FALLING FREELY IN AIR. Robert G. Dorsch and Joseph Levine. February 1952. 29p. diagrs., photos., 2 tabs. (NACA RM E51L17)

The freezing of free-falling water droplets in air was investigated by a photographic technique. Information on the following was obtained: (1) droplet shape after freezing, (2) the occurrence of collisions of partly frozen or frozen and liquid droplets, and (3) the freezing temperatures of individual free-falling droplets.

NACA RM E51L18

AN ACTIVE PARTICLE DIFFUSION THEORY OF FLAME QUENCHING FOR LAMINAR FLAMES. Dorothy M. Simon and Frank E. Belles. March 1952. 24p. diagrs., 3 tabs. (NACA RM E51L18)

An equation for quenching distance based on the destruction of chain carriers by the surface is derived. The equation expresses the quenching distance in terms of the diffusion coefficients and partial pressures of the chain carriers, the time between effective collisions of chain carriers and gas phase molecules, the efficiency of the surface as a chain

breaker, the total pressure of the mixture, and a constant which depends on the geometry of the quenching surface. Quenching distances measured by flashback for propane-air flames are shown to be consistent with the mechanism. The derived equation is used with the lean inflammability limit and a rate constant calculated from burning velocity data to estimate quenching distances for propane-air (hydrocarbon lean) flames satisfactorily.

NACA RM E51L20

FRICTION AND SURFACE DAMAGE OF SEVERAL CORROSION-RESISTANT MATERIALS. Marshall B. Peterson and Robert L. Johnson. February 1952. 20p. photos., diagrs., 2 tabs. (NACA RM E51L20)

Friction and surface damage of several materials that are resistant to corrosion due to liquid metals was studied in air. The values of kinetic friction coefficient at low sliding velocities and photomicrographs of surface damage were obtained. Appreciable surface damage was evident for all materials tested. The friction coefficients for the combinations of steel, stainless steel, and monel sliding against steel, stainless steel, nickel, Inconel, and Nichrome ranged from 0.55 for the monel-Inconel combination to 0.97 for the stainless-steel-nickel combination; for steel, stainless steel, monel, and tungsten carbide against zirconium, the friction coefficient was approximately 0.47. Lower coefficients of friction (0.20 to 0.60) and negligible surface failure at light loads were obtained with tungsten carbide when used in combination with various plate materials.

NACA RM E52A08

VARIATION OF PRESSURE LIMITS OF FLAME PROPAGATION WITH TUBE DIAMETER FOR VARIOUS ISOOCTANE-OXYGEN-NITROGEN MIXTURES. Adolph E. Spakowski and Frank E. Belles. March 1952. 20p. diagrs. (NACA RM E52A08)

An investigation was made of the change in the pressure limits of flame propagation with tube diameter for various isooctane-oxygen-nitrogen mixtures. Pressure limits were measured in cylindrical glass tubes of four different inside diameters at six different oxygen-nitrogen ratios. Under the experimental conditions, flame propagation was found to be impossible in isooctane-oxygen-nitrogen mixtures with oxygen concentrations less than 11 to 12 percent. Critical tube diameters for flame propagation were calculated and the effect of pressure was determined and compared with the effect of pressure on quenching distance. Critical diameters were related to flame speeds for various isooctane-oxygen-nitrogen mixtures.

NACA TM 1333

ON ROTATIONAL CONICAL FLOW. (Sui Moti Conici Rotazionali). Carlo Ferrari. February 1952. 12p. diagrs. (NACA TM 1333. Trans. from Onore di Modesto Panetti, November 25, 1950).

Some general properties of isoenergetic rotational conical fields are determined. For such fields, provided the physical parameters of the fluid flow are known on a conical reference surface, it being understood that they satisfy certain imposed conditions, it is shown how to construct the hodographs in the various meridional semiplanes, as the envelope of either the tangents to the hodographs or of the osculatory circles.

NACA TM 1329

CONCERNING THE FLOW ABOUT RING-SHAPED COWLINGS. PART IX - THE INFLUENCE OF OBLIQUE ONCOMING FLOW ON THE INCREMENTAL VELOCITIES AND AIR FORCES AT THE FRONT PART OF CIRCULAR COWLS. (Über die Strömung an ringförmigen Verkleidungen. IX Mitteilung: Der Einfluss der Schräganblasung auf die Uebergeschwindigkeiten und Luftkräfte am vorderen Teil von Ringhauben). Dietrich Küchemann and Johanna Weber. February 1952. 16p. diagrs. (NACA TM 1329) Trans. from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin. FB 1236/9; Aerodynamische Versuchsanstalt Göttingen E. V. Institut für theoretische Aerodynamik. (Bericht) 43/A/10. June 10, 1943).

The dependence of the maximum incremental velocities and air forces on a circular cowling on the mass flow and the angle of attack of the oblique flow is determined with the aid of pressure-distribution measurements. The particular cowling tested had been partially investigated in NACA TM 1327.

BRITISH REPORTS

N-13033 *

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF THE CONDENSATION OF ATMOSPHERIC WATER VAPOUR ON TOTAL HEAD AND OTHER MEASUREMENTS IN THE N.P.L. HIGH SPEED TUNNELS. H. H. Pearcey. NOTE ON THE INTERPRETATION OF READINGS OF PITOT AND STATIC TUBES IN A HIGH SPEED TUNNEL IN WHICH CONDENSATION OF MOISTURE IS TAKING PLACE. C. N. H. Lock. 1951. 38p. diagrs., 5 tabs. (ARC R & M 2249. Formerly ARC 7482; FM 669; 8455; FM 776)

At high Mach numbers condensation causes a considerable total-head loss which increases with distance along the working section, and serious discrepancies in pitot traverse drag which most probably increase with airfoil chord. It is considered that future high-speed tunnels, especially if they are built with longer working sections or to take larger chord airfoils, should be so constructed as to permit the use of dry air.

N-13034 *

Aeronautical Research Council (Gt. Brit.)

PARACHUTE DESIGN. T. F. Johns. 1951. 30p. diagrs., 4 tabs. (ARC R & M 2402; ARC 10,579. Formerly RAE Tech. Note Arm. 365)

This report records the methods of parachute design which have been developed in England during the latter part of the war. It begins with a discussion of the main characteristics of a parachute and of the effects of various factors on these characteristics. It then describes the main types of parachute which are at present in use and discusses the merits of each type. Details are given of the methods of manufacture which have been found to be the most satisfactory.

N-13035*

Aeronautical Research Council (Gt. Brit.)
EXPRESSIONS FOR THE RATES OF CHANGE OF CRITICAL FLUTTER SPEEDS AND FREQUENCIES WITH INERTIAL, AERODYNAMIC AND ELASTIC COEFFICIENTS. G. H. L. Buxton and I. T. Minhinnick. 1951. 71p. diagrs. (ARC R & M 2444; ARC 9140. Formerly RAE SME 3339)

Formulas are derived giving the rates of change of the critical speeds and frequencies for flutter of an aeroelastic system of a general number of degress of freedom, with each of the dynamical coefficients occurring in the equations of motion. Summation relations between the rates of change are obtained. Special forms of formulas for binary flutter are given and simple formulas for rates of change of critical speeds and frequencies when all the coefficients of a given type are changed in the same ratio are obtained for this particular case.

N-13036*

Aeronautical Research Council (Gt. Brit.)
SOME OBSERVATIONS ON DIFFUSION FLAMES AT LOW PRESSURES. F. H. Holderness. 1951. 6p. diagrs., 3 tabs. (ARC R & M 2445; ARC 10,064. Formerly NGTE R. 3)

A description is given of some observations on the flames from wick lamps and candles burning in a stream of air in a chamber which can be gradually exhausted. The effects of scale, temperature, and of the chemical nature of the fuel on the pressure at which extinction occurs is examined.

N-13038*

Aeronautical Research Council (Gt. Brit.)
SANDWICH CONSTRUCTION AND CORE MATERIALS. PART IV. NOTES ON SOME METHODS OF TESTING CORE MATERIALS. F. T. Barwell. 1951. 17p. diagrs. (ARC R & M 2467. Formerly ARC 9591; Strut 1020; Plas. 61)

Discusses the properties required of low-density core materials and the methods of testing for these properties. An order of tests is given whereby unpromising material may be quickly eliminated.

N-13040*

Aeronautical Research Council (Gt. Brit.)
LOW-SPEED WIND-TUNNEL TESTS ON THE BAYNES CARRIER WING; A TAILLESS GLIDER. J. Trouncer. 1951. 41p. diagrs., 35 tabs. (ARC R & M 2487; ARC 6608; ARC 7125; ARC 7127; ARC 8590; ARC 8910. Formerly RAE Aero 1802; Tech. Note Aero 1191; Tech. Note Aero 1608; Tech. Note Aero 1672)

Longitudinal and lateral stability tests were made on the glider as designed with a tank and with a fuselage replacing the tank. The effects of end fins, split flaps, and elevons are also given. In the final design condition with the fuselage instead of the tank the maximum trim lift coefficient was 1.08 (flaps up) and 1.27 (flaps down). Instability developed before the stall, flaps up, but could be cured by fitting tip slats. The changeover from tank to fuselage caused a decrease in C_{m_o} of 0.019; of this change ΔC_{m_o} tank = +0.001 and ΔC_{m_o} fuselage = -0.020.

N-13042*

Aeronautical Research Council (Gt. Brit.)
AN EXPERIMENTAL INVESTIGATION INTO THE SUITABILITY OF A CORRUGATED CONSTRUCTION WING FOR A LAMINAR-FLOW AEROFOIL. J. C. King. 1951. 25p. diagrs., photos. (ARC R & M 2530; ARC 8852. Formerly RAE SME 3291)

Describes a detailed experimental investigation into the structural features of a 6-foot chord wing specimen having thick skin reinforced by spanwise corrugations. The tests included surface distortion, proof and ultimate tests on the specimen and compression tests on two panels. A short length of parallel specimen was used with a simplified test rig built for the purpose.

N-13049*

Aeronautical Research Council (Gt. Brit.)
HIGH SPEED WIND TUNNEL TESTS ON MODEL OF TWO JET-PROPELLED FIGHTERS (METEOR AND VAMPIRE). Staff of RAE High Speed Wind Tunnel. 1951. 113p. diagrs., photos., 8 tabs. (ARC R & M 2504; ARC 7013, ARC 10,187; ARC 7406; ARC 8241; ARC 8566; ARC 8711; ARC 8911; ARC 9183. Formerly RAE Aero 1833; Tech. Note Aero 1474; Tech. Note Aero 1631; Aero 2026; Aero 2058; Tech. Note Aero 1696; Tech. Note Aero 1235; Tech. Note Aero 1302; Tech. Note Aero 1588)

Describes measurements of lift, drag and pitching moment made in the RAE High-Speed Wind Tunnel on models of the Meteor and Vampire. Additional tests, including measurements of pressure distribution and tuft observations, were made to investigate alternative nacelles for the Meteor. Further tests to investigate changes of stability and trim were made on both models.

N-13050 *

Aeronautical Research Council (Gt. Brit.)
MEASUREMENT OF AIRCRAFT ATTITUDE RELATIVE TO FLIGHT PATH DURING DIVES. J. E. H. Braybon. 1951. 11p. diagrs., photos. (ARC R & M 2564; ARC 10,604. Formerly AAEE Rept. A.A.E.E./Arm/Res/13)

Deals with development of a technique for direct recording of the attitude of an aircraft relative to flight path during dives, that is, the direction of incidence of free air flow relative to aircraft datum, using a wind vane coupled to a Desynn transmitter. Results obtained under steady conditions of dive angle and A.S.I. show agreement with those deduced from level flight results using conventional air-flow incidence/lift-coefficient relation. Included are details of instrumentation required to obtain simultaneous records of flight conditions and corresponding incidence under nonsteady conditions such as exist during rocketry attacks.

N-13127*

Forest Products Research Lab. (Gt. Brit.)
INVESTIGATIONS INTO GLUES AND GLUING. PROGRESS REPORT SIXTY-FIVE - NOVEMBER, 1951. TESTS CONNECTED WITH THE PROPOSED REVISION OF BS1203. R. J. Newall. 12p. 4 tabs. (Forest Products Research Lab.)

Knife tests have been made on a number of species of plywood bonded with various adhesives after (a) steaming at different pressures, (b) boiling continuously for periods up to three weeks, and (c) cyclical treatments involving boiling and cooling in water or boiling and oven drying to 100° C.

N-13320*

Royal Aircraft Establishment (Gt. Brit.)
ROLLING BALANCE MEASUREMENTS. PART II - RESULTS OF TESTS ON TWO TAPERED WINGS. (Messungen an der Rollwaage. II. Messergebnisse an zwei Trapezflügeln). G. Thiel. September 1951. 50p. diagrs., tab. (RAE Library Trans. 379, pt. 2; MOS GDC 10/451(11)T. Trans. from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin. FB 1808/2; Deutsche Versuchsanstalt für Luftfahrt E. V., Berlin. Institut für Aerodynamik. Jf 227/1, November 20, 1943).

Measured the rolling and yawing moments due to rolling of two tapered wings (with and without split flaps) which only differed in thickness. The experiments were made at Reynolds numbers 0.84×10^{6} referred to the mean wing chord and over an angle of attack range of 0° to 30° and the rate of roll was varied. The results are compared with theory.

N-13391*

Aeronautical Research Council (Gt. Brit.)
THE THEORETICAL LIFT AND PITCHING MOMENT OF A HIGHLY-SWEPT DELTA WING ON A BODY OF ELLIPTIC CROSS-SECTION. T. Nonweiler. 1951. 16p. diagrs. (ARC CP 58; ARC 13,696)

This note investigates the lift, pitching-moment and induced drag coefficients of a highly-swept delta wing attached to an elliptic cylinder of constant cross-section. These coefficients are derived by treating the changes in perturbation velocity parallel to the free-stream direction as small compared with the velocity changes in transverse planes. Curves are given which enable these coefficients to be determined for various values of the body width and body height.

N-13392*

Aeronautical Research Council (Gt. Brit.)
THE MEASUREMENT OF HEAT TRANSFER AND SKIN FRICTION AT SUPERSONIC SPEEDS; PRELIMINARY RESULTS OF MEASUREMENTS ON A FLAT PLATE AT A MACH NUMBER OF 2.5. J. E. Johnson and R. J. Monaghan. 1951. 35p. diagrs., 3 tabs. (ARC CP 59; ARC 12,483)

Gives details of a 5-inch by 5-inch supersonic tunnel designed for heat transfer and boundary-layer research and the preliminary results obtained with it at a Mach number of 2.5. A steam heated copper plate 5 inches by 14 inches is let into one wall and provision is made for measuring the plate temperature and the heat dissipated from the plate to the air stream over a range of temperature differences. Measurements of boundary-layer profile and plate temperature without heat transfer have also been made.

N-13393*

Aeronautical Research Council (Gt. Brit.)
A THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE FLOW IN A DUCT OF VARYING CROSS-SECTION, WITH PARTICULAR APPLICATION TO THE DESIGN OF DUCTS FOR FREE FLIGHT GROUND-LAUNCHED MODEL TESTS. C. H. E. Warren, R. E. Dudley and P. J. Herbert. 1951. 37p. diagrs., 4 tabs. (ARC CP 60; ARC 13,726)

The flow in a duct was investigated theoretically for the case when there are no internal shocks or separation, and the results have been confirmed by wind-tunnel tests. The theoretical results are used to predict the flow where there are no internal shocks or separation in the duct. The wind-tunnel results are required to determine the flow when separation occurs. In such cases, it is found that the jumps in static pressure in the region of the breakaway are in fair agreement with the jumps found by Eggink in experiments of a related nature. It does not appear possible to predict the position of the regions of breakaway from the few tests made. It is considered that at supersonic free-stream Mach numbers the internal drag can be calculated with fair accuracy, but that at subsonic Mach numbers an appreciable uncertainty may be caused by an error in the estimation of the static pressure on the base of the duct.

N-13394*

Aeronautical Research Council (Gt. Brit.)
THE SUPERSONIC PRESSURE DRAG OF A SWEPT WING WITH A CRANKED MAXIMUM THICKNESS LINE. K. D. Thomson. 1951. 37p. diagrs., tab. (ARC CP 61; ARC 13,582)

The linearized theory is applied to a particular family of sweptback wings with cranked maximum thickness lines, and the drag of one member is analyzed and compared with several other wings whose solutions are well known. The indications are that one can approximate to the variation of drag with Mach number by combining curves of certain delta and "chevron" wings.

N-13395*

Aeronautical Research Council (Gt. Brit.)
PRESSURE MEASUREMENTS IN A SUPERSONIC TUNNEL ON A TWO-DIMENSIONAL AEROFOIL OF R.A.E. 104 SECTION. D. W. Holder, A. Chinneck and R. J. North. December 28, 1950. 13p. diagrs., photos. (ARC CP 62; ARC 13,622)

Measurements of the pressure distribution over the surface of a two-dimensional airfoil of RAE 104 section have been made at a Reynolds number of about 0.8×10^6 and at free-stream Mach numbers of 1.42, 1.60, and 1.79. The observations include schlieren photography of the flow, and were made at angles of attack of 0° and 2°.

N-13396*

Aeronautical Research Council (Gt. Brit.)
OBSERVATIONS OF THE SUPERSONIC FLOW ROUND A 6% THICK DOUBLE WEDGE. D. W. Holder, A. Chinneck and D. G. Hurley. December 28, 1950. 12p. photos., diagrs., tab. (ARC CP 63; ARC 13,623)

At a Mach number of 1.57 and Reynolds number of 0.8×10^6 pressure measurements and flow photographs were taken for a 6 percent thick two-dimensional symmetrical double wedge at angles of attack between 0° and 8°. Although the results are in general agreement with exact theory, discrepancies occur at mid-chord where the expansion is observed to be more gradual than would be expected in the absence of boundary layer, and close to the trailing edge where separation occurs when the airfoil is at angle of attack. Shock waves were observed at the nose and tail under conditions for which expansions alone would be expected.

N-13405*

Aeronautical Research Council (Gt. Brit.)
TESTS ON A 'LIGHTHILL' NOSE-SUCTION AEROFOIL IN THE N.P.L. 4-FT. NO. 2 WIND TUNNEL. F. Cheers, W. G. Raymer and Ola Douglas. 1951. 7p. diagrs., photos. (ARC R & M 2355. Formerly ARC, Performance Sub-Committee 10,506; Perf.301; FM 1095)

A series of tests on an 8.6 percent thick nose-suction airfoil designed by Lighthill has been made in the 4-ft No. 2 wind tunnel at the National Physical Laboratory at Reynolds numbers of 0.385 and 0.577×10^6. The results show that the wing stalls at $\alpha \leq 13^\circ (C_L = 1.12)$ without suction, the lift coefficient at the stall increasing approximately linearly with suction quantity and reaching 1.93 at $C_Q = 0.019$ and 23° angle of attack.

N-13406*

Aeronautical Research Council (Gt. Brit.)
TESTS ON YAWED AEROFOILS IN THE 20 x 8-IN. HIGH SPEED TUNNEL. J. A. Beavan and N. Bumstead. 1951. 9p. diagrs. (ARC R & M 2458. Formerly ARC, Fluid Motion Sub-Committee 10,730; FM 1133)

Tests on NACA 0020 sections of 1.2 and 2.0-inch chord completely spanning the tunnel, yawed 40° and straight, showed that there was no appreciable difference in compressibility drag rise due to wind-tunnel interference. The results, and further measurements on a Piercy airfoil previously tested, showed also that the gain in Mach number has been increased from 65 to about 80 percent of the theoretical value that assumes infinite span and no boundary layer effects due to reduction of tunnel humidity. Some explorations of the flow behind the airfoil are considered to justify these conclusions at Mach numbers up to at least 0.92.

N-13407*

Aeronautical Research Council (Gt. Brit.)
AN INVESTIGATION INTO THE EFFECT OF FORCED AND NATURAL AFTERBODY VENTILATION ON THE HYDRODYNAMIC CHARACTERISTICS OF A SMALL FLYING BOAT (SARO 37) WITH A 1:15 FAIRING OVER THE MAIN STEP. J. A. Hamilton. 1951. 28p. diagrs., photos., 2 tabs. (ARC R & M 2463; ARC 10,589. Formerly MAEE Rept. F/Res/204)

The fairing with no ventilation reduced the steady-run stability range to 3°, produced violent skipping in steady runs and landings, reduced the stable range of attitudes for landing, elevator fixed, to 2°, and so increased the water resistance beyond the hump that take-off within a certain range of attitudes was impossible without considerable pitching disturbance. Natural ventilation increased the steady-run stability range, reduced the violence of skipping in steady runs and landings, increased the stable range for landing, elevator fixed, to 4°, reduced water resistance so that only mild afterbody sticking occurred, and reduced the free-to-trim attitudes in the planing range by 2°. The addition of forced ventilation to natural ventilation raised the skipping limit in steady runs approximately 1°, and eliminated afterbody sticking.

N-13408*

Aeronautical Research Council (Gt. Brit.)
A METHOD OF DESIGNING CORNER CHANNELS AND CASCADES ON A HYPERBOLIC BASE-LINE. R. J. Monaghan. 1951. 10p. diagrs., tab. (ARC R & M 2464; ARC 9522. Formerly RAE Aero 2104)

Presents a method for the design of two-dimensional corner channels and cascade airfoils. The first step is to construct a flow pattern which satisfies the given flow conditions. Any two streamlines are then chosen as the boundaries of a corner channel, and a number of similar channels are placed side by side with their outer streamlines coinciding at infinity in each direction. If the velocity distributions in the channels are suitable a closed airfoil section is left between each pair. It only remains to round off the leading edge to allow for slight changes in angle of attack, and the cascade airfoil is obtained.

N-13409*

Aeronautical Research Council (Gt. Brit.)
SOME OBSERVATIONS ON SHARP-NOSED PROFILES AT SUPERSONIC SPEED. J. Valensi and F. W. Pruden. (Presented to VI International Congress of Applied Mechanics). 1951. 17p. photos., diagrs. (ARC R & M 2482. Formerly ARC, Fluid Motion Sub-Committee 10,607; FM 1108)

Two-dimensional tests have been made on two airfoils, one a wedge section and the other a double wedge section, each with a nose semiangle of 3.6^{0}. The tests were made in a 5- by 2-inch wind tunnel at M = 1.4, and comprised Schlieren observation and pressure measurement. The results have been compared with exact inviscid theory. Several divergences were noticed and are discussed. Excellent agreement with theory was obtained under certain conditions, and where serious disagreement occurred it was partly attributable to wind tunnel interference.

N-13410*

Aeronautical Research Council (Gt. Brit.)
PREVENTION OF CASTOR SHIMMY BY THE TWIN-CONTACT TYPE. O. J. Marstand. 1951. 15p. diagrs., photo. (ARC R & M 2508. Formerly RAE SME 3195)

Results of full-scale experiments on shimmy suppression by the twin-contact pneumatic tire are given. These results are supported theoretically and by some related facts of experience. The method is compared with existing ones and some practical considerations are discussed. The method is generally effective in tail and nose wheels without the use of other forms of heavy damping, over which it may have some advantages in simplicity, cost and effectiveness. It is likely to be suitable for production and use in new aircraft and some existing types.

N-13411*

Aeronautical Research Council (Gt. Brit.)
THE IDEAL DRAG DUE TO A SHOCK WAVE. C. N. H. Lock. 1951. 17p. diagrs., 4 tabs. (ARC R & M 2512. Formerly ARC, Aerodynamics Sub-Committee 5852; FM 528; Ae. 2032; ARC, Fluid Motion Panel 8458; FM 777)

The subject of this note is the increase of the drag of an airfoil which arises from the presence of limited shock waves when the forward speed lies between the so-called shock stalling speed and the velocity of sound. Part 1 presents a method of calculating a first approximation to the ideal theoretical drag rise due to a shock wave on an airfoil. Part 2 extends the method to cover the use of the Kármán-Tsien solution in place of the Glauert relation.

N-13412*

Aeronautical Research Council (Gt. Brit.)
AN APPROXIMATE SOLUTION OF TWO FLAT PLATE BOUNDARY-LAYER PROBLEMS. E. J. Watson and J. H. Preston. 1951. 13p. diagrs., 3 tabs. (ARC R & M 2537. Formerly ARC, Fluid Motion Sub-Committee 9914; FM 982)

The method presented here for obtaining an approximate solution of the laminar boundary-layer equations is based on the iteration process of Piercy and Preston. It leads to a simple analytical approximation of good accuracy for Blasius' solution of the boundary-layer flow past a flat plate. The main purpose of this paper is, however, the application of the method to a generalization of Blasius' problem, namely the case of a flat plate in a uniform stream when there is a suction velocity normal to the plate proportional to $x^{-1/2}$ where x is the distance along the plate from its leading edge.

N-13413*

Aeronautical Research Council (Gt. Brit.)
A REVIEW OF THE PROBLEM OF CHOOSING A CLIMB TECHNIQUE, WITH PROPOSALS FOR A NEW CLIMB TECHNIQUE FOR HIGH PERFORMANCE AIRCRAFT. K. J. Lush. 1951. 15p. diagrs (ARC R & M 2557; ARC 11,708; ARC 12,081. Formerly AAEE Rept. A. A. E. E. /Res/237)

The problem of choosing the best climbing technique is considered and limitations of the present technique discussed. Introduction of "energy height" as a variable permits a more exact treatment to be attempted and enables a geometrical illustration to be developed of the general problem of optimum climb between specified end conditions. From discussion of this illustration it is tentatively concluded that a revised climb technique, outlined in this report, will give improved performance by building up a relatively high kinetic energy at low altitudes for conversion into potential energy (that is height) at high altitudes.

N-13414*

Aeronautical Research Council (Gt. Brit.)
CALCULATED DATA FOR THE COMBUSTION WITH LIQUID OXYGEN OF WATER-DILUTED ALCOHOLS AND PARAFFIN IN ROCKET MOTORS. I. C. Hutcheon and S. W. Green. 1951. 13p. diagrs., 3 tabs. (ARC R & M 2572; ARC 11,561. Formerly RAE Tech. Note RPD 6/47)

Flame compositions, combustion temperatures, and specific impulses have been calculated for the combustion with liquid oxygen of aviation turbine paraffin and of ethyl or methyl alcohol with varying additions of water. Calculations have been confined to propellant combinations with an excess of alcohol or paraffin and which produce combustion temperatures below about 2,700° K. An expansion ratio of 20:1 has been assumed in obtaining the specific impulses, and the methods of calculation are fully explained.

N-13415*

Aeronautical Research Council (Gt. Brit.)
A NEW METHOD OF NUMERICAL INTEGRATION OF THE EQUATIONS OF THE LAMINAR BOUNDARY LAYER. T. G. Cowling. 1951. 14p. diagrs., 5 tabs. (ARC R & M 2575. Formerly ARC, Fluid Motion Sub-Committee 8690; FM 808)

This new method for the numerical solution of the boundary-layer equations rests on the fact that the equations of steady flow are special cases of the equations of general motion. Velocity profiles are found at successive sections across the boundary layer. Trial values of the velocity are assumed at any section. From these, space derivatives of the velocity are deduced by using finite differences, and time derivatives by using the equations of motion. Trial values are then adjusted to give zero time derivatives of the velocity at the section.

N-13416 *

Aeronautical Research Council (Gt. Brit.)
LATERAL CONTROL WITH HIGH LIFT DEVICES. A. D. Young. With appendix, by R. R. Duddy. 1951. 36p. diagrs., tab. (ARC R & M 2583; ARC 5144. Formerly RAE BA 1659)

Presents a summary of existing information on lateral control with high-lift devices. The devices considered are classified as: (a) those devices that can be used with full-span flaps, which include spoilers, auxiliary airfoils, ailerons behind Zap-type flaps, and ailerons behind slotted flaps; and (b) those devices which can be used only with nearly full-span flaps, which include short-span wide-chord ailerons floating-tip ailerons, and ailerons formed from part of rear flap of large double-slotted flap.

N-13417*

Aeronautical Research Council (Gt. Brit.)
CONTRA-FLOW TURBO-COMPRESSOR TESTS. A. D. Baxter and C. W. R. Smith. 1951. 43p. diagrs., photos., 3 tabs. (ARC R & M 2607; ARC 6002. Formerly RAE E. 3945; E. 3829)

In order to investigate the practical possibilities of the contra-flow type of turbocompressor various designs of single-stage wheels were tested and a complete turbocompressor constructed. This note describes the work on these items and the conclusions reached.

N-13498*

Royal Aircraft Establishment (Gt. Brit.)
APPROXIMATE CALCULATION OF THE TURBULENT BOUNDARY LAYER IN TWO-DIMENSIONAL INCOMPRESSIBLE FLOW. E. C. Maskell. November 1951. 61p. diagrs., 2 tabs. (RAE Aero 2443)

An approximate method is constructed for calculating the development of the turbulent boundary layer, given the velocity distribution outside the layer. The characteristics which may be determined are the momentum thickness θ, the profile parameter H, the skin-friction coefficient c_f, and the separation point. By making use of an empirical approximation, the momentum equation is directly integrated to determine θ. H is determined from an empirical differential equation similar in form to the von Doenhoff-Tetervin and Garner equations. The Ludwieg-Tillman formula is used to calculate the skin friction and, by extrapolation, to determine the separation point.

N-13574*

National Gas Turbine Establishment (Gt. Brit.)
THE CONTROLLED PRODUCTION OF STREAMS OF IDENTICAL DROPLETS. N. A. Dimmock. May 1951. 13p. diagrs., photos. (NGTE Memo. M. 115)

Using the apparatus described, it is possible to obtain streams of evenly spaced, identical droplets, with a diameter range of from 10 to 300 microns. Their formation can be watched in slow motion using a stroboscopic light source, and photographs obtained of any part of the formation. A possible development of the apparatus is suggested.

N-13588*

National Gas Turbine Establishment (Gt. Brit.)
STUDIES ON THE SPONTANEOUS IGNITION OF FUELS INJECTED INTO A HOT AIR STREAM. GENERAL INTRODUCTION AND PART I. THE DEVELOPMENT OF A COMBUSTION TEST RIG FOR MEASURING THE IGNITION DELAY OF FUELS. B. P. Mullins. August 1951. 32p. diagrs., photo., 2 tabs. (NGTE R. 89)

A standardized test rig, consisting essentially of a 6-inch-diameter metal duct through which the hot vitiated air from a slave combustion chamber is passed and into which fuel is injected, has been fully devel-

oped to measure ignition delays under appropriate conditions of short reaction time. The ignition delay is calculated from measurements of the length of the induction zone and the air velocity. The apparatus and technique are described and some theoretical aspects of the work are discussed in this report which includes some typical results for a kerosene spray.

N-13589*

National Gas Turbine Establishment (Gt. Brit.) STUDIES ON THE SPONTANEOUS IGNITION OF FUELS INJECTED INTO A HOT AIR STREAM. PART II. THE EFFECT OF PHYSICAL FACTORS UPON THE IGNITION DELAY OF KEROSINE-AIR MIXTURES. B. P. Mullins. September 1951. 56p. diagrs., 17 tabs. (NGTE R. 90)

The effect of a number of physical variables upon the ignition delay of kerosene was measured in the combustion rig described in NGTE R. 89. Air/fuel ratio and gas velocity have a negligible effect; spray particle size, fuel temperature, and coarse air turbulence have a small effect. Thus, the ignition delay at a given air temperature increases at the rate of ~1 percent per 3μ increase in spray Sauter mean diameter, decreases by ~15 percent with 60° C of fuel preheat, decreases by ~25 percent with fuel prevaporization, and is changed slightly when the induction zone is situated in the wake of a baffle plate.

UNPUBLISHED PAPERS

N-6270*

CONTRIBUTIONS TO THE HOT-WIRE METHOD. (Beiträge zur Hitzdrahtmethode). G. Datwyler. January 1952. 32p. diagrs. (Trans. from Zeitschrift für angewandte Mathematik und Physik, v. 1, no. 5, 1950, p.298-316).

The characteristics of hot wires are calculated approximately, by using the experimental results of the heat loss of thin cylinders in a cross-stream. They are based upon the similarity law of heat transfer by forced convection. The approximation lies in that the heat losses at the two ends of such probes are neglected, so that the results apply exactly only to wires of finite length as a part of infinitely long wires. Starting from an evaluation formula previously derived, a practical method is developed for determining the sensitivity of hot-wire probes. This method is based on the complete semiempirical equation by King.

DECLASSIFIED NACA REPORTS

NACA ACR L5H31*

COMPARISON OF TESTS OF A 4-FOOT-DIAMETER PROPELLER IN THE LANGLEY 8-FOOT AND 16-FOOT HIGH-SPEED TUNNELS. Morton Cooper. March 1946. 24p. diagrs., photo. (NACA ACR L5H31) (Declassified from Restricted, 2/28/52)

Tests have been conducted to compare the characteristics of a given propeller in different wind tunnels. NACA 4-(3.9)(07)-0345-C propeller characteristics are given for blade angles of 26°, 31.5°, 36.5°, 41°, and 45° at the 0.75 radius at a tunnel Mach number of 0.200 and for blade angles of 41°, 45°, and 49° at a tunnel Mach number of 0.480. Agreement for the corrected results is within 0.5 percent over most of the range tested, is well within experimental accuracy, and indicates that no tunnel-wall effects of significant magnitude exist other than those for which corrections are currently applied.

NACA ARR L6D23*

EFFECT OF SHANK DESIGN ON PROPELLER PERFORMANCE AT HIGH SPEEDS. James B. Delano and Melvin M. Carmel. June 1946. 87p. diagrs., photos., tab. (NACA ARR L6D23) (Declassified from Restricted, 2/28/52)

Tests of three two-blade propellers, designed for the the same operating condition and differing essentially only in shank design have been made through a range of blade angle from 20° to 58.5° for free-stream Mach numbers ranging from 0.20 to 0.70. The propellers have thickness ratios of 0.185, 0.500, and 1.000 at the spinner surface. The results indicate that the losses due to compressibility effects on the outboard sections can be minimized by the use of thin shank sections capable of carrying a large part of the thrust load.

NACA RM L6L20a

SUMMARY OF AVAILABLE DATA RELATING TO REYNOLDS NUMBER EFFECTS ON THE MAXIMUM LIFT COEFFICIENTS OF SWEPT-BACK WINGS. Harold H. Sweberg and Roy H. Lange. March 4, 1947. 20p. diagrs., tab. (NACA RM L6L20a) (Declassified from Restricted, 2/28/52)

The foreign and American data show that a low Reynolds numbers (below about 2×10^6) higher maximum lift coefficients were measured in most cases for moderately sweptback wings than for unswept wings of similar plan form; at high Reynolds numbers, however, increasing sweepback resulted in decreasing maximum lift coefficients. A smaller rate of increase of the maximum lift coefficient with Reynolds number was measured for the sweptback wings than for similar unswept wings in the critical range of Reynolds number. Increasing the Reynolds number resulted in decreases in the maximum lift coefficients of the two wings of approximately triangular plan form that were investigated.

NACA RM L6L27a

AERODYNAMIC CHARACTERISTICS AT HIGH SPEEDS OF FULL-SCALE PROPELLERS HAVING DIFFERENT SHANK DESIGNS. Julian D. Maynard. February 13, 1947. 72p. diagrs., photos., tab. (NACA RM L6L27a) (Declassified from Restricted, 2/28/52)

Tests of two two-blade propellers differing essentially in shank design only have been made. One propeller had a shank section typical of conventional blades and the other had an aerodynamically efficient airfoil section. The blades were tested through a range of angles from 20° to 55° at various rotational speeds and at airspeeds up to 496 mph. Although both propellers were very efficient, the one with the efficient airfoil section was about 5 percent more efficient.

NACA RM L7K28

HIGH-SPEED WIND-TUNNEL INVESTIGATION OF A FLYING-BOAT HULL WITH HIGH LENGTH-BEAM RATIO. John M. Riebe and Rodger L. Naeseth. June 20, 1948. 30p. diagrs., photo., 4 tabs. (NACA RM L7K28) (Declassified from Restricted, 2/28/52)

An investigation was made in the Langley high-speed 7- by 10-foot tunnel of a high length-beam ratio flying boat hull, the hull with step fairing, the hull with bottom rounded, and for comparison a streamline body of revolution. Mach numbers ranged from 0.4 to 0.85; angles of attack ranged from -2° to 7.25° at the low Mach numbers. Drag coefficients and longitudinal and lateral-stability parameters presented include the interference of the thin 40° sweptback support wing.

NACA RM L50H17a

A METHOD FOR PREDICTING THE LOW-SPEED CHORDWISE PRESSURE DISTRIBUTION OVER SHARP-EDGE AIRFOIL SECTIONS WITH PLAIN FLAPS AT THE LEADING AND TRAILING EDGES. Robert J. Nuber and Jones F. Cahill. October 2, 1950. 28p. diagrs. (NACA RM L50H17a) (Declassified from Restricted, 2/28/52)

A method is presented for the calculation of the low-speed chordwise pressure distribution over various relatively thin sharp-edge airfoils equipped with leading-edge and trailing-edge flaps of arbitrary size and deflection.

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1008

A SMALL-DEFLECTION THEORY FOR CURVED SANDWICH PLATES. Manuel Stein and J. Mayers. 1951. ii, 6p. diagrs. (NACA Rept. 1008. Formerly NACA TN 2017)

A small-deflection theory that takes into account deformations due to transverse shear is presented for the elastic-behavior analysis of orthotropic plates of constant cylindrical curvature, with consideration of buckling included. The theory is applicable primarily to sandwich construction.

NACA Rept. 1019

RELATION BETWEEN INFLAMMABLES AND IGNITION SOURCES IN AIRCRAFT ENVIRONMENTS. Wilfred E. Scull. 1951. iii, 38p. diagrs., 6 tabs. (NACA Rept. 1019. Formerly NACA TN 2227)

Data, which are applicable to the problem of aircraft fire hazards, were obtained from a literature survey and analyzed and discussed. Data pertaining to the ignition characteristics of inflammables ignited under various experimental conditions by heated surfaces, electric sparks and arcs and flames or hot gases are presented. Possible remedial measures, indicated by the survey to be capable of reducing aircraft fire hazards, are discussed.

NACA Rept. 1020

MEASUREMENTS OF AVERAGE HEAT-TRANSFER AND FRICTION COEFFICIENTS FOR SUBSONIC FLOW OF AIR IN SMOOTH TUBES AT HIGH SURFACE AND FLUID TEMPERATURES. Leroy V. Humble, Warren H. Lowdermilk and Leland G. Desmon. 1951. ii, 15p. diagrs. (NACA Rept. 1020. Formerly RM E7L31; RM E8L03; RM E50E23; RM E50H23)

An investigation of forced-convection heat transfer and associated pressure drops was conducted with air flowing through smooth tubes for an over-all range of surface temperature from 535° to 3050° R, inlet-air temperature from 535° to 1500° R, Reynolds number up to 500,000, exit Mach number up to 1, heat flux up to 150,000 Btu per hour per square foot, length-diameter ratio from 30 to 120, and three entrance configurations. Most of the data are for heat addition to the air; a few results are included for cooling of the air. The over-all range of surface-to-air temperature ratio was from 0.46 to 3.5.

NACA TN 2612

STRESS PROBLEMS IN PRESSURIZED CABINS. W. Flügge, Stanford University. February 1952. 91p. diagrs. (NACA TN 2612)

The report presents information on the stress problems in the analysis of pressurized cabins of high-altitude aircraft not met with in other fields of stress analysis relating to aircraft. The material may be roughly divided into shell problems and plate problems, the former being concerned with the curved walls of the cabin or pressure vessel and the latter being concerned with small rectangular panels of its walls, framed by stiffeners, but not necessarily plane.

NACA TN 2613

DETERMINATION OF INDICIAL LIFT AND MOMENT OF A TWO-DIMENSIONAL PITCHING AIRFOIL AT SUBSONIC MACH NUMBERS FROM OSCILLATORY COEFFICIENTS WITH NUMERICAL CALCULATIONS FOR A MACH NUMBER OF 0.7. Bernard Mazelsky. February 1952. 30p. diagrs., tab. (NACA TN 2613)

The indicial lift and moment functions for a pitching airfoil are calculated for a Mach number of 0.7 from the available flutter coefficients for an oscillating airfoil. Comparison of the indicial lift functions at a Mach number of 0 and 0.7 indicates that the growth of lift to the steady state is less rapid for compressible flow than for incompressible flow.

NACA TN 2614

ANALYTICAL INVESTIGATION ON SOME THREE-DIMENSIONAL FLOW PROBLEMS IN TURBOMACHINES. Frank E. Marble and Irving Michelson, California Institute of Technology. March 1952. 109p. diagrs., 2 tabs. (NACA TN 2614)

The flow of an incompressible inviscid fluid through a turbomachine with blade rows consisting of an infinite number of similar infinitely thin blades has been investigated theoretically in order to examine and describe the three-dimensional flow phenomena and to illustrate the methods of calculation developed.

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NACA TN 2623

COMPARISON OF SUPERSONIC MINIMUM-DRAG AIRFOILS DETERMINED BY LINEAR AND NONLINEAR THEORY. E. B. Klunker and Keith C. Harder. February 1952. 19p. diagrs. (NACA TN 2623)

Supersonic profiles of minimum pressure drag for a given thickness ratio and for a given area have been determined with the use of a nonlinear pressure relation and compared with minimum-drag profiles found by linearized theory. The results show that linearized theory is adequate for determining the profile shape, though not the drag, for Mach numbers from 2 to 10 for optimum airfoils with a finite trailing-edge thickness.

NACA TN 2624

FLAME SPEEDS OF METHANE-AIR, PROPANE-AIR, AND ETHYLENE-AIR MIXUTRES AT LOW INITIAL TEMPERATURES. Gordon L. Dugger and Sheldon Heimel. February 1952. 25p. diagrs., tab. (NACA TN 2624)

Flame speeds were determined for methane-air, propane-air, and ethylene-air mixtures at -73° C and for methane-air mixtures at -132° C. The data extend the curves of maximum flame speed against initial mixture temperature previously established for the range from room temperature to 344° C. Both a thermal and diffusion theory predicted the effect of low initial temperatures within approximately 20 percent, as was found previously for high initial temperatures. The low-temperature data also extended the linear correlations between maximum flame speed and calculated equilibrium active-radical concentrations, which were established by the reported high-temperature data. Flame speed was determined from the total area of the outside edge of the shadow of a nozzle flame.

NACA TN 2625

SUMMARY OF ACCELERATION AND AIRSPEED DATA FROM COMMERCIAL TRANSPORT AIRPLANES DURING THE PERIOD FROM 1933 TO 1945. Walter G. Walker and Roy Steiner. February 1952. 30p. diagrs., 5 tabs. (NACA TN 2625)

Normal acceleration and airspeed data collected in transport airplanes from 1933 to 1945 are summarized and analyzed with respect to gusts and gust loads. The accelerations experienced in most operations equaled or exceeded the limit-gust-load-factor increment, on the average, twice (once positive and once negative) in 10^7 flight miles. The gusts experienced in most operations exceeded 33 feet per second, on the average, twice (once positive and once negative) in 10^7 flight miles. The loads experienced for several operations varied appreciably from average conditions. A predominating factor causing the variations in the load experience was the differences in the gust experience, with operating speeds in rough air being a secondary contributing or moderating factor.

NACA TN 2632

CORROSION OF MAGNESIUM ALLOY ZK60A IN MARINE ATMOSPHERE AND TIDEWATER. Fred M. Reinhart, National Bureau of Standards. February 1952. 10p. photos., 4 tabs. (NACA TN 2632)

The corrosion resistance of unprotected magnesium-zinc-zirconium alloy ZK60A was determined in a marine atmosphere and in tidewater. The unprotected alloy was so rapidly attacked in tidewater that it would be of no practical value in applications subject to wetting by sea water. In the marine atmosphere, the rate of corrosion was much less and the alloy should give good service if adequately protected.

NACA TN 2638

STUDY OF INADVERTENT SPEED INCREASES IN TRANSPORT OPERATION. Henry A. Pearson. March 1952. 29p. diagrs., tab. (NACA TN 2638)

Some factors relating to the speed and Mach number margins required in operation of transport airplanes are discussed for the purpose of indicating how these margins should vary with the airplane qualities. Most of the cases investigated show that on a percentage basis smaller margins should be required of the faster airplane than the slower airplane. Equations are suggested which allow these margins to be estimated.

NACA TN 2645

EFFECTS OF WING LIFT AND WEIGHT ON LANDING-GEAR LOADS. Dean C. Lindquist. March 1952. 42p. diagrs., photo., tab. (NACA TN 2645)

The effects of wing lift and weight on maximum landing gear loads were investigated by drop testing a small landing gear with an oleo shock strut in the Langley impact basin. Lift forces were mechanically applied to the dropping mass to produce wing lift factors between 0 and 2. 0. Dropping weight ranged between 1000 and 2500 pounds. The results show the relationship between lift force, weight, and landing-gear loads for a range of vertical velocities between 0 and 12 feet per second.

NACA TN 2647

IMPLICATION OF THE TRANSPORT EQUATION FOR THE SEMIEMPIRICAL TREATMENT OF SHIELDS. Philip Schwed. March 1952. 31p. (NACA TN 2647)

The semiempirical method of dealing with shields by treating them as composed of layers is revised and extended by taking the angular distribution of the radiation into account and by making use of the trans-

port equation to obtain expansions suitable for special cases. Such expansions are given for the case where multiple scattering with angular deviation is of relatively little import and for the contrary case where this latter process dominates. A method for obtaining the parameters for layers of finite thickness from data on very thin layers is presented. The expansion used for the case where multiple scattering dominates is illustrated by consideration of a thick nonabsorbing neutron shield of high atomic weight. The physical significance of the expansion coefficients introduced is determined.

NACA TN 2648

EXPERIMENTAL INVESTIGATION OF TRANSITION OF A MODEL HELICOPTER ROTOR FROM HOVERING TO VERTICAL AUTOROTATION. S. E. Slaymaker, Robert R. Lynn and Robin B. Gray, Princeton University. March 1952. 29p. diagrs., photos. (NACA TN 2648)

An experimental investigation was made of the variation of average induced flow around a model helicopter during transition from hovering flight to steady autorotative vertical descent. Test data were obtained from simulated power failures under many different conditions. Results are summarized for variation in disk loading, blade angles, and pitch-change rate and "effective induced velocities" calculated for the various conditions are presented. Comparisons of theoretical and experimental data indicate that conditions peculiar to vertical descent in the transition range cause variations in performance not predicted by the theoretical analysis.

NACA TN 2649

EFFECT OF MACH NUMBER ON THE FLOW AND APPLICATION OF COMPRESSIBILITY CORRECTIONS IN A TWO-DIMENSIONAL SUBSONIC-TRANSONIC COMPRESSOR CASCADE HAVING VARIED POROUS-WALL SUCTION AT THE BLADE TIPS. William B. Briggs. March 1952. 43p. diagrs., photos. (NACA TN 2649)

A 65-(12)10 compressor blade cascade was evaluated at design geometry for Mach numbers from 0.12 to 0.89 with the boundary layer controlled through upstream slots and porous walls. The suction control was specified by a two-dimensionality criterion. The data show the effect of Mach number on turning angle, blade wake, blade profile pressure distribution, and static-pressure rise. The influence of suction on these parameters and secondary losses is illustrated. A system for correlating the experimental static-pressure rise with the theoretical is presented. Prandtl-Glauert and Kármán-Tsien compressibility correction predictions are compared with the data. A new method utilizing the vector-mean velocity and the contraction coefficient is presented.

NACA TN 2650

RADIOAUTOGRAPHIC METHOD FOR EXAMINING DISTRIBUTION OF PARTICLES IN A CYCLOTRON BEAM. M. L. Pool and S. Fultz, Ohio State University Research Foundation. March 1952. 20p. diagrs., photos., 5 tabs. (NACA TN 2650)

The relative distribution of particles emitted from activated metal foil has been obtained by the use of radioautographs of the foil, and hence the time-averaged distribution of particles in the cyclotron beam which causes activation of the foil can also be obtained. This has been established for Kodak Super Pan Press B film provided the maximum photographic density of the radioautograph is kept below 1.1. The method has been confirmed by direct comparison of density values and count rates and has also been verified for higher energy components of the β-rays emitted from the foils.

NACA TN 2651

SUPERSONIC CONICAL FLOW. Stephen H. Maslen, Brown University. March 1952. 32p. diagrs., tab. (NACA TN 2651)

A numerical method is described for the solution of the nonlinear equations for supersonic conical flow. The procedure is a combination of the method of characteristics and the relaxation process. A method for calculating the position of the shock is inherent in the analysis. The method presented is applicable to any conical flow and a solution for the flow about a triangular wing with supersonic leading edges is included as an illustration.

NACA TN 2652

APPLICATION OF A CHANNEL DESIGN METHOD TO HIGH-SOLIDITY CASCADES AND TESTS OF AN IMPULSE CASCADE WITH 90° OF TURNING. John D. Stanitz and Leonard J. Sheldrake. March 1952. 65p. diagrs., photos., 2 tabs. (NACA TN 2652)

A technique is developed for the application of a channel design method to the design of high-solidity cascades with prescribed velocity distributions as a function of arc length along the blade-element profile. The technique applies to both incompressible and subsonic linearized compressible (ratio of specific heats equal to -1.0), nonviscous, irrotational, fluid motion. An impulse cascade with 90° turning was designed for incompressible flow and was tested at the design angle of attack over a range of downstream Mach number from 0.2 to choke flow. To achieve good efficiency, the cascade was designed for prescribed velocities with maximum allowable blade loading according to limitations imposed by considerations of boundary-layer separation.

NACA TN 2653

A THERMODYNAMIC STUDY OF THE TURBINE-PROPELLER ENGINE. Benjamin Pinkel and Irving M. Karp. March 1952. 90p. diagrs. (NACA TN 2653)

Equations and charts are presented for computing performance parameters of a turbine-propeller engine for any given set of operating conditions and component efficiencies. In order to illustrate some of the turbine-propeller system performance characteristics, the total thrust horsepower per unit mass rate of air flow and the specific fuel consumption are presented for a wide range of flight engine design operating conditions and given design component efficiencies. The performance of a turbine-propeller engine containing a matched set of components is presented for a range of engine operating conditions. The influence of the characteristics of the individual components of off-design-point performance is shown. The flexibility of operation of two turbine-propeller engines is discussed; one engine has a divided turbine system in which the first turbine drives only the compressor and the second turbine independently drives the propeller, and the other engine has a connected turbine system which drives both the compressor and the propeller.

NACA TN 2655

CRITICAL STUDY OF INTEGRAL METHODS IN COMPRESSIBLE LAMINAR BOUNDARY LAYERS. Paul A. Libby, Morris Morduchow and Martin Bloom, Polytechnic Institute of Brooklyn. March 1952. 40p. diagrs., 3 tabs. (NACA TN 2655)

A number of the most promising integral methods for solving approximately the compressible-laminar-boundary-layer equations are investigated in order to determine a convenient and accurate method of calculating boundary-layer characteristics. The chief methods considered are the one-parameter Kármán-Pohlhausen method with three different assumptions for the velocity profiles and the two-parameter method with two different assumptions for the velocity profiles. Comparison of the results is made with those of known exact solutions for skin-friction and heat-transfer coefficients, velocity profiles, velocity derivatives, and especially laminar-boundary-layer stability. From this comparison, it is found that Kármán-Pohlhausen method with the sixth-degree polynomial as the velocity profile is the most suitable for many practical purposes.

NACA TN 2658

LAMINAR BOUNDARY LAYER OVER FLAT PLATE IN A FLOW HAVING CIRCULAR STREAMLINES. Artur Mager and Arthur G. Hansen. March 1952. 28p. diagrs., tab. (NACA TN 2658)

The laminar-boundary-layer development over a semi-infinite flat plate placed in a flow with concentric circular streamlines was investigated with the limitation of small total turning of the main-stream flow. The shape of the velocity profiles in the direction of the main-stream flow and perpendicular to it was analytically determined for an incompressible flow and a compressible flow with Prandtl number equal to 1. The boundary-layer thickness was shown to be proportional to the square root of the distance from the leading edge of the plate when measured along the streamline of the main-stream flow. The deflection of the boundary-layer flow at the plate surface from the direction of a circular streamline in the main flow was shown to vary directly with the turning. With increase in the Mach number of the main-stream flow, both the boundary-layer thickness and the deflection increased.

NACA TN 2664

EXPERIMENTAL INVESTIGATION OF THE TURBULENT-BOUNDARY-LAYER TEMPERATURE-RECOVERY FACTOR ON BODIES OF REVOLUTION AT MACH NUMBERS FROM 2.0 TO 3.8. Howard A. Stine and Richard Scherrer. March 1952. 20p. diagrs. (NACA TN 2664)

A turbulent-boundary-layer temperature recovery factor of 0.885 ± 0.011 was measured on both a 10° cone and a 40° cone cylinder at Mach numbers from 2 to 3.8 and Reynolds numbers based on surface kinematic viscosity from 4×10^5 to 4×10^6. Comparisons are made with available theories and experiments.

NACA TN 2666

TWO-DIMENSIONAL SUBSONIC FLOW PAST ELLIPTIC CYLINDER BY THE VARIATIONAL METHOD. G. V. R. Rao, New York University. March 1952. 39p. diagrs., 3 tabs. (NACA TN 2666)

A method of solution is presented for compressible fluid flow past an elliptic cylinder by means of the variational method. The solution is obtained as a function of thickness ratio and free-stream Mach number. Numerical examples are carried out for several thickness ratios and Mach numbers and the results are compared with those obtained by other methods. It is seen that the variational method yields good results for flow past a thick body at a low Mach number as well as for flow past a thin body at a high Mach number.

NACA RM 51G11

EFFECTIVE MODULUS IN PLASTIC BUCKLING OF HIGH-STRENGTH ALUMINUM-ALLOY SHEET. James A. Miller and Pearl V. Jacobs, National Bureau of Standards. September 1951. 15p. diagrs., 2 tabs. (NACA RM 51G11)

Results of compressive tests on duplicate longitudinal specimens from sheets of 75S-T6 and R301-T aluminum alloys in three thicknesses are presented as graphs of tangent modulus E_t, secant modulus E_s, and $\sqrt{\frac{1}{4} + \frac{3}{4}\frac{E_t}{E_s}}$ plotted against stress on a dimensionless basis. These functions may be used to obtain values of the plasticity coefficients referred to in "A Unified Theory of Plastic Buckling of Columns and Plates" by Elbridge Z. Stowell (NACA Rep. 898). In Stowell's theory the critical stress computed for the elastic case is multiplied by the appropriate plasticity coefficient to give the critical stress for the plastic case.

NACA RM E51G14

EXPERIMENTAL INVESTIGATION OF AN 0.8 HUB-TIP RADIUS-RATIO, NONTWISTED-ROTOR-BLADE TURBINE. David H. Silvern and William R. Slivka. December 1951. 18p. diagrs. (NACA RM E51G14)

An experimental investigation of an 0.8 hub-tip radius ratio, nontwisted-rotor-blade turbine designed for a stagnation-pressure ratio of 2.5 and an equivalent mean blade speed of 643 feet per second was made in a cold-air turbine with (a) nontwisted stator blades, and (b) twisted stator blades designed to maintain zero rotor-inlet incidence angles. Turbine efficiencies of the order of 0.85 at the design point were obtained with a nontwisted-rotor-blade turbine with a hub-tip radius ratio of 0.80. The turbine with the twisted stator blades gave higher efficiencies at the design point (of the order of 1.5 percentage points) than the turbine with the nontwisted stator blades.

NACA TM 1264

CALCULATION OF THE LATERAL-DYNAMIC STABILITY OF AIRCRAFT. (Raschet Bokovoi Dinamicheskoi Ustoichivosti Samolets). A. Raikh. February 1952. 82p. diagrs., 4 tabs. (NACA TM 1264. Trans. from Central Aero-Hydrodynamical Institute, Transactions, No. 453, 1939).

Graphs and formulas are given with the aid of which all the aerodynamic coefficients required for computing the lateral dynamic stability can be determined. A number of numerical examples are given for obtaining the stability derivatives and solving the characteristic-stability equation. Approximate formulas are derived with the aid of which rapid preliminary computations may be made and the stability coefficients corrected for certain modifications of the airplane. A derivation of the lateral-dynamic-stability equations is included.

UNPUBLISHED PAPERS

N-12716*

BOUNDARY LAYER IN COMPRESSIBLE GAS. (Pogranichnyi sloi v szhimaemon gaze). A. Dorodnitsyn. 65p. diagrs., 2 tabs. (Trans. from Prikladnaya Matematika i Mekhanika, v. 6, no. 6, 1942, p. 449-486).

Considers a laminar boundary layer of a compressible gas with absence of heat exchange between the body and the flowing gas. With certain assumptions various methods of boundary-layer theory for noncompressible fluid may be applied to the gas. For the laminar layer, the integral equation analogous to the Kármán equation is given and for its solution the Pohlhausen method is generalized and applied. The cases of plates and bodies of revolution are considered. The generalization of the Blasius-Howarth method is examined. The paper also considers a turbulent boundary layer in a compressible gas. The basic assumptions and expressions for the dynamic values are given.

DECLASSIFIED NACA REPORTS

NACA RM E8F01

PHOTOGRAPHIC STUDY OF COMBUSTION IN A ROCKET ENGINE. I - VARIATION IN COMBUSTION OF LIQUID OXYGEN AND GASOLINE WITH SEVEN METHODS OF PROPELLANT INJECTION. Donald R. Bellman and Jack C. Humphrey. August 26, 1948. 51p. photos., diagrs., tab. (NACA RM E8F01) (Declassified from Restricted, 1/3/52)

Motion pictures up to 3000 frames per second were taken of the combustion of liquid oxygen and gasoline in a 100-pound thrust rocket engine. The effect of seven methods of propellant injection on the uniformity of combustion was investigated. The flame front was generally found to extend to the injector faces and all the injection systems showed considerable nonuniformity of combustion. Pressure vibration records indicated combustion vibrations that corresponded to resonant-chamber frequencies.

NACA RM E50F19

INTERNAL-FILM-COOLING EXPERIMENTS IN 4-INCH DUCT WITH GAS TEMPERATURES TO 2000° F. George R. Kinney and John L. Sloop. September 21, 1950. 34p. diagrs., tab. (NACA RM E50F19) (Declassified from Restricted, 1/3/52)

An investigation of film cooling was conducted in a 4-inch-diameter duct at gas temperatures from 600° to 2000° F and Reynolds numbers from 400,000 to 1,400,000. The coolants were water and ethylene glycol at flows of 1 to 6 percent of the gas flow. During vaporization of the liquid film, coolants kept the duct wall below the boiling temperature of the liquid; little additional duct cooling was obtained from coolant vapor alone. Data were generalized over part of the coolant-flow range by use of heat-transfer relations in a form that facilitates prediction of coolant flow required to film-cool a duct for a desired length when temperature and flow of the hot gas are known.

NACA RM E51C13

INVESTIGATION OF ANNULAR LIQUID FLOW WITH COCURRENT AIR FLOW IN HORIZONTAL TUBES. George R. Kinney and Andrew E. Abramson. May 25, 1951. 33p. diagrs., photos., 2 tabs. (NACA RM E51C13) (Declassified from Restricted, 1/3/52)

Visual observations and flow analyses were made of annular liquid flow with cocurrent air flow in horizontal tubes. Experiments were conducted with air temperatures of 80°, 475°, and 800° F, air-stream Reynolds numbers from 410,000 to 2,900,000, and liquid flows from 0.3 to 21 percent of air flows. Annular liquid films were approximately 0.0005 to 0.005 inch thick. Film surface changed from relatively smooth with the liquid annulus in the region where viscous forces are appreciable to disturbed

where turbulent forces are predominant. Change in cooling effectiveness of liquid films in film-cooling experiments was related to film-surface change; surface condition could be predicted approximately knowing liquid flow and viscosity.

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CURRENT NACA REPORTS

NACA Rept. 1016

EFFECT OF TUNNEL CONFIGURATION AND TESTING TECHNIQUE ON CASCADE PERFORMANCE. John R. Erwin and James C. Emery. 1951. ii, 15p. diagrs., photos. (NACA Rept. 1016. Formerly TN 2028)

An investigation has been conducted to determine the influence of aspect ratio, boundary-layer control by means of slots and porous surfaces, Reynolds number and tunnel end-wall condition upon the performance of airfoils in cascades. A representative compressor-blade section (the NACA 65-(12)10) of aspect ratios of 1, 2, and 4 has been tested at low speeds in cascades with solid and with porous side walls. Two-dimensional flow was established in porous-wall cascades of each of the three aspect ratios tested: the flow was not two-dimensional in any of the solid-wall cascades.

NACA Rept. 1032

A COMPARISON OF THEORY AND EXPERIMENT FOR HIGH-SPEED FREE-MOLECULE FLOW. Jackson R. Stalder, Glen Goodwin and Marcus O. Creager. 1951. ii, 22p. diagrs., photos. (NACA Rept. 1032. Formerly NACA TN 2244)

A comparison is made of free-molecule-flow theory with the results of wind-tunnel tests performed to determine the drag and temperature-rise characteristics of a transverse circular cylinder. The measured values of the cylinder center-point temperature confirmed the salient point of the heat-transfer analysis which was the prediction that an insulated cylinder would attain a temperature higher than the stagnation temperature of the stream. Good agreement was obtained between the theoretical and the experimental values for the drag coefficient.

NACA Rept. 1033

COMPARISON BETWEEN THEORY AND EXPERIMENT FOR WINGS AT SUPERSONIC SPEEDS. Walter G. Vincenti. 1951. ii, 11p. diagrs., photos. (NACA Rept. 1033. Formerly TN 2100)

A critical comparison is presented between experimental and theoretical results for the aerodynamic characteristics of wings at supersonic flight speeds. After a brief review of supersonic wing theory and of previous results from two-dimensional pressure-distribution tests, an account is given of an NACA study of the force characteristics of three dimensional wings at supersonic speed. Typical experimental and theoretical results are presented for the lift, pitching-moment, and drag characteristics of several families of wings of varying plan form and section. The regions of agreement and disagreement between experiment and theory are noted and discussed.

NACA Rept. 1034

INVESTIGATION OF SPOILER AILERONS FOR USE AS SPEED BRAKES OR GLIDE-PATH CONTROLS ON TWO NACA 65-SERIES WINGS EQUIPPED WITH FULL-SPAN SLOTTED FLAPS. Jack Fischel and James M. Watson. 1951. ii, 25p. diagrs. (NACA Rept. 1034. Formerly TN 1933)

Contains results and discussion of an investigation of plug and retractable ailerons used as speed brakes or glide-path controls on an NACA 65-210 wing and an NACA 65_2-215 wing of aspect ratio 5.76 equipped with full-span slotted flaps. Incremental lift, drag, and pitching-moment data are presented for various flap conditions through a large angle-of-attack range at Mach numbers from 0.13 to 0.71. Analysis indicates that this use of spoiler ailerons is feasible and desirable for normal or emergency operation of airplanes. These speed brakes or glide-path controls would probably have small effect on wing pitching moments and should retain their rolling effectiveness.

NACA TN 2598

A TECHNIQUE APPLICABLE TO THE AERODYNAMIC DESIGN OF INDUCER-TYPE MULTISTAGE AXIAL-FLOW COMPRESSORS. Melvyn Savage and Loren A. Beatty. March 1952. ii, 62p. diagrs., 8 tabs. (NACA TN 2598)

A method is presented for the preliminary design of high-pressure-ratio multistage axial-flow compressors using the solid-body inducer design in which the first stage has the radial total-temperature distribution required to make the second-stage inlet axial velocity constant radially. The remaining stages have constant power input radially, solid-body average tangential velocities, and radially constant inlet axial velocities. Typical preliminary design calculations are presented for inlet hub-tip ratios of 0.40, 0.50, and 0.60 with weight flows ranging from 20.0 to 32.5 pounds per second per square foot of frontal area and average pressure ratios per stage ranging from 1.28 to 1.38. Some of the effects of specific weight flow, rotational speed, hub-tip ratio, turning angle, and inlet air angle on power input, amount of

radial flow, and over-all pressure ratio are investigated.

NACA TN 2640

INTERACTION OF COLUMN AND LOCAL BUCKLING IN COMPRESSION MEMBERS. P. P. Bijlaard and G. P. Fisher, Cornell University. March 1952. 110p. diagrs., photos., 4 tabs. (NACA TN 2640)

Simple formulas are obtained which express the actual buckling stress directly in terms of the column or plate buckling stresses. Columns with box, I-, H-, and T-sections and angles are considered separately. Interaction of practically significant magnitude occurs only in cases of flexural and torsional buckling. In these cases the additional effect of distorsion of the cross section is also taken into account. The theory includes buckling in the plastic range. Tests were carried out for a considerable range of ratios of corrected free length to radius of gyration on two sections, for one of which the local buckling stress was in the plastic, and for the other, in the elastic, domain. The experimental buckling stresses are in excellent agreement with those predicted by the theory.

NACA TN 2665

AN EXTENSION OF LIFTING ROTOR THEORY TO COVER OPERATION AT LARGE ANGLES OF ATTACK AND HIGH INFLOW CONDITIONS. Alfred Gessow and Almer D. Crim. April 1952. 36p. diagrs. (NACA TN 2665)

The report derives analytical expressions for the flapping, thrust, torque, and profile-drag power of a hinged rotor in which the small-angle limitations and the assumption of nonstalled flow in the reversed-velocity region of standard rotor theory are removed. The equations are thus applicable to high-speed helicopters and to certain types of convertible aircraft.

NACA TN 2667

GENERALIZED LINEARIZED CONICAL FLOW. W. D. Hayes, R. C. Roberts and N. Haaser, Brown University. March 1952. 48p. diagrs., tab. (NACA TN 2667)

A basic theory of generalized linearized supersonic conical flow for both inside and outside the Mach cone was developed and applied to several specific problems including unsteady-flow conditions. A triangular lifting wing in pitching and rolling with both subsonic and supersonic leading edges was investigated and pressure coefficients were obtained. A family of thin sweptback triangular wings having symmetrical thickness distribution was also investigated and analytic expressions for wave drag and pressure coefficients were determined. Values of wave-drag coefficients were calculated and the results presented graphically.

NACA TN 2668

EXPERIMENTAL INVESTIGATION OF A 90° CASCADE DIFFUSING BEND WITH AN AREA RATIO OF 1.45:1 AND WITH SEVERAL INLET BOUNDARY LAYERS. Daniel Friedman and Willard R. Westphal. April 1952. 30p. diagrs., photos., 2 tabs. (NACA TN 2668)

An experimental investigation was conducted in order to determine the performance of a 90° cascade diffusing bend with an area ratio of 1.45:1 and a 19-inch-square inlet with several inlet-boundary-layer shapes and thicknesses. The maximum mean inlet Mach number was 0.41 and the corresponding airfoil Reynolds number was 950,000. The experimental results seem to indicate that, when the duct configuration requires a bend, a certain amount of diffusion can be obtained without an appreciable rise in the total-pressure losses. If length is important, this configuration requires much less space than the usual diffuser-bend combination.

NACA TN 2669

APPROXIMATE THEORY FOR CALCULATION OF LIFT OF BODIES, AFTERBODIES, AND COMBINATIONS OF BODIES. Barry Moskowitz. April 1952. 39p. diagrs. (NACA TN 2669)

An expression is developed for the lift of a slender afterbody in terms of the "slender-body" approximate potential at the after end in conjunction with a suitably calculated value of the potential at the forward end. The failure of the usual "slender-body" theory to predict any lift on a slender cylindrical afterbody is thereby corrected. The same expression is used to compute the part of the interference lift generated by the presence of a neighboring body, due to the interference upwash. Another expression is developed to compute the remainder of the interference lift, due to an interference pressure gradient. The lift is determined for a cone-cylinder body, a cylindrical afterbody of a slender wing-body combination, and three combinations of bodies to illustrate the method.

NACA TN 2671

INVESTIGATION OF STRESS DISTRIBUTION IN RECTANGULAR PLATES WITH LONGITUDINAL STIFFENERS UNDER AXIAL COMPRESSION AFTER BUCKLING. Chi-Teh Wang and Harry Zuckerberg, New York University. March 1952. 61p. diagrs. (NACA TN 2671)

An investigation was carried out to study the elastic behavior after buckling of a rectangular plate reinforced with longitudinal stiffeners and subjected to compressive loads in a direction parallel to the stiffeners. Two possible buckling modes were investigated, namely, that in which the plate buckles around the stiffeners as nodal lines and that in which the plate buckles with the intermediate stiffeners as a unit. For the first buckling mode the calculated results were compared with experimental results and the agreement was found to be good. The method of analysis used is a modified variational procedure; this was found to give much better results with the same amount of computational labor.

NACA TN 2673

THEORETICAL PERFORMANCE OF AN AXIAL-FLOW COMPRESSOR IN A GAS-TURBINE ENGINE OPERATING WITH INLET WATER INJECTION. Reece V. Hensley. March 1952. 25p. diagrs. (NACA TN 2673)

The performance of an axial-flow compressor operating in a gas-turbine engine with inlet water injection and compressor-outlet saturation was theoretically evaluated. Changes in compressor pressure ratio, compressor efficiency, and compressor work due to water injection were determined for altitudes up to 50,000 feet, Mach numbers up to 2.0, and normal compressor pressure ratios of 4, 8, and 16.

NACA TN 2679

THE STABILITY UNDER LONGITUDINAL COMPRESSION OF FLAT SYMMETRIC CORRUGATED-CORE SANDWICH PLATES WITH SIMPLY SUPPORTED LOADED EDGES AND SIMPLY SUPPORTED OR CLAMPED UNLOADED EDGES. Paul Seide. April 1952. 27p. diagrs. (NACA TN 2679)

A theory for the elastic behavior of orthotropic sandwich plates is used to determine the compressive buckling-load parameters of flat symmetrical corrugated core sandwich plates with simply supported loaded edges and simply supported or clamped unloaded edges.

NACA TN 2680

FLAME SPEEDS OF 2, 2, 4-TRIMETHYLPENTANE-OXYGEN-NITROGEN MIXTURES. Gordon L. Dugger and Dorothy D. Graab. April 1952. 25p. diagrs., photo., 2 tabs. (NACA TN 2680)

Flame speeds of homogeneous 2,2,4-trimethylpentane-oxygen-nitrogen mixtures were determined as functions of mixture composition at two or three initial temperatures by a Bunsen-burner method. Oxygen-nitrogen mixtures containing 0.210 to 0.496 mole fraction of oxygen were used. Maximum flame speed increased linearly with oxygen concentration for each initial temperature. An empirical equation including the effects of initial temperature and oxygen concentration was obtained. Both a thermal and a diffusion theory predicted the relative effect of oxygen concentration on maximum flame speed within 20 percent. No linear correlations between maximum flame speed and calculated active particle concentrations were obtained.

NACA TN 2681

A COMPRESSIBLE-FLOW PLOTTING DEVICE AND ITS APPLICATION TO CASCADE FLOWS. Willard R. Westphal and James C. Dunavant. April 1952. 21p. diagrs., photos. (NACA TN 2681)

A simplified method has been devised for the solution of two-dimensional compressible flows through well-defined passages. This method makes use of plastic cams which automatically set the length-to-width ratio of rectangles formed by streamlines and equipotential lines represented by spring-steel wires. Pressure distribution around four cascades of turbine blades and along the surface of a choked nozzle determined by this method are shown to compare well with experimental results.

NACA TN 2682

TRANSVERSE VIBRATIONS OF HOLLOW THIN-WALLED CYLINDRICAL BEAMS. Bernard Budiansky and Edwin T. Kruszewski. April 1952. 29p. diagrs. (NACA TN 2682)

The variational principle, differential equations, and boundary conditions considered appropriate to the analysis of transverse vibrations of hollow cylindrical beams are shown. General solutions for the modes and frequencies of cantilever and free cylindrical beams of arbitrary cross section but of uniform thickness are given. The combined influence of the secondary effects of transverse shear deformation, shear lag, and longitudinal inertia is shown in the form of curves for cylinders of rectangular cross section and uniform thickness. The contribution of each of the secondary effects to the total reduction in the actual frequency is also indicated.

NACA TN 2686

EXPERIMENTAL INVESTIGATION OF HEAT TRANSFER THROUGH LAMINAR AND TURBULENT BOUNDARY LAYERS ON A COOLED FLAT PLATE AT A MACH NUMBER OF 2.4. Ellis G. Slack. April 1952. 31p. diagrs. (NACA TN 2686)

Wind-tunnel tests of the heat-transfer characteristics for laminar and turbulent boundary layers on a cooled flat plate were conducted at a Mach number of 2.4.

Data were obtained for a Reynolds number range of 1.5×10^5 to 3×10^6 and for a surface-temperature range of -40° F to 45° F with recovery temperature of the order of 65° F. The temperature-recovery factors agreed well with previous flat-plate results. The heat-transfer results were obtained with negative temperature gradients along the surface and, when related to the constant-surface-temperature case, were, in general, in good agreement with theory.

NACA TN 2687

APPLICATION OF TRANSONIC SIMILARITY. Adolf Busemann. April 1952. 22p. diagrs. (NACA TN 2687)

From a review of the different similarity approaches to compressible potential flow, the meaning and limitations of transonic similarity are traced back to their origin. Although the main text deals with the quasi two-dimensional flow, special suggestions for the case of axisymmetrical bodies are added in an appendix.

NACA RM L52B04

GUST-TUNNEL INVESTIGATION OF DELTA-WING MODEL WITH THE LEADING EDGE SWEPT BACK 60°. Harold B. Pierce and Slaton L. Johns. April 1952. 12p. diagrs., photo., 3 tabs. (NACA RM L52B04)

A gust-tunnel investigation of a delta-wing model with the leading edge swept back 60° has indicated that the gust load is greater than would be predicted by using a slope of the lift curve determined from steady-flow force tests. The use of a slope of a lift curve derived from simple aspect-ratio considerations resulted in a good estimate of the load.

NACA TM 1318
National Advisory Committee for Aeronautics.
FRICTION AND WEAR. (Le frottement et l'usure). J. Pomey. March 1952. 108p. diagrs., photos., 12 tabs. (NACA TM 1318. Trans. from Office National d'Études et de Recherches Aéronautiques, Rapport Technique 36, 1948; Groupement Francais pour le Développement des Recherches Aéronautiques).

This report covers a general survey of the field of friction and wear. This survey includes discussions of hydrodynamic lubrication, boundary lubrication, seizure and dry friction. Definitions are derived, fundamentals are discussed in considerable detail, and the effects of surface films (adsorbed lubricants or chemically reacted compounds) are studied. Some experimental results are also included.

NACA TM 1336

DEVELOPMENT OF A LAMINAR BOUNDARY LAYER LAYER BEHIND A SUCTION POINT. (Entwicklung einer laminaren grenzschicht hinter einer absaugestelle). W. Wuest. March 1952. 18p. diagrs. (NACA TM 1336. Trans. from Ingenieur-Archiv, v. 17, 1949, p.199-206).

A theoretical investigation is made of the development of a laminar boundary layer behind a suction slot that is assumed to cut off part of the boundary layer without exerting any sink effect. The development, which is approximate, is based on the heat conduction equation. The heat conduction equation enters the analysis through a linearization of the Prandtl-Mises form of the boundary-layer equation.

BRITISH REPORTS

N-13865*

National Gas Turbine Establishment (Gt. Brit.)
AIR COOLING METHODS FOR GAS TURBINE COMBUSTION SYSTEMS. F. J. Bayley. August 1951. 44p. diagrs. (NGTE R.101)

Presents an account of the whole of the work which has been done at N.G.T.E. on the problem of cooling gas turbine combustion systems. Each of the different methods of wall cooling is discussed separately and the theory and mechanism of the cooling process is developed from first principles. Sufficient information is given to enable any of the various methods to be applied to practical wall cooling problems. A comparison is made between the effectiveness of the cooling systems and their relative advantages and disadvantages for different gas turbine applications are discussed.

N-13906*

Royal Aircraft Establishment (Gt. Brit.)
A CONTRIBUTION TO NON-LINEAR MECHANICS GRAPHICAL INTEGRATION OF EQUATIONS OF THE TYPE $\ddot{X} + F(X)\dot{X} + X = 0$. F. Holoubek. November 1951. 19p. diagrs., photos. (RAE Tech. Note Mech. Eng. 99)

The equation $\ddot{x} + f(x)\dot{x} + x = 0$ is characteristic of the motion of an oscillatory system in which the damping is a function of the displacement. In systems largely departing from linearity the quasi-harmonic solution becomes rather inaccurate. This paper describes a graphical method of double integration of the equation, made relatively simple by the use of two elementary computing aids. A method of "linearization" of the general equation in certain cases is also discussed.

N-14086*

National Gas Turbine Establishment (Gt. Brit.)
THE N.G.T.E. MODEL-DISC SPINNING-RIG, AND THE EFFECT OF BORE AND BOLT-HOLES ON BURSTING SPEEDS. A. Graham and V. C. H. Bailey. May 1951. 29p. diagrs., photos., 3 tabs. (NGTE R. 91)

A description is given of a spinning rig driven by an air turbine capable of bursting disks of up to about 8 inches diameter and 4 pounds in weight. Bursting experiments on disks in an as-cast aluminum alloy, chosen for its uniformity and isotropy, gave a consistent value for the reduction of bursting speed due to an uncompensated hole, and this agreed with the mean of a range of values found by other workers who used a variety of materials. Various peculiarities are found to be explicable in general terms, and the conclusion is drawn that experimental variations in the weakening due to a hole, and the amount by which bursting speed differs from that to be expected from a calculated elastic distribution of stress, may be due to specified differences in the stress/strain properties of the materials which are not revealed by conventional measures of ductility.

UNPUBLISHED PAPERS

N-12154*

Pennsylvania State Coll. Engineering Experiment Station. BENDING OF THIN PLATES WITH SMALL COMPOUND CURVATURE. H. G. Lew and J. A. Fox. August 28, 1951. 58p. diagrs., photo., 8 tabs. (Pennsylvania State Coll. Engineering Experiment Station)

An analysis is presented of the behavior of thin plates with a small amount of initial curvature under edge loads. Small deflection problems of the plate were considered. For these problems, a number of closed form solutions are presented; and, in addition the Rayleigh-Ritz method was used where closed form solutions are not possible. Some tests were made. The results for small initial curvature compared favorably with theoretical results. Methods are presented in the form that they can be applied readily to the solution of thin plates under edge loads or surface loads.

DECLASSIFIED NACA REPORTS

NACA RM A9E31

TESTS OF THE NACA 64-010 AND 64A010 AIRFOIL SECTIONS AT HIGH SUBSONIC MACH NUMBERS. Albert D. Hemenover. July 8, 1949. 19p. diagrs., tab. (NACA RM A9E31) (Declassified from Restricted, 3/10/52)

Aerodynamic characteristics of the NACA 64-010 and 64A010 airfoil sections are compared from wind-tunnel tests at Mach numbers from 0.3 to 0.9.

NACA RM E8J13

INVESTIGATION OF A VARIABLE MACH NUMBER SUPERSONIC TUNNEL WITH NONINTERSECTING CHARACTERISTICS. John C. Evvard and DeMarquis D. Wyatt. November 15, 1948. 28p. diagrs., photos., tab. (NACA RM E8J13) (Declassified from Confidential, 3/10/52)

A method is presented for the design of supersonic wind-tunnel nozzles that produce uniform flow over a continuously variable Mach number range without the use of flexible walls. Experimental results obtained from a preliminary investigation of such a tunnel are included. Mach numbers were obtained in the range of 1.75 to 2.65 with less than 1-percent variation in Mach number in the test section downstream of an over-expansion region observed in the neighborhood of the nozzle throat.

NACA RM E8L10

PERFORMANCE OF SUPERSONIC AXIAL-FLOW COMPRESSORS BASED ON ONE-DIMENSIONAL ANALYSIS. Linwood C. Wright and John F. Klapproth. March 25, 1949. 29p. diagrs. (NACA RM E8L10) (Declassified from Confidential, 3/28/52)

A general analysis of the computed pressure ratio and mass flow of four practical types of single-stage axial-flow supersonic compressor is given. The ultimate performance of supersonic compressors is not discussed. Instead the factors limiting present design are considered in order to outline the performance that seems obtainable in the best design based on present knowledge of the four configurations.

NACA RM E9I21

TEMPERATURE SURVEY OF THE WAKE OF TWO CLOSELY LOCATED PARALLEL JETS. John L. Sloop and Gerald Morrell. February 6, 1950. 37p. diagrs., photos., 8 tabs. (NACA RM E9I21) (Declassified from Confidential, 3/10/52)

A temperature survey was made of the wake of two closely located parallel jets emerging into the atmosphere from two types of twin convergent nozzle: (1) 1-inch-diameter throats with centers 1.42 inches apart, and (2) 0.863-inch-diameter throats with centers 1.5 inches apart followed by simulated 1-inch-diameter shrouds 0.466 inch long. Expansion ratio was 9.7; average jet total temperature, 1334° F; and ratio of specific heats, about 1.27. In the case of jets issuing from shrouded nozzles, less interaction occurred than for jets issuing from unshrouded nozzles.

NACA RM E9L01

TEMPERATURE AND PRESSURE DISTRIBUTIONS IN DUAL PARALLEL JETS IMPINGING ON THE GROUND FROM A TURBOJET ENGINE. J. Elmo Farmer, Francis S. Stepka and Floyd B. Garrett. February 20, 1950. 23p. diagrs., photo. (NACA RM E9L01) (Declassified from Confidential, 3/10/52)

An investigation was conducted to determine the temperature and pressure distributions in dual jets of a

turbojet engine located close together and impinging on the ground at an angle of 20°. The temperature and pressure profiles obtained in the investigation indicate that a pronounced mutual interference between the two parallel jets beyond 1 diameter downstream of the nozzle exits caused the gases to expand upward between the two jets. The jet boundary was found to be farther above the ground between the two jets than it was directly behind them.

NACA RM L7L29

THE NACA 2000-HORSEPOWER PROPELLER DYNAMOMETER AND TESTS AT HIGH SPEED OF AN NACA 10-(3)(08)-03 TWO-BLADE PROPELLER. Blake W. Corson, Jr. and Julian D. Maynard. July 20, 1948. 85p. diagrs., photos., 3 tabs. (NACA RM L7L29) (Declassified from Restricted, 3/28/52)

Contains detailed description of a 2000-horsepower propeller dynamometer used to make wind-tunnel tests of a two-blade NACA 10-(3)(08)-03 propeller for a range of blade angles from 20° to 55° at airspeeds up to 500 miles per hour. The results of these tests and comparisons with results obtained from a theoretical analysis and from previous tests made in other wind tunnels are presented.

NACA RM L8E26

AERODYNAMIC CHARACTERISTICS AT HIGH SPEEDS OF A TWO-BLADE NACA 10-(3)(062)-045 PROPELLER AND OF A TWO-BLADE NACA 10-(3)(08)-045 PROPELLER. William Solomon. October 1, 1948. 54p. diagrs., photo., tab. (NACA RM L8E26) (Declassified from Confidential, 3/28/52)

Characteristics are given for the two-blade NACA 10-(3)(062)-045 propeller and for the two-blade NACA 10-(3)(08)-045 propeller over a range of advance ratio from 0.5 to 3.8, the blade-angle range covering 20° to 55° measured at the 0.75 radius. Maximum efficiencies of the order of 91.5 to 92 percent were obtained for the propellers. The propeller with the thinner airfoil sections over the outboard portion of the blades, the NACA 10-(3)(062)-045 propeller, had lower losses at high tip speeds, the difference amounting to about 5 percent at a helical tip Mach number of 1.10.

NACA RM L8G19

WIND-TUNNEL INVESTIGATION AT LOW SPEEDS OF THE PITCHING DERIVATIVES OF UNTAPERED SWEPT WINGS. Robert MacLachlan and Lewis R. Fisher. September 29, 1948. 22p. diagrs., photo., tab. (NACA RM L8G19) (Declassified from Restricted, 3/10/52)

Contains wind-tunnel results of the independent effects of varying aspect ratio and angle of sweep on the longitudinal rotary stability derivatives of a series of untapered wings tested in pitching flow. Comparison is made of experimental and theoretical results.

NACA RM L8H10

EFFECT OF AIRFOIL PROFILE OF SYMMETRICAL SECTIONS ON THE LOW-SPEED STATIC-STABILITY AND YAWING DERIVATIVES OF 45° SWEPTBACK WING MODELS OF ASPECT RATIO 2.61. William Letko and Byron M. Jaquet. November 9, 1948. 21p. diagrs., photo., tab. (NACA RM L8H10) (Declassified from Restricted, 3/10/52)

Contains results of tests made in the Langley stability tunnel for determining the effects of airfoil profile of symmetrical sections on the low-speed static-stability and yawing derivatives of untapered 45° sweptback wing models of aspect ratio 2.61. The wings had the following profiles normal to the leading edge: biconvex (12 percent thick), NACA 65_1-012, and NACA 0012.

NACA RM L8J07

THE EFFECT OF NEGATIVE DIHEDRAL, TIP DROOP, AND WING-TIP SHAPE ON THE LOW-SPEED AERODYNAMIC CHARACTERISTICS OF A COMPLETE MODEL HAVING A 45° SWEPTBACK WING. M. Leroy Spearman and Robert E. Becht. December 6, 1948. 50p. diagrs., photo., tab. (NACA RM L8J07) (Declassified from Restricted, 3/10/52)

An investigation has been conducted in the Langley 300-mph 7- by 10-foot tunnel to determine the effect of negative dihedral, tip droop, and wing-tip shape on the low-speed aerodynamic characteristics of a complete model having a 45° sweptback wing. Longitudinal and lateral stability characteristics were obtained for the model with and without tail surfaces.

NACA RM L8L31a

EFFECT OF AIRFOIL PROFILE OF SYMMETRICAL SECTIONS ON THE LOW-SPEED ROLLING DERIVATIVES OF 45° SWEPTBACK-WING MODELS OF ASPECT RATIO 2.61. William Letko and Jack D. Brewer. March 4, 1949. 27p. diagrs., photo., 2 tabs. (NACA RM L8L31a) (Declassified from Restricted, 3/10/52)

Contains results of tests made in the Langley stability tunnel to determine the effects of airfoil profile of symmetrical sections on the low-speed rolling derivatives of untapered 45° sweptback-wing models of 2.61 aspect ratio. The wings had the following profiles normal to the leading edge: biconvex (12 percent thick), NACA 65_1-012, and NACA 0012. Also contains calculations of stability boundaries and motions at subsonic speeds of a transonic airplane configuration using the different wing profiles.

NACA RM L9D29

THE EFFECT OF BLADE-SECTION THICKNESS RATIOS ON THE AERODYNAMIC CHARACTERISTICS OF RELATED FULL-SCALE PROPELLERS AT MACH NUMBERS UP TO 0.65. Julian D. Maynard and Seymour Steinberg. June 6, 1949. 90p. diagrs., photos., tab. (NACA RM L9D29) (Declassified from Confidential, 3/28/52)

Results of an investigation of two full-scale NACA propellers are presented for a range of blade angles from 20° to 55° at airspeeds up to 500 miles per hour. These results are compared with the results from previous tests of five related NACA propellers to evaluate the effects of blade-section thickness ratios on propeller aerodynamic characteristics.

NACA RM L50I13
National Advisory Committee for Aeronautics.
INVESTIGATION OF THE PRESSURE-RATIO REQUIREMENTS OF THE LANGLEY 11-INCH HYPERSONIC TUNNEL WITH A VARIABLE-GEOMETRY DIFFUSER. Mitchel H. Bertram. October 6, 1950. 19p. diagrs. (NACA RM L50I13) (Declassified from Confidential, 3/10/52)

Tests were conducted in the Langley 11-inch hypersonic tunnel at a Mach number of 6.86 to determine the stagnation pressure ratios across the system required to maintain supersonic flow with the use of a variable-geometry diffuser. With such a diffuser, it was possible in some cases to reduce the pressure ratio required to maintain flow to about one-third of that required for starting with a consequent quadrupling of the duration of test run.

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NACA TN 2644

EXPERIMENTAL INVESTIGATION OF AN NACA 64A010 AIRFOIL SECTION WITH 41 SUCTION SLOTS ON EACH SURFACE FOR CONTROL OF LAMINAR BOUNDARY LAYER. Dale L. Burrows and Milton A. Schwartzberg. April 1952. 37p. diagrs., photos. (NACA TN 2644)

A wind-tunnel investigation of an NACA 64A010 airfoil model with 41 suction slots per surface indicated that laminar flow could be obtained over 0.91 chord on one surface up to a Reynolds number of 10×10^6 with an estimated net drag saving of about 50 percent over the plain smooth airfoil. Extensive laminar flow could not be obtained at higher Reynolds numbers because of increased sensitivity of the flow to minute surface irregularities and slight inaccuracies of slot-entry contour.

NACA TN 2659

A MINATURE ELECTRICAL PRESSURE GAGE UTILIZING A STRETCHED FLAT DIAPHRAGM. John L. Patterson. April 1952. 47p. diagrs., photos., 2 tabs. (NACA TN 2659)

A variable-air-gap, inductance-type, electrical pressure gage is described that is basically 7/16 inch in diameter and 1/4 inch in thickness. The gage was designed to measure accurately pressures fluctuating at high frequencies and has proved to be of value as a general-purpose electrical gage for aeronautical work where small size and minimum response to acceleration forces are important factors. Design equations and curves are presented which can be used to predict the deflections and fundamental natural frequencies of stretched flat diaphragms.

NACA TN 2677

WING-BODY INTERFERENCE AT SUPERSONIC SPEEDS WITH AN APPLICATION TO COMBINATIONS WITH RECTANGULAR WINGS. Jack N. Nielsen and William C. Pitts. April 1952. 63p. diagrs., 2 tabs. (NACA TN 2677)

An exact theoretical method is developed that permits the determination of the pressure field of a wing-body combination having a circular body and wings with supersonic leading and trailing edges. Detailed calculations are performed for the case of a rectangular wing or all-movable control surface on a body at zero angle of attack. Design charts are presented showing the effect of interference on the lift and center-of-pressure position of the wings. The physical basis of the interference is discussed.

NACA TN 2678

ABNORMAL GRAIN GROWTH IN S-816 ALLOY. A. I. Rush, J. W. Freeman and A. E. White, University of Michigan. April 1952. 30p. photos., diagrs., tab. (NACA TN 2678)

Preliminary results are presented from an investigation to establish the fundamental causes of abnormal grain growth in S-816 alloy under conditions encountered during forging of blades for aircraft gas turbines. The data are confined to experiments to produce abnormally large grains in bar stock under controlled conditions. It was found that critical deformation for grain growth is apparently independent of temperature of deformation; repeated critical deformations between reheats to 2150° F produce much larger grains than a single critical deformation; grain growth characteristics are sensitive to prior history; and abnormal grain growth can be induced by temperature cycling alone to temperatures of 2150° F with certain prior histories.

NACA TN 2684

A LOW-SPEED INVESTIGATION OF A FUSELAGE-SIDE AIR INLET FOR USE AT TRANSONIC FLIGHT SPEEDS. Mark R. Nichols and Edwin B. Goral. April 1952. 60p. diagrs., photos., tab. (NACA TN 2684. Formerly RM L7A06)

Low-speed pressure-recovery and surface-pressure measurements for a twin fuselage-side air-inlet arrangement intended for use at transonic speeds are presented. The model was developed by adding a canopy and nose-wheel fairing to basic transonic annular inlet studied in TN 2685. The results indicate shape requirements of fuselage nose, canopy, and nose-wheel fairing for maintaining substream surface velocities everywhere ahead of entrance.

NACA TN 2685

A LOW-SPEED INVESTIGATION OF AN ANNULAR TRANSONIC AIR INLET. Mark R. Nichols and Donald W. Rinkoski. April 1952. 38p. diagrs., photos. (NACA TN 2685. Formerly RM L6J04)

Low-speed wind-tunnel tests were conducted as preliminary steps in the study of fuselage-air-inlet

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arrangements believed suitable for use at transonic speeds. The forward part of the model consisted of an NACA 1-85-050 cowling located at the base of the long protruding fuselage nose designed to maintain substream surface velocities everywhere ahead of the entrance and thereby to avoid or minimize adverse boundary-layer-shock interaction effects up to low supersonic speeds. Pressure-recovery and surface-pressure measurements are presented for the model with three fuselage nose shapes for ranges of angle of attack and inlet-velocity ratio useful for high-speed flight.

NACA TN 2691

THEORETICAL AND EXPERIMENTAL ANALYSIS OF ONE-DIMENSIONAL COMPRESSIBLE FLOW IN A ROTATING RADIAL-INLET IMPELLER CHANNEL. Seymour Lieblein. April 1952. 47p. diagrs., photo. (NACA TN 2691)

An analysis of the one-dimensional compressible flow in a radial-inlet impeller channel was conducted in order to provide an insight into the characteristics of the passage mean flow. A theoretical investigation of the flow in an illustrative impeller channel showed the general flow behavior, location of critical section and effect of losses in an impeller channel. A further analysis was conducted of the one dimensional flow in a previously reported experimental radial-inlet impeller. The general flow behavior, effective flow area, inlet throat formation, maximum flow, and loss variations were analyzed.

NACA TM 1317

A SIMPLE NUMERICAL METHOD FOR THE CALCULATION OF THE LAMINAR BOUNDARY LAYER. (Ein einfaches numerisches Verfahren zur Berechnung der laminaren Grenzschicht). K. Schröder. April 1952. 47p. diagrs., 3 tabs. (NACA TM 1317. Trans. from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin. FB 1741; Deutsche Versuchsanstalt für Luftfahrt E. V., Berlin. Institut für Aerodynamik, February 25, 1943.)

An iteration difference method for the calculation of the incompressible laminar boundary layer is described. The method uses Prandtl's boundary layer equation and the boundary conditions directly and permits the attainment of an arbitrary accuracy. The method has been tested successfully in the continuation of the Blasius profile on the flat plate, on the circular cylinder investigated by Heimenz and on an elliptical cylinder of fineness ratio 1:4. The method makes possible the testing of previously developed methods, all of which contain important assumptions.

BRITISH REPORTS

N-14191*

National Gas Turbine Establishment (Gt. Brit.)
STUDIES ON THE SPONTANEOUS IGNITION OF FUELS INJECTED INTO A HOT AIR STREAM. PART III. THE EFFECT OF CHEMICAL FACTORS UPON THE IGNITION DELAY OF KEROSINE-AIR MIXTURES. B. P. Mullins. October 1951. 57p. 31 tabs., diagrs. (NGTE R. 95)

Ignition delay measurements at atmospheric pressure were carried out in the 3° diffuser rig described in NGTE Report R. 89 using kerosene containing various additives. Regarding the fuel composition, for air temperatures in the range 750°-1000° C, it was found that the following additives had little effect upon the ignition delays of kerosene and that in no case was 50-percent reduction observed: 5-percent diethylether, 5-percent propylene oxide, 5-percent nitrobenzene, 2-percent tertiarybutylhydroperoxide, 5-percent acetaldehyde, 5-percent carbon disulphide (v/v), 4-percent ferric stearate, 5-percent cobalt stearate, and 5-percent cupric stearate (w/w). Of these additives the first three were the most effective. Ethyl nitrate, amyl nitrite and ethyl nitrite when added to kerosene in high concentrations were found to cause very large reductions in ignition delay, the magnitude of which depended upon the additive concentration, as also did the slope of the ignition delay versus temperature curves. Ethyl nitrate had by far the largest effect of any of the additives tested. The two nitrous esters were less effective than diethylether at 5-percent concentrations.

N-14192*

National Gas Turbine Establishment (Gt. Brit.)
STUDIES ON THE SPONTANEOUS IGNITION OF FUELS INJECTED INTO A HOT AIR STREAM. PART IV. IGNITION DELAY MEASUREMENTS ON SOME GASEOUS FUELS AT ATMOSPHERIC AND REDUCED STATIC PRESSURES. B. P. Mullins. October 1951. 52p. 18 tabs., diagrs., photos. (NGTE R. 96)

Ignition delay measurements were made at air temperatures between 600° and 1000° C and within the static pressure range 0.3 to 1.0 atmosphere on carbon monoxide, methane, ethane, calor gas, buta gas, acetylene and hydrogen using the continuous flow method of test described in NGTE Report R. 89, and the present report is mainly a catalog of the experimental results.

N-14217*

Royal Aircraft Establishment (Gt. Brit.)
AN APPROXIMATION TO THE SLOW MODE OF LONGITUDINALLY DISTURBED MOTION OF AN AIRCRAFT IN LEVEL FLIGHT. A. W. Thorpe. September 1951. 45p. diagrs., 3 tabs. (RAE Aero 2438)

This report develops an approximate theory of longitudinal response which applies to the slow mode of motion after a disturbance. The present theory is complementary to that for the quick period motion which has been given by Gates and Lyon in R & M 2027. The approximate equations have been solved algebraically and the solutions tabulated. Some numerical examples have been solved to indicate the accuracy which may be expected.

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NACA TN 2484

EFFECT OF COMPRESSIBILITY ON THE FLOW PAST A TWO-DIMENSIONAL BUMP. W. F. Lindsey and Bernard N. Daley. April 1952. 34p. diagrs., photos. (NACA TN 2484. Formerly RM L6K12b)

An investigation has been conducted to determine experimentally the effects of compressibility on the flow past a bump and to compare the experimentally determined results with theory. Pressure measurements and schlieren photographs were made of the flow past two bumps having thickness-chord ratios of 0.10 and 0.30 at Mach numbers between 0.20 and 0.84.

NACA TN 2660

AN APPROACH TO THE PREDICTION OF THE FREQUENCY DISTRIBUTION OF GUST LOADS ON AIRPLANES IN NORMAL OPERATIONS. Harry Press. April 1952. 34p. diagrs., 2 tabs. (NACA TN 2660)

As a basis for the prediction of the gust-load history of airplanes in service operations, the statistical concepts of random variables and probability distributions are applied to the "sharp edge gust" formula. Expressions are derived for the frequency distribution of gust loads in terms of distributions of the related variables such as effective gust velocity and airspeed. Solutions are obtained under assumptions that appear reasonable on the basis of present practices in gust research. The results are applied in an example and the predicted load experience is compared with the available flight loads data for this case.

NACA TN 2661

A SUMMARY OF DIAGONAL TENSION. PART I - METHODS OF ANALYSIS. Paul Kuhn, James P. Peterson and L. Ross Levin. May 1952. v, 131p. diagrs., photo. (NACA TN 2661)

Previously published methods for stress and strength analysis of plane and curved shear webs working in diagonal tension are presented as a unified method. The treatment is sufficiently comprehensive and detailed to make the paper self-contained. Part I discusses the theory and methods for calculating the stresses and shear deflections of web systems as well as the strengths of the web, the stiffeners, and the riveting. Part II, published separately, presents the experimental evidence.

NACA TN 2662

A SUMMARY OF DIAGONAL TENSION. PART II - EXPERIMENTAL EVIDENCE. Paul Kuhn, James P. Peterson and L. Ross Levin. May 1952. ii, 81p. diagrs., photos., 8 tabs. (NACA TN 2662)

Methods of analyzing web systems working in diagonal tension have been given in Part I of this paper. Part II presents the experimental evidence.

NACA TN 2663

THE GUST AND GUST-LOAD EXPERIENCE OF A TWIN-ENGINE LOW-ALTITUDE TRANSPORT AIRPLANT IN OPERATION ON A NORTHERN TRANSCONTINENTAL ROUTE. Harry Press and Robert L. McDougal. April 1952. 33p. diagrs., 8 tabs. (NACA TN 2663)

An analysis of the gust and gust-load experience of a low-altitude transcontinental transport airplane, based on 834 hours of VGH record, is presented. The relation of gust experience to airspeed, altitude, season of the year, and flight condition is considered. An estimate of the over-all gust history for the present type of operations is derived from a synthesis of the VGH data and available V-G data.

NACA TN 2674

SOME EXPERIMENTS ON VISUALIZATION OF FLOW FIELDS BEHIND LOW-ASPECT-RATIO WINGS BY MEANS OF A TUFT GRID. John D. Bird and Donald R. Riley. May 1952. 32p. photos., diagrs., tab. (NACA TN 2674)

A technique for obtaining a physical picture of the flow behind lifting surfaces is described wherein the action of a large number of tufts of uniform length attached to a wire grid are photographed from far downstream. This procedure yields, with a minimum of labor, an approximate vector plot of the flow field in a plane normal to the air stream. The flow fields behind a rectangular wing and several triangular wings were investigated through the angle-of-attack range. The effects of tip-control deflection, sideslip, and oscillation in sideslip on the flow field behind a 60° triangular wing were also determined.

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NACA TN 2683

SURVEY OF PORTIONS OF THE CHROMIUM-COBALT-NICKEL-MOLYBDENUM QUATERNARY SYSTEM AT 1200° C. Sheldon Paul Rideout and Paul A. Beck, University of Notre Dame. April 1952. 81p. diagrs., photos., 20 tabs. (NACA TN 2683)

A survey was made of portions of the chromium-cobalt-nickel-molybdenum quaternary system at 1200° C by means of microscopic and X-ray diffraction studies. Since the face-centered cubic (alpha) solid solutions form the matrix of almost all practically useful high-temperature alloys, the solid solubility limits of the quaternary alpha phase were determined up to 20 percent molybdenum. The component cobalt-nickel-molybdenum, chromium-cobalt-molybdenum, and chromium-nickel-molybdenum ternary systems were also studied. The survey of these systems was confined to the determination of the boundaries of the face-centered cubic (alpha) solid solutions and of the phases coexisting with alpha at 1200° C.

NACA TN 2688

THREE-DIMENSIONAL SUPERSONIC NOZZLES AND INLETS OF ARBITRARY EXIT CROSS SECTION. John C. Evvard and Stephen H. Maslen. April 1952. 12p. diagrs. (NACA TN 2688)

A method is presented for obtaining three dimensional unsymmetric supersonic nozzles and inlets from known axisymmetric flows. Streamlines bounding the desired exit shape are traced through the known basic flow solution to give the required unsymmetric wall contours. Several examples are given.

NACA TN 2690

CONDENSATION OF AIR IN SUPERSONIC WIND TUNNELS AND ITS EFFECTS ON FLOW ABOUT MODELS. C. Frederick Hansen and George J. Nothwang. April 1952. 49p. photos., diagrs. (NACA TN 2690)

Condensation of air in supersonic wind tunnels is investigated. Theoretical limits of the threshold of condensation are calculated and compared with experiment. Test results are presented which indicate the effectiveness of water vapor, carbon dioxide, and silica gel as condensation nuclei in supersaturated air. The properties of a partially condensed supersonic air stream are estimated and the effects of condensation phenomena in flow about models are examined.

NACA TN 2693

A THEORY AND METHOD FOR APPLYING INTERFEROMETRY TO THE MEASUREMENT OF CERTAIN TWO-DIMENSIONAL GASEOUS DENSITY FIELDS. Walton L. Howes and Donald R. Buchele. April 1952. 46p. diagrs. (NACA TN 2693)

A theory and method are developed for applying interferometry to the measurement of certain two dimensional gaseous density fields. The theory includes effects of optical refraction upon the observed interference pattern. Expressions for the relative density difference and optical distortion corresponding to an observed interference-fringe shift are derived in exact form and then in the form of power series approximations. An evaluation procedure is outlined and applied in the determination of the density field in a boundary layer formed by supersonic air flow along a flat plate.

NACA TN 2696

A FUNDAMENTAL STUDY OF THE MECHANISM BY WHICH HYDROGEN ENTERS METALS DURING CHEMICAL AND ELECTROCHEMICAL PROCESSING. L. D. McGraw, C. A. Snavely, H. L. Moore, P. T. Woodberry and C. L. Faust, Battelle Memorial Institute. April 1952. ii, 43p. photos., diagr., 6 tabs. (NACA TN 2696)

Through the correlation of several known methods of controlling entry and exit of hydrogen in steel with the known chemical behavior of atomic and molecular hydrogen suitable reagents were found which increase or, for the first time, significantly decrease hydrogen permeability and embrittlement of steels during cathodic pickling and plating operations. This succesful correlation was an important step toward arriving at the mechanism of hydrogen entry into steel. It is proposed that entry is through the direct formation of metal hydrides (intermetallic compounds) or solid solutions of hydrogen in metal at the instant of hydrogen discharge and that exit is the decomposition of metal hydrides or of solid solutions of hydrogen in metal.

NACA TN 2701

A SURVEY OF THE AIRCRAFT-NOISE PROBLEM WITH SPECIAL REFERENCE TO ITS PHYSICAL ASPECTS. Harvey H. Hubbard. May 1952. 41p. diagrs., photos. (NACA TN 2701)

This paper presents brief discussions on three general phases of the aircraft-noise problem. The effects of noise are discussed as a background for the reader and as a basis for discussion of the other material. A description of the physical characteristics of aircraft noise and some ways of protection from noise are also included, along with a limited bibliography of research work applying to the aircraft-noise problem.

NACA RM E52B20

INTERNAL-FILM-COOLING EXPERIMENTS WITH 2- AND 4-INCH SMOOTH-SURFACE TUBES AND GAS TEMPERATURES TO 2000° F. George R. Kinney. April 1952. 27p. diagrs., 2 tabs. (NACA RM E52B20)

An experimental investigation of internal-liquid-film cooling was conducted in 2- and 4-inch-diameter smooth-surface tubes with hot air flows at 800° to 2000° F and Reynolds numbers from 220,000 to 1,100,000. The coolant was water at flows of 0.8 to 12 percent of air flow. Greater cooling effectiveness was obtained than in a previous investigation with a rough-surface tube. When coolant flows were large enough, film disturbances occurred which reduced cooling effectiveness in the same manner in both 2- and 4-inch tubes. All data were generalized by means of heat transfer correlation and data obtained over a range of coolant flows in a form which facilitates the estimation of the flow of film coolant required to cool a length of tube when the temperature and flow of hot gases are known.

NACA RM L52B18a

BIBLIOGRAPHY OF NACA PAPERS ON ROTATING-WING AIRCRAFT, JANUARY 1952. Alfred Gessow. March 1952. 13p. (NACA RM L52B18a. Formerly RM L7J30)

A bibliography of NACA papers on rotating-wing aircraft issued up to January 1952 is presented. The list of papers is subdivided for ready reference under appropriate subject headings, and the titles are listed chronologically within each subject.

BRITISH REPORTS

N-14040*

Royal Aircraft Establishment (Gt. Brit.)
THE MEASUREMENT OF HEAT TRANSFER AND SKIN FRICTION AT SUPERSONIC SPEEDS.
PART III - MEASUREMENTS OF OVERALL HEAT TRANSFER AND OF THE ASSOCIATED BOUNDARY LAYERS ON A FLAT PLATE AT $M_1 = 2.43$. R. J. Monaghan and J. R. Cooke. December 1951. 64p. diagrs., photos., 3 tabs. (RAE Tech. Note Aero 2129)

A mean value of 0.906 was obtained for temperature-recovery factor and the over-all heat transfer measurements from plate to stream agreed well with other published results. There was some forward movement of the boundary-layer transition, a variation in the exponent of the turbulent velocity distribution and an increase in displacement thickness with heat transfer. However, no decrease in skin friction below its zero heat transfer value was found.

UNPUBLISHED PAPERS

N-8810*

CONTRIBUTION TO THE WING THEORY FOR SLIGHTLY INHOMOGENEOUS PARALLEL FLOW. (Beitrag zur Theorie des Tragflügels in schwach inhomogener Parallelströmung). F. Vandrey. March 1952. 12p. diagrs. (Trans. from Zeitschrift für angewandte Mathematik und Mechanik, v. 20, no. 3, June 1940, p. 148-152).

Calculation of lift distribution of a wing in a flow with a velocity varying from point to point is traced back to calculation of the lift distribution of a wing of equal chord distribution with an additional twist in a homogeneous parallel flow. The twist is determined from the condition of equivalent pressure on both sides of a surface of constant basic velocity. Presupposition for applicability of the method is the condition that the velocity of the basic flow does not vary greatly in the direction normal to the wind.

N-12159*

THE PROBLEM OF FLOW AROUND A BODY IN INCOMPRESSIBLE POTENTIAL FLOWS. PART II. (Das Umströmungsproblem bei inkompressiblen Potentialströmungen). F. Riegels. April 1952. 31p. diagrs., 10 tabs. (Trans. from Ingenieur-Archiv, v. 17, no. 1-2, 1949, p. 94-106).

For bodies of moderate thickness and camber but otherwise arbitrary shape, a theory is developed which permits determination of the flow velocity, the force, and the moment with the aid of source and vortex distributions on a straight-line segment of the length of the largest chord of the body.

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CURRENT NACA REPORTS

NACA TN 2700

RECIPROCITY RELATIONS IN AERODYNAMICS. Max. A. Heaslet and John R. Spreiter. May 1952. 38p. diagrs. (NACA TN 2700)

Reserve-flow theorems in aerodynamics are shown to be based on the same general concepts involved in many reciprocity theorems in the physical sciences. Reciprocal theorems for both steady and unsteady motion are found as a logical consequence of this approach. No restrictions on wing plan form or flight Mach number are made beyond those required in linearized compressible-flow analysis. A number of examples are listed, including general integral theorems for lifting, rolling, and pitching wings and for wings in nonuniform downwash fields. Correspondence is also established between the build-up of circulation with time of a wing starting impulsively from rest and the build-up of lift of the same wing moving in the reverse direction into a sharp-edge gust.

NACA TN 2728

EXPERIMENTS TO DETERMINE NEIGHBORHOOD REACTIONS TO LIGHT AIRPLANES WITH AND WITHOUT EXTERNAL NOISE REDUCTION. Fred S. Elwell, Aeronautical Research Foundation. May 1952. 75p. diagrs., maps, photos., 12 tabs. (NACA TN 2728)

Experiments to determine neighborhood reactions to the noise of light airplanes with and without noise-reduction equipment were conducted at a number of sites which might be convenient locations for landing strips within the metropolitan area of Boston, Mass. Two standard airplanes and two airplanes modified by reduction gears, four-bladed propellers, and engine exhaust silencers were used. Flights were made close to residential properties of varying income levels, population densities, and proximity to trade centers in order to determine whether the degree of noise reduction previously found to be aerodynamically and structurally practicable produced a significant reduction in neighborhood objections to such aircraft operations.

N-3074B*

INDEX OF NACA TECHNICAL PUBLICATIONS, 1949-MAY 1951. (Supplement to the index of NACA technical publications, 1915-1949). viii, 201p. (NACA)

This is the first supplement to the Index of NACA Technical Publications, 1915-1949 and covers documents issued through May 1951. There is a classified listing of the subject categories, a chronological list of publications under each subject category, an alphabetical index to the subject categories, and an author index.

BRITISH REPORTS

N-14293*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF INDUCED VELOCITY VARIATION ON HELICOPTER ROTOR DAMPING IN PITCH OR ROLL. G. J. Sissingh. November 1951. 16p. diagrs. (RAE Tech. Note Aero 2132)

A continuation of NACA TN 2136 by Amer on the aerodynamic damping of a rotor with centrally arranged flapping hinges in a steady pitching or rolling motion. Considers the effect of variation in induced velocity due to changes in distribution of thrust around the rotor disk. Results agree favorably with flight results given in Amer's report. The rotor damping primarily depends on two quantities: (1) the ratio of collective pitch to the thrust coefficient ÷ solidity ratio, and (2) the tip-speed ratio x rotor angle of attack ÷ collective pitch.

N-14418*

Aeronautical Research Council (Gt. Brit.)
APPROXIMATE TWO-DIMENSIONAL AEROFOIL THEORY. PART VI. AEROFOILS WITH HINGED FLAPS. S. Goldstein and J. H. Preston. August 2, 1945. 42p. diagrs., 4 tabs. (ARC CP 73; ARC 8877)

The calculation of the velocity at the surface and of other aerodynamic properties, especially the hinge moment, of an airfoil with a hinged flap is considered using a simple theory. It is shown in the appendix how more accurate results may be obtained.

N-14655*

National Gas Turbine Establishment (Gt. Brit.)
A THEORETICAL NOTE UPON THE MECHANISM OF DEPOSITION IN TURBINE BLADE FOULING. M. C. G. Smith. February 1952. 40p. diagrs. (NGTE Memo. M. 145)

The three principal modes by which deposition is likely to occur, namely by direct impact, vapor dif-

fusion, and Brownian movement of small liquid or solid particles, are considered in detail. Data are presented from which it is possible to estimate the quantity of fouling matter reaching the surface provided its state, concentration, and, in particular, the size of the particles, are known.

N-14703*

Royal Aircraft Establishment (Gt. Brit.)
THE MAGNETIC PROPERTIES OF SOME DUCTILE OR MACHINABLE PERMANENT MAGNET ALLOYS. E. C. Railton. November 1951. 10p. diagr., tab. (RAE Tech. Note EL. 29)

The magnetic properties of certain Cu-Ni-Fe and Co-Fe-V alloys have been measured. The alloys are respectively ductile after heat treatment and machinable before heat treatment, and may have application as permanent magnets in aircraft electrical instruments. The Cu-Ni-Fe alloy had magnetic properties that approached those sought. The Co-Fe-V alloy began to approach published claims for it but is, in general, less useful.

N-14704*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) PRECESSION RATE TRIALS OF THE GYRO UNITS OF THE GYRO-MAGNETIC COMPASSES MARK 4F and 4B. March 4, 1952. 7p. 9 tabs. (AAEE Rept. A. A. E. E. /Inst/84)

Trials were made to determine the precession rates of the gyros of the GM 4F and GM 4B units. The trial showed that three out of the eight gyro units tested had precession rates in excess of the specification.

N-14705*

Royal Aircraft Establishment (Gt. Brit.)
FRICTION TESTS AT HIGHER TEMPERATURES IN AN INVESTIGATION OF "SCHMELZFLUSSSCHMIERUNG". (Gleitversuche bei hoheren temperaturen zur untersuchung der "schmelzflussschmierung"). E. Siebel. November 1951. 53p. diagrs., photos., 7 tabs. (RAE Library Trans. 391. Trans. from Staatliches Materialprufungsamt, Berlin)

Reports tests of materials for ammunition and gun barrels. Some materials showed a fall of friction due to surface melting when rubbing at high speeds and pressures. This was investigated. Methods of separating the rubbing surfaces by a layer which does not produce the low friction associated with this "melt lubrication" were investigated. Measurements were made of the coefficients of friction, temperatures and load carrying capacities of the materials.

N-14707*

Royal Aircraft Establishment (Gt. Brit.)
HELICOPTER BEHAVIOUR IN THE VORTEX RING CONDITIONS. Wm. Stewart. November 1951. 15p. diagrs., tab. (RAE Tech. Note Aero 2131)

A region of roughness, associated with the air flow conditions of the vortex-ring state, occurs when a helicopter is operating in vertical or near vertical descents in the range of about 500 and 1500 ft/min. The turbulent circulating air and the rapid changes in local velocities in this flow pattern can cause serious helicopter handling difficulties. This could cause concern in a slow steep approach, particularly under instrument flying conditions. This report describes flight experience in the vortex-ring conditions with the Sikorsky R-4B, R-6 and S-51, Bell 47 and the Bristol 171 helicopters.

N-14709*

Royal Aircraft Establishment (Gt. Brit.)
SOME CURVES FOR USE IN CALCULATIONS OF THE PERFORMANCE OF CONICAL CENTREBODY INTAKES AT SUPERSONIC SPEEDS AND AT FULL MASS FLOW. L. E. Fraenkel. December 1951. 33p. diagrs., 2 tabs. (RAE Tech. Note Aero 2135)

Presents curves of a number of parameters which frequently occur in calculations of the performance of conical centerbody intakes at supersonic speeds and full mass flow. These parameters follow directly from the theoretical supersonic flow past cones. Semicone angles of 15°, 20°, 22.5°, 25°, and 30° are considered, and the range of free stream Mach number is approximately 1.3 to 3.0.

N-14710*

National Gas Turbine Establishment (Gt. Brit.)
A PHENOMENOLOGICAL THEORY OF UNIAXIAL DEFORMATION. A. Graham. December 1951. 30p. diagrs. (NGTE R. 94)

Previous theories are briefly reviewed and a form of the Nutting equation in which the constants are expressed as functions of temperature is shown to avoid some of the difficulties of theories which assume existence of an equation of state in terms of stress, strain, straining rate, and temperature. A linear theory is developed in which deformation is represented as a Boltzmann superposition of increments of creep due to increments of load. The resulting superposition integral is not an equation of state in the above-mentioned terms. It directly predicts behavior under various conditions of loading. The theory is extended to cover temperature and apparent changes in material constants.

REC'D JUL 1 1952

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1014

STUDY OF EFFECTS OF SWEEP ON THE FLUTTER OF CANTILEVER WINGS. J. G. Barmby, H. J. Cunningham and I. E. Garrick. 1951. ii, 25p. diagrs., photo., 7 tabs. (NACA Rept. 1014. Formerly TN 2121; RM L8H30)

An experimental and analytical investigation of the flutter of uniform, cantilever, sweptback wings is reported. The experiments employed group of wings swept back by rotating and by shearing. The angle of sweep ranged from 0° to 60° and the Mach numbers extended to approximately 0.85. Comparison with experiment indicates that the analysis developed in the present paper is satisfactory, at least for nearly uniform cantilever wings of moderate length-chord ratios.

NACA Rept. 1018

A THEORETICAL ANALYSIS OF THE EFFECT OF TIME LAG IN AN AUTOMATIC STABILIZATION SYSTEM ON THE LATERAL OSCILLATORY STABILITY OF AN AIRPLANE. Leonard Sternfield and Ordway B. Gates, Jr. 1951. ii, 12p. diagrs. (NACA Rept. 1018. Formerly TN 2005)

A method is presented for determining the effect of time lag in an automatic stabilization system on the lateral oscillatory stability of an airplane. The method is applied to a typical present-day airplane equipped with an automatic pilot sensitive to yawing acceleration and geared to the rudder so that rudder control is applied in proportion to the yawing acceleration.

NACA Rept. 1027

BUCKLING OF THIN-WALLED CYLINDER UNDER AXIAL COMPRESSION AND INTERNAL PRESSURE. Hsu Lo, Harold Crate and Edward B. Schwartz. 1951. 9p. diagrs. (NACA Rept. 1027. Formerly TN 2021)

An investigation was made of a thin-walled cylinder under axial compression and various internal pressures to study the effect of the internal pressure on the compressive buckling stress of the cylinder. A theoretical analysis based on a large-deflection theory was also made. The theoretically predicted increase of compressive buckling stress due to internal pressure agrees fairly well with the experimental results.

NACA Rept. 1031

A STUDY OF THE USE OF EXPERIMENTAL STABILITY DERIVATIVES IN THE CALCULATION OF THE LATERAL DISTURBED MOTIONS OF A SWEPT-WING AIRPLANE AND COMPARISON WITH FLIGHT RESULTS. John D. Bird and Byron M. Jaquet. 1951. ii, 25p. diagrs., photos., 4 tabs. (NACA Rept. 1031. Formerly TN 2013)

Experimentally determined lateral-stability derivatives of a swept-wing airplane are presented to show effects of slots, flaps, propeller, and ventral fins and are used in calculations of a number of lateral disturbed motions. The calculated motions are compared with those obtained in flight tests to determine the applicability of the experimental stability derivatives. The effects of nonlinearity of some of the aerodynamic forces with sideslip are shown by a few supplemental calculations.

NACA Rept. 1036

EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF VISCOSITY ON THE DRAG AND BASE PRESSURE OF BODIES OF REVOLUTION AT A MACH NUMBER OF 1.5. Dean R. Chapman and Edward W. Perkins. 1951. ii, 24p. photos., diagrs. (NACA Rept. 1036. Formerly NACA RM A7A31a)

Models were tested to evaluate effects of Reynolds number for both laminar and turbulent boundary layers. Principal geometric variables investigated were afterbody shape and length-diameter ratio. Force tests and base-pressure measurements were made. Schlieren photographs were used to analyze the effects of viscosity on flow separation and shock-wave configuration and to verify the condition of the boundary layer as deduced from the force tests. The results are discussed and compared with theoretical calculations.

NACA Rept. 1039

ON THE PARTICULAR INTEGRALS OF THE PRANDTL-BUSEMANN ITERATION EQUATIONS FOR THE FLOW OF A COMPRESSIBLE FLUID. Carl Kaplan. 1951. ii, 6p. (NACA Rept. 1039. Formerly TN 2159)

The particular integrals of the second-order and third-order Prandtl-Busemann iteration equations for the flow of a compressible fluid are obtained by means of the method in which the complex conjugate variables z and $\bar{z}$ are utilized as the independent variables of the analysis. The assumption is made that the Prandtl-Glauert solution of the linearized or first-order iteration equation for the two-dimensional

flow of a compressible fluid is known. The forms of the particular integrals, derived for subsonic flow, are readily adapted to supersonic flows with only a change in sign of one of the parameters of the problem.

NACA TN 2489

AERODYNAMIC CHARACTERISTICS OF A REFINED DEEP-STEP PLANING-TAIL FLYING-BOAT HULL WITH VARIOUS FOREBODY AND AFTERBODY SHAPES. John M. Riebe and Rodger L. Naeseth. June 1952. 48p. photos., diagrs., 8 tabs. (NACA TN 2489. Formerly RM L8F01)

An investigation was made in the Langley 300-mph 7- by 10-foot tunnel to determine the aerodynamic characteristics of a refined deep-step planing-tail hull with various forebody and afterbody shapes and, for comparison, a streamline body simulating the fuselage of a modern transport airplane. The results of the tests indicated that the configurations incorporating a forebody with a length-beam ratio of 7 had lower minimum drag coefficients than the configurations incorporating a forebody with length-beam ratio of 5. The lowest minimum drag coefficients, which were considerably less than that of a conventional hull and slightly less than that of a streamline body, were obtained on the length-beam-ratio-7 forebody, alone and with round center boom. Drag coefficients and longitudinal- and lateral-stability parameters presented include the interference of a 21-percent-thick support wing.

NACA TN 2641

A VECTOR STUDY OF LINEARIZED SUPERSONIC FLOW APPLICATIONS TO NONPLANAR PROBLEMS. John C. Martin. June 1952. 81p. diagrs., tab. (NACA TN 2641)

A vector study of the partial-differential equation of steady linearized supersonic flow is presented. General expressions are derived which relate the velocity potential in the stream to the conditions on the disturbing surfaces. Problems concerning nonplanar systems are investigated, and methods are derived for the solution of some simple problems. The damping in roll is found for rolling tails consisting of four, six, and eight rectangular fins.

NACA TN 2657

SOME EFFECTS OF FREQUENCY ON THE CONTRIBUTION OF A VERTICAL TAIL TO THE FREE AERODYNAMIC DAMPING OF A MODEL OSCILLATING IN YAW. John D. Bird, Lewis R. Fisher and Sadie M. Hubbard. April 1952. 39p. diagrs., photo., tab. (NACA TN 2657)

The damping in yaw and the directional stability of a model freely oscillating in yaw were measured tail-off and tail-on and compared with the values obtained by theoretical consideration of the unsteady lift associated with an oscillating vertical tail. A range of low frequencies comparable to those of the lateral motions of airplanes was covered. The analysis includes the effects of vertical-tail aspect ratio and the two-dimensional effects of compressibility.

NACA TN 2670

HIGH-SPEED SUBSONIC CHARACTERISTICS OF 16 NACA 6-SERIES AIRFOIL SECTIONS. Milton D. Van Dyke. March 1952. 65p. diagrs., tab. (NACA TN 2670. Formerly RM A7J23)

High-speed subsonic characteristics have been measured for NACA 63-, 64-, 65-, and 66-series airfoil sections having thickness ratios of 6, 8, 10, and 12 percent and an ideal lift coefficient of 0.2. For given thickness ratio, airfoil sections with minimum pressure near 40-percent chord exhibit the best overall aerodynamic characteristics. For even the thinnest sections, good high-speed performance is maintained over a wide range of lift coefficient.

NACA TN 2672

THEORETICAL AUGMENTATION OF TURBINE-PROPELLER ENGINE BY COMPRESSOR-INLET WATER INJECTION, TAIL-PIPE BURNING, AND THEIR COMBINATION. Reece V. Hensley. March 1952. 43p. diagrs. (NACA TN 2672)

A theoretical evaluation of the performance of turbine propeller engines with augmentation by water injection, tail-pipe burning, and by their combination was made. The investigation covered the flight conditions for which each method of augmentation was most suitable for Mach numbers up to 1.1 and altitudes up to 35,000 feet. The variation in augmentation with varying compressor and turbine efficiencies, compressor pressure ratio, and turbine-inlet temperature was calculated. The augmentation with varying ambient temperature and relative humidity was determined and the dependence of the augmentation on the completeness of evaporation during compression was investigated.

NACA TN 2676

SUMMARY OF STALL-WARNING DEVICES. John A. Zalovcik. May 1952. 15p. diagrs. (NACA TN 2676)

Principles involved in the operation of stall-warning devices are described and conditions under which difficulty may be experienced are pointed out. Some specific examples of stall-warning devices are illustrated and described.

NACA TN 2689

EFFECT OF HIGH-LIFT DEVICES ON THE LOW-SPEED STATIC LATERAL AND YAWING STABILITY CHARACTERISTICS OF AN UNTAPERED 45° SWEPT-BACK WING. Jacob H. Lichtenstein. May 1952. 20p. diagrs., photo. (NACA TN 2689. Formerly RM L8G20)

Results of a low-speed wind-tunnel investigation to determine the effect of high-lift devices on the static lateral stability derivatives and the yawing derivatives of an untapered 45° sweptback wing are presented. The tests were made in the curved-flow test section of the Langley stability tunnel at a Reynolds number of 1.1×10^6.

NACA TN 2692

ON THE FORM OF THE TURBULENT SKIN-FRICTION LAW AND ITS EXTENSION TO COMPRESSIBLE FLOWS. Coleman duP Donaldson. May 1952. 19p. diagrs. (NACA TN 2692)

A derivation of the form of the incompressible turbulent skin-friction law for an insulated flat plate is made in such a way that it may be extended to compressible flows. The ratio of compressible to incompressible skin friction is obtained, and the results are shown to be in good agreement with existing experimental results.

NACA TN 2695

MIGRATION OF COBALT DURING FIRING OF GROUND-COAT ENAMELS ON IRON. William N. Harrison, Joseph C. Richmond, Joseph W. Pitts and Stanley G. Benner, National Bureau of Standards. June 1952. 28p. photos., 5 tabs. (NACA TN 2695)

A typical porcelain-enamel ground coat containing a small amount of radioactive cobalt as oxide was prepared, applied to sandblasted enameling-iron blanks, and fired under conditions selected to give underfired, normally fired, and overfired coatings. Examination of these specimens revealed that a cobalt-bearing metallic deposit had been formed at the enamel-metal interface during firing, and that the enamel layer was depleted in cobalt oxide near the interface. The amounts of such deposit and depletion were found to vary directly with the severity of the firing treatment. The amount of metallic deposit was extremely small, on the order of 0.01 micron thick if computed as a continuous layer of metallic cobalt in the case of the normally fired specimens.

NACA TN 2697

METHOD AND GRAPHS FOR THE EVALUATION OF AIR-INDUCTION SYSTEMS. George B. Brajnikoff. April 1952. 41p. diagrs., tab. (NACA TN 2697)

Graphs that allow rapid evaluation of air-induction systems from considerations of their aerodynamic parameters in combination with power-plant characteristics are presented for the supersonic Mach numbers up to 3.0. Restrictions imposed by the engine characteristics on the use of a fixed-size air inlet are discussed and illustrated by means of sample solutions. The relation between the engine characteristics, flight conditions, inlet characteristics, and inlet area for optimum performance is given.

NACA TN 2698

THEORETICAL ANALYSIS OF HYDRODYNAMIC IMPACT OF A PRISMATIC FLOAT HAVING FREEDOM IN TRIM. Robert W. Miller. June 1952. 31p. diagrs., 2 tabs. (NACA TN 2698)

The paper presents the derivation and a method for solution of equations taking into account the effects of freedom in trim on the loads, moments, and motions of a prismatic, V-bottom float forebody during hydrodynamic impact. Comparisons of solutions of the equations with fixed-trim solutions and with some experimental data are presented and indicate that the solutions are reasonable and consistent with both the experimental data and with general experience.

NACA TN 2699

CALCULATION OF LIFT AND PITCHING MOMENTS DUE TO ANGLE OF ATTACK AND STEADY PITCHING VELOCITY AT SUPERSONIC SPEEDS FOR THIN SWEPTBACK TAPERED WINGS WITH STREAMWISE TIPS AND SUPERSONIC LEADING AND TRAILING EDGES. John C. Martin, Kenneth Margolis and Isabella Jeffreys. June 1952. 116p. diagrs., 9 tabs. (NACA TN 2699)

On the basis of linearized supersonic-flow theory formulas for the stability derivatives C_{m_α}, C_{L_q}, and C_{m_q} were derived for a series of thin sweptback tapered wings with streamwise tips and supersonic leading and trailing edges. The results of the analysis are presented as a series of design charts. Some illustrative variations of the derivatives and of the chordwise center-of-pressure location with the various wing design parameters are also included.

NACA TN 2702

AN APPROXIMATE METHOD OF DETERMINING THE SUBSONIC FLOW IN AN ARBITRARY STREAM FILAMENT OF REVOLUTION CUT BY ARBITRARY TURBOMACHINE BLADES. Chung-Hua Wu, Curtis A. Brown and Vasily D. Prian. June 1952. 46p. diagrs., 4 tabs. (NACA TN 2702)

A method is presented to obtain a relatively quick approximate solution of the detailed subsonic flow of a nonviscous fluid past arbitrary turbomachine blade sections lying on an arbitrary surface of revolution. Calculation is first made for the flow along a particular streamline about midway between two adjacent blades. Extension of the flow from this streamline to the blade surfaces is then made by the use of a Taylor's series, and a method is provided to correct the solution to fit the given blade shape and operating conditions. The method is illustrated with examples of compressible flow in a turbine cascade and a centrifugal compressor. Three terms of the Taylor's series are found to give sufficient accuracy. Sufficient convergence is obtained for the turbine cascade after two cycles of computation and for the centrifugal compressor after four cycles of compu-

tation. (Each cycle of computation takes 16 hours.) The detailed flow distribution obtained compares very well with an available numerical solution and experimental data.

NACA TN 2703

ELECTRICAL TECHNIQUES FOR COMPENSATION OF THERMAL TIME LAG OF THERMOCOUPLES AND RESISTANCE THERMOMETER ELEMENTS. Charles E. Shepard and Isidore Warshawsky. May 1952. ii, 85p. diagrs., photos., 9 tabs. (NACA TN 2703)

Basic electrical networks are described that compensate for the thermal time lag of thermocouple and resistance thermometer elements. For a given set of operating conditions, networks requiring no amplifiers can provide a thirtyfold reduction in effective time lag. This improvement is obtained without attenuation of the voltage signal, but does result in a large reduction in the amount of electric power available because of an increase in the output impedance of the network. Networks using commercially available amplifiers can provide a thousandfold reduction in the effective time lag without attenuation of the alternating voltage signal or of the available electric power, but the improvement is often obtained at the expense of loss of the zero-frequency signal. The completeness of compensation is limited by the extent of off-design operation required.

NACA TN 2704

FATIGUE STRENGTHS OF 14S-T4 ALUMINUM ALLOY SUBJECTED TO BIAXIAL TENSILE STRESSES. Joseph Marin and W. P. Hughes, Pennsylvania State College. June 1952. 24p. photos., diagrs., 5 tabs. (NACA TN 2704)

The purpose of this investigation was to determine the influence of biaxial tensile stresses on the fatigue strength of a 14S-T4 aluminum alloy when subjected to various ratios of biaxial stresses. The effect upon the fatigue strength of varying the ratios of biaxial stresses was studied. The biaxial fatigue stresses were produced by applying simultaneously a pulsating internal pressure and a fluctuating axial tensile load to a thin-walled tubular specimen. The maximum and minimum values of the longitudinal and circumferential stresses were kept in phase by adjusting the testing machine. The fatigue strengths and S-N diagrams were obtained up to about 10^7 cycles for four principal stress ratios.

NACA TN 2705

THEORY OF SUPERSONIC POTENTIAL FLOW IN TURBOMACHINES. Robert H. Wasserman. June 1952. 44p. diagrs. (NACA TN 2705)

A general method for solving supersonic potential flow problems for stationary or rotating coordinate systems is presented. The principal attributes of the method are: It can handle flows which cannot be treated as two-dimensional, and a sound theoretical basis gives assurance of its validity for a class of boundary-value problems. An application to the design of a compressor rotor is made.

NACA TN 2706

EFFECT OF CHANGING PASSAGE CONFIGURATION ON INTERNAL-FLOW CHARACTERISTICS OF A 48-INCH CENTRIFUGAL COMPRESSOR. I - CHANGE IN BLADE SHAPE. Donald J. Michel, John Mizisin and Vasily D. Prian. May 1952. 40p. diagrs., photo., tab. (NACA TN 2706)

The passage contour of a 48-inch centrifugal impeller was modified by changing the shape of the blades. A comparison of the internal-flow characteristics was made of the original and modified passage contours at the design flow rate. In addition, the internal-flow characteristics of the modified passage are presented and analyzed over the entire flow range from maximum flow to surge at a corrected impeller tip speed of 700 feet per second. At design flow, the modified impeller, which had lesser deceleration rates along the blade surfaces, showed a general improvement in efficiency throughout the passage over that of the original impeller. At high weight flows (negative angles of attack), there were large separation losses at the inlet because of the shape of the leading edge; at low flow rates (positive angle of attack), the separation losses were not as great. The low-efficiency regions in the passage generally occurred near the flow surfaces with decelerating flow, except along the driving face where most boundary-layer build-up by adverse velocity gradients was probably eliminated by secondary flows or bleeding through the clearance space.

NACA TN 2707

ANALOGUE-COMPUTER SIMULATION OF AN AUTOPILOT SERVO SYSTEM HAVING NONLINEAR RESPONSE CHARACTERISTICS. Arthur L. Jones and John S. White. June 1952. 30p. diagrs. (NACA TN 2707)

The nonlinear response characteristics of an electrohydraulic servo system were successfully simulated using an electronic analogue computer (differential analyzer). In obtaining a satisfactory simulation it was necessary not only to take into account an easily recognized nonlinear amplifier response but also the accumulative effect of some time lags of the servo system.

NACA TN 2708

COMPARISON OF THREE MULTICYLINDER ICING METERS AND CRITIQUE OF MULTICYLINDER METHOD. Wallace E. Howell, Mount Washington Observatory. June 1952. 40p. diagrs., photos., 6 tabs. (NACA TN 2708)

Three multicylinder icing meters, fundamentally similar but differing from each other in important

deisgn details, were compared in use at the Mount Washington Observatory. Comparison of relative effectiveness of the instruments, evaluation of observational errors, determination of the effects of detailed design differences, and recommendations for further improvements of design are presented. An evaluation of the multicylinder method, concerned with the validity of the theoretical basis and the degree to which the instruments and the technique of their use permit accurate determinations of the physical measurements involved, is also included.

NACA TN 2709

FATIGUE AND STATIC TESTS OF FLUSH-RIVETED JOINTS. Darnley M. Howard and Frank C. Smith, National Bureau of Standards. June 1952. 38p. photos., diagrs., 3 tabs. (NACA TN 2709)

Fatigue and static tests were made of 1/8-inch diameter A17S-T3 100° countersunk-head rivets in lap and butt joints. Both machine-countersunk and dimpled holes were used. The sheet materials were 0.032-inch-thick bare and alclad 24S-T3 and 75S-T6 aluminum alloys and 0.064-inch-thick alclad 75S-T6 alloy. From the results no satisfactory single relation between static properties and fatigue life covering the four materials could be found.

NACA TN 2710

DIFFUSION OF HEAT FROM A LINE SOURCE IN ISOTROPIC TURBULENCE. Mahinder S. Uberoi and Stanley Corrsin, Johns Hopkins University. June 1952. 90p. diagrs., photos., tab. (NACA TN 2710)

An experimental and analytical study has been made of some features of the turbulent heat diffusion behind a line heated wire stretched perpendicular to a flowing isotropic turbulence. The mean temperature distributions have been measured with systematic variations in wind speed, size of turbulence producing grid, and downstream location of heat source. The nature of the temperature fluctuation field has been studied. A comparison of Lagrangian and Eulerian analyses for diffusion in a nondecaying turbulence yields an expression for turbulent-heat-transfer coefficient in terms of turbulence velocity and a Lagrangian "scale." A convenient form has been deduced for the criterion of interchangeability of instantaneous space and time derivatives in a flowing turbulence.

NACA TN 2712

FLOW CHARACTERISTICS OVER A LIFTING WEDGE OF FINITE ASPECT RATIO WITH ATTACHED AND DETACHED SHOCK WAVES AT A MACH NUMBER OF 1.40. John H. Hilton, Jr. June 1952. 21p. diagrs., photos. (NACA TN 2712)

A series of schlieren photographs and pressure distributions obtained in the Langley 4- by 4-foot supersonic tunnel are presented to illustrate the general characteristics of supersonic flow over a wedge under conditions of attached and detached shock. The pressure distributions and aerodynamic coefficients are compared with shock-expansion theory.

NACA TN 2713

EFFECT OF COMPRESSOR-OUTLET AIR BLEED ON PERFORMANCE OF A CENTRIFUGAL-FLOW TURBOJET ENGINE WITH A CONSTANT-AREA JET NOZZLE. Sidney C. Huntley. June 1952. 20p. diagrs. (NACA TN 2713)

The effect of compressor-outlet air bleed on the performance of a centrifugal-flow turbojet engine is presented. The cost of compressor-outlet air bleed in terms of the increase in net-thrust specific fuel consumption was about 2 percent for each percent of air bleed for constant engine speed, maximum net thrust, or constant net-thrust operation. When maximum net-thrust operation with air bleed occurred at a constant tail-pipe temperature, the maximum net thrust decreased at a rate of about 2.5 percent for each percent of air bleed, while the loss in net thrust with air bleed at constant engine speed was only about 0.5 percent for each percent of air bleed.

NACA TN 2714

NORMAL ACCELERATIONS AND OPERATING CONDITIONS ENCOUNTERED BY A HELICOPTER IN AIR-MAIL OPERATIONS. Almer D. Crim and Marlin E. Hazen. June 1952. 17p. diagrs., photos., 2 tabs. (NACA TN 2714)

An analysis is presented of the normal accelerations and operating conditions encountered by a single-rotor helicopter engaged in air-mail operation in the vicinity of Los Angeles and its suburbs.

NACA TN 2716

EFFECT OF OPEN CIRCULAR HOLES ON TENSILE STRENGTH AND ELONGATION OF SHEET SPECIMENS OF A MAGNESIUM ALLOY. R. S. Barker, Aluminum Company of America. June 1952. 24p. diagrs., 6 tabs. (NACA TN 2716)

The effect of open circular holes on the tensile strength and elongation of sheet specimens of magnesium alloy AM-C52S in both the annealed and the hard-rolled condition was investigated. Tests were made to study the effect of variable ratio of hole diameter to total specimen width and also the effect of spacing and arrangement of the holes. It was found that greater reductions in strength were exhibited by the annealed material but that the hard-rolled material showed the greater reductions in elongation.

NACA TN 2717

EFFECT OF TEMPERATURES FROM -70° TO 600° F ON STRENGTH OF ADHESIVE-BONDED LAP SHEAR SPECIMENS OF CLAD 24S-T3 ALUMINUM ALLOY AND OF COTTON- AND GLASS-FABRIC PLASTIC LAMINATES. H. W. Eickner, W. Z. Olson and R. F. Blomquist, Forest Products Laboratory. June 1952. 26p. diagrs., 6 tabs. (NACA TN 2717)

The performance of 14 commercial adhesives at temperatures from -70° to 600° F was evaluated in lap shear specimens of clad 24S-T3 aluminum alloy to itself and that of 7 commercial adhesives at -70° to 250° F in lap joints of cotton-fabric-phenolic laminate to itself, of glass-fabric-polyester laminate to itself, and in joints of each of these laminates to clad aluminum. One hot-setting tape adhesive was found to be consistently superior to all others in lap-joint specimens of aluminum tested at 450° F after 192 hours at 450° F. The best of the commercial adhesives evaluated at -70° to 250° F in lap shear specimens of plastic laminates bonded to themselves and to aluminum had only fair resistance to stressing immediately upon reaching 250° F. The adhesives generally performed adequately in the various joints at -70° F.

NACA TN 2718

TWO-DIMENSIONAL STEADY NONVISCOUS AND VISCOUS COMPRESSIBLE FLOW THROUGH A SYSTEM OF EQUIDISTANT BLADES. Hans J. Reissner, Leonard Meyerhoff and Martin Bloom, Polytechnic Institute of Brooklyn. June 1952. 48p. diagrs., 4 tabs. (NACA TN 2718)

The problem of two-dimensional flow of a compressible nonviscous fluid through blade systems of equidistant spacing, of identical shape, and of straight-line arrangement of position is analyzed. Viscous flow through a grid system of equidistant, narrowly spaced blades is treated in an appendix.

NACA TN 2719

INVESTIGATION OF STATISTICAL NATURE OF FATIGUE PROPERTIES. E. Epremian and R. F. Mehl, Carnegie Institute of Technology. June 1952. ii, 119p. diagrs., photos., tab. (NACA TN 2719)

Extensive fatigue tests were made on annealed Armco iron and plain carbon and alloy steels heat-treated to different strengths and microstructures. Statistics of fatigue-fracture curves and endurance limits were determined from the experimental data obtained and, for various other materials, from a survey of literature. The results were analyzed to show the relative effects of various metallurgical factors on the statistical nature of fatigue properties. Other phases of the problem studied include: dependence of statistical variation in fatigue life on stress level in the fracture range, statistics for location of crack initiation, size effect, understressing effect, and the form and method of plotting the S-N diagram.

NACA TN 2721

INITIAL RESULTS OF INSTRUMENT-FLYING TRIALS CONDUCTED IN A SINGLE-ROTOR HELICOPTER. Almer D. Crim, John P. Reeder and James B. Whitten. June 1952. 16p. diagrs., photos. (NACA TN 2721)

Instrument-flying trials have been conducted in a single-rotor helicopter to determine the adequacy of existing longitudinal flying-qualities requirements under instrument conditions. In addition, lateral-directional characteristics were examined. The suitability, for helicopter use, of standard airplane instruments was also investigated.

NACA TN 2722

DISPLACEMENT EFFECT OF A THREE-DIMENSIONAL BOUNDARY LAYER. Franklin K. Moore. June 1952. 15p. diagrs. (NACA TN 2722)

A method is described for determining the "displacement surface" of a known three-dimensional boundary-layer flow in terms of the mass-flow defects associated with the profiles of the two velocity components parallel to the surface. The displacement surface height is shown to differ, in general, from that associated with the resultant mass-flow defect, even at stagnation points of the secondary flow. Numerical values are found for the known three-dimensional boundary-layer flow about a cone at a small angle of attack to a supersonic stream.

NACA TN 2723

USE OF THE BOUNDARY LAYER OF A CONE TO MEASURE SUPERSONIC FLOW INCLINATION. Franklin K. Moore. June 1952. 21p. diagrs. (NACA TN 2723)

An instrument is suggested for the measurement of supersonic flow inclination, taking advantage of the effect of angle of attack on the meridional velocity profile of the boundary layer on a cone. This effect of angle of attack may be measured by the difference of total pressure recorded by two probes pointing toward the apex and located in the plane of symmetry of the flow.

NACA TN 2725

INTERACTION OF OBLIQUE SHOCK WAVES WITH REGIONS OF VARIABLE PRESSURE, ENTROPY, AND ENERGY. W. E. Moeckel. June 1952. 34p. diagrs. (NACA TN 2725)

Equations are developed for computing the propagation of oblique shock waves through regions in which pressure, energy, or entropy are continuously variable. For the special cases of supersonic shear flow and Prandtl-Meyer flow, charts are given of shock angle as function of Mach number for any initial-strength wave. A sufficient condition for the avoidance of upstream effects due to shock propagation is found. A wave-interaction procedure for determining supersonic portions of the flow downstream of the shock is described, and an approximate method for dealing with imbedded subsonic regions is proposed.

NACA TN 2729

AN ANALYSIS OF SUPERSONIC FLOW IN THE REGION OF THE LEADING EDGE OF CURVED AIRFOILS, INCLUDING CHARTS FOR DETERMINING SURFACE-PRESSURE GRADIENT AND SHOCK-WAVE CURVATURE. Samuel Kraus. June 1952. 45p. diagrs., 5 tabs. (NACA TN 2729)

Flow in the region of the leading edge of curved airfoils with attached shock waves is investigated. Tables and charts are presented for determining the surface-pressure gradient and shock-wave curvature in supersonic flow of an ideal diatomic gas. The results cover a range of Mach numbers from 1.5 to infinite and deflection angles from zero up to those approaching shock detachment. Calculations of surface-pressure gradient and shock-wave curvature are also made for curved airfoils in supersonic flow of a calorically imperfect, diatomic gas. An approximate procedure for determining the flow field a short distance downstream of the leading edge is also presented.

NACA TN 2731

INFLUENCE OF STRUCTURE ON PROPERTIES OF SINTERED CHROMIUM CARBIDE. H. J. Hamjian and W. G. Lidman. June 1952. 21p. diagrs., photos., 5 tabs. (NACA TN 2731)

An investigation was conducted to study the influence of structural variations on the properties of chromium carbide sintered under pressure. The results show that the room-temperature strength and hardness are influenced by the stages of sintering, which are defined by grain size and by the number, size, location, and shape of pores. The extent to which sintering has progressed during the second stage when densification occurs and the sintering conditions which will yield optimum room-temperature strength can be determined from hardness. It was found that coarse-grained structures are detrimental to room temperature strength. On the basis of limited data, coarse-grained structures may not be detrimental at elevated temperatures.

NACA RM 52D03

DESIGN OF APPARATUS FOR DETERMINING HEAT TRANSFER AND FRICTIONAL PRESSURE DROP OF NITRIC ACID FLOWING THROUGH A HEATED TUBE. Bruce A. Reese and Robert W. Graham, Purdue University. June 1952. 61p. diagrs., photos., tab. (NACA RM 52D03)

A design basis is presented for test apparatus to measure heat-transfer and pressure-drop characteristics of white fuming nitric acid under conditions simulating those occurring in a regeneratively cooled rocket engine. The apparatus is designed so that heat-transfer and fluid-friction data can be obtained over the following ranges: inlet pressure to test section, atmospheric to 400 pounds per square inch absolute; mean fluid temperature at entrance to heated test section, -30° to 300° F; heat input to test section, 0.5 to 1.5 Btu per second per square inch; and Reynolds number, 60,000 to 200,000.

NACA RM E52A11

ANALYSIS OF A PNEUMATIC PROBE FOR MEASURING EXHAUST-GAS TEMPERATURES WITH SOME PRELIMINARY EXPERIMENTAL RESULTS. Marvin D. Scadron. May 1952. 26p. diagrs., 4 tabs. (NACA RM E52A11)

A pneumatic probe based on continuity of mass flow through two restrictions separated by a cooling chamber was constructed to measure gas temperature at and beyond the limit of thermocouples. This probe consisted of a subsonic flat-plate orifice for the first restriction and a sonic-flow converging-diverging nozzle for the second restriction. The effect of variation in gas constants on the calibration is examined for common engine-exhaust gases. A high-temperature wind tunnel that allowed calibration of the probe at temperatures up to 2000° R and Mach numbers up to 0.8 is described. Agreement to better than 30° R between pneumatic probe indication and the indication of a rake of radiation-shielded thermocouples indicates that extrapolation of the calibration to higher temperatures is possible with fair accuracy.

NACA RM E52C05

INVESTIGATION OF EFFECTIVE THERMAL CONDUCTIVITIES OF POWDERS. R. G. Deissler and C. S. Eian. June 1952. 44p. diagrs., tab. (NACA RM E52C05)

A simplified analysis was made to determine the effective thermal conductivity of a powder from the fraction of space occupied by the gas and the conductivities of the solid and the gas which make up the powder. In order to check the analysis and to obtain data of current technical interest, tests were conducted to determine the conductivity of magnesium oxide powder in various gases at temperatures between 200° and 800° F. Good agreement was obtained between analytical and experimental results. The effects of some of the factors neglected in the simplified analysis such as the bending of heat-flow lines and the irregularity of the arrangement of the particles were investigated and discussed.

NACA RM E52D03

PRELIMINARY SURVEY OF BOUNDARY-LAYER DEVELOPMENT AT A NOMINAL MACH NUMBER OF 5.5. Harold L. Bloom. June 1952. 26p. diagrs., photos. (NACA RM E52D03)

Mean skin-friction coefficients on a flat-plate model, with and without initial roughness, and on a wind tunnel wall were measured at a nominal Mach number of 5.5 over a Reynolds number range from 1×10^6 to 1×10^7, and the results were compared with analytical values. Although evidence of air condensation was obtained in the test section, experimental mean skin-friction coefficients on the tunnel wall and on the flat plate with artificial transition agreed quite well with the analytical results of H. U. Eckert and E. R. Van Driest. Experimental skin-friction coefficients on the plate with natural transition fell between theoreti-

cal laminar values and the analytical turbulent values of Eckert and of Van Driest. Because of the presence of air condensation, the results reported herein must be regarded as tentative.

NACA RM L52A28

NORMAL ACCELERATIONS AND ASSOCIATED OPERATING CONDITIONS ON FOUR TYPES OF COMMERCIAL TRANSPORT AIRPLANES FROM VGH DATA AVAILABLE AS OF SEPTEMBER 1951. Roy Steiner and Doris A. Persh. May 1952. 8p. diagrs., 5 tabs. (NACA RM L52A28)

The NACA VGH time-history records of normal acceleration, airspeed, and altitude of 377, 520, and 118 hours each for 3 four-engine aircraft and 377 hours for a twin-engine aircraft have been evaluated. The summaries of gust loads and the associated operating conditions are presented.

NACA TM 1331

INVESTIGATIONS OF THE BOUNDARY-LAYER CONTROL OF A FULL SCALE SWEPT WING WITH AIR BLED OFF FROM THE TURBOJET. (Recherches sur l'Hypersustentation d'une Aile en Flèche Réelle par Controle de la Couche Limite Utilisant le Prélèvement d'Air sur le Turbo-Réacteur). P. Rebuffet and Ph Poisson-Quinton. April 1952. 43p. diagrs., photos. (NACA TM 1331. Trans. from Recherche Aéronautique, no.14, March-April, 1950, p.39-54)

The various stages of a boundary-layer control study, culminating in the investigation of combined suction and blowing in conjunction with a drooped-nose flap and a form of double-slotted trailing-edge flap on a full-scale 10-percent thick $31^{\circ}\ 20'$ sweptback wing model in the Chalais-Meudon large-scale tunnel, are described. The suction and blowing was accomplished with ejectors fed by bleed-off air from a turbojet engine. A lift coefficient increment of 1.36 was obtained by the use of boundary-layer control.

NACA TM 1332

EXTENSION TO THE CASES OF TWO DIMENSIONAL AND SPHERICALLY SYMMETRIC FLOWS OF TWO PARTICULAR SOLUTIONS TO THE EQUATIONS OF MOTION GOVERNING UNSTEADY FLOW IN A GAS. (Estensione ai Casi di Simmetria Centrale Bi-e Tri-Dimensionale di Due Particolari Soluzioni delle *Equazioni del Moto Gassoso Non Permanente*). Lorenzo Poggi. June 1952. 6p. (NACA TM 1332. Trans. from Onore di Modesto Panetti, November 25, 1950.)

The author previously discovered two interesting particular solutions to the equations of motion describing unsteady flow in a gas confined solely to a one-dimensional duct. These solutions are now extended to cover the more noteworthy cases of central symmetry in two and three dimensions.

NACA TM 1334

THE EFFECT OF HIGH VISCOSITY ON THE FLOW AROUND A CYLINDER AND AROUND A SPHERE. (Der Einfluss grosser Zähigkeit bei der Strömung um den Zylinder und um die Kugel). F. Homann. June 1952. 29p. diagrs., tab. (NACA TM 1334. Trans. from Zeitschrift für angewandte Mathematik und Mechanik, v. 16, no. 3, June 1936, p. 153-164).

The report records an experimental and theoretical investigation of the influence of high viscosity on the stagnation pressure of flow around cylinders and spheres. For the three-dimensional problem, a differential equation is set up which corresponds to the two-dimensional solution by Heimenz. Theoretical methods are developed for determining the stagnation pressure for the two- and the three-dimensional cases of flow around cylinders and spheres, respectively. The results thus obtained are compared with experimental results obtained in an oil channel at Reynolds numbers up to approximately 100. Finally, a procedure to determine the velocity and the pressure variation, as well as the variation of the free-stream velocity gradient on the stagnation streamline, is shown and used for the practical case of Reynolds number 100.

NACA TM 1338

THE OXIDATION OF METALS AND ALLOYS. (Uber das Zundern von Metalle und Legierungen). Erich Scheil. June 1952. 16p. diagrs., photos. (NACA TM 1338. Trans. from Zeitschrift für Metallkunde, v. 29, July 1937, p. 209-214).

This paper reviews the various types of oxidation processes occurring with pure metals and gives explanations for the varying time-temperature-oxidation rate relations that exist for copper, tungsten, zinc, cadmium, and tantalum. The effect of shape and crystal structure on oxidation is discussed. Principles derived are applied to the oxidation of alloys.

NACA TM 1339

VELOCITY OF ACTION OF OXYGEN, HYDROGEN SULFIDE, AND HALOGENS ON METALS. (Die Geschwindigkeit der Einwirkung von Sauerstoff, Schwefelwasserstoff, und Halogenen auf Metalle). G. Tammann and W. Köster. June 1952. 21p. diagrs., 20 tabs. (NACA TM 1339. Trans. from Zeitschrift für anorganische und allgemeine Chemie, v. 123, August 1922, p. 196-201 and 208-224).

This report discusses a method of determining the rate of surface oxidation of a metal by the change in the color of the surface film produced by reactions with oxygen, chlorine, or iodine. The metals studied included iron, nickel, copper, zinc, cadmium, tin, lead, cobalt, and manganese. Tables are given for surface film thickness versus color for various times.

NACA TM 1345

TRANSLATIONAL MOTION OF BODIES UNDER THE FREE SURFACE OF A HEAVY FLUID OF FINITE DEPTH. (O postupatelnom dvizhenii tel pod svobodnoi poverkhnost'yu tyazheloi zhidkosti konechnoi glubiny). M. D. Haskind. June 1952. 20p. diagr. (NACA TM 1345. Trans. from Prikladnaya Matematika i Mekhanika, v. 9, no. 1, September 1945, p. 67-78).

The problem of the uniform motion of a solid body under the free surface of a heavy incompressible fluid of finite depth is treated. The problem is a two-dimensional one and is handled completely by the methods of complex function theory.

N-3074B

INDEX OF NACA TECHNICAL PUBLICATIONS, 1949-MAY 1951. (Supplement to the index of NACA technical publications, 1915-1949). viii, 201p. (NACA)

This report, previously listed in Research Abstract no. 24 as being available for loan only, is now available for issue.

BRITISH REPORTS

N-14296*

Aeronautical Research Council (Gt. Brit.)
GENERAL HANDLING TESTS OF THE SIKORSKY R-4B HELICOPTER (HOVERFLY MK. I). W. Stewart. 1951. 21p. diagrs., photos., tab. (ARC R & M 2431; ARC 10,211. Formerly RAE Aero 2164)

Throughout the flying range, the stability of the helicopter is poor but the controls are very effective. The lateral control may be criticized as too sensitive. Maneuvers on the helicopter require a precise coordination of all controls, including the collective pitch and throttle controls. Vibration in the control column and lateral force required to trim, make it very tiring to fly the Hoverfly for any length of time. A loss of control is experienced at zero forward airspeed and high power conditions, when the collective pitch is reduced, unless the reduction is made very slowly.

N-14304*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF THE SWEEPBACK OF DELTA WINGS ON THE PERFORMANCE OF AN AIRCRAFT AT SUPERSONIC SPEEDS. A. Robinson and F. T. Davies. 1951. 6p. diagrs. (ARC R & M 2476; 10,594. Formerly College of Aeronautics, Cranfield Rept. 6)

The variation with sweepback of the total drag of an aircraft in level flight at supersonic speeds is calculated. It is shown that sweepback is not uniformly beneficial, but that in general the optimum amount of sweepback depends on the design speed and altitude.

N-14305*

Aeronautical Research Council (Gt. Brit.)
INTERFERENCE ON A WING DUE TO A BODY AT SUPERSONIC SPEEDS. S. Kirkby and A. Robinson. 1952. 10p. diagrs. (ARC R & M 2500; 10,631, FM 1113. Formerly College of Aeronautics, Cranfield Rept.7)

The wing-body combination considered consists of a right-circular conical body, of small semivertical angle, carrying an unswept symmetrical rectangular wing whose chord is inclined at a small angle to the axis of the body cone. In theory, the conical body is replaced by an axial doublet system and the upwash velocity increment is calculated at the midchord line of the wing. The resultant lift increment on the wing due to body interference is then calculated by Ackeret's theory. Curves are plotted to show the variation of induced wing-lift coefficient with cone angle for different wing positions.

N-14306*

Aeronautical Research Council (Gt. Brit.)
OVERALL THRUST, THRUST GRADING, AND TORQUE MEASUREMENTS ON A TWO-BLADE, 6-1/2 PER CENT THICK, NACA 16 SECTION PROPELLER IN THE HIGH-SPEED TUNNEL. G. S. Hislop, G. F. Hughes and D. S. Capps. 1951. 45p. diagrs., photos., tab. (ARC R & M 2515; 10,975. Formerly RAE Aero 2213)

Blade angles were varied and the solidity was 7-1/2 percent total solidity at 0.7R. The Mach number range was 0.1 to 0.8. It was concluded that it should be possible to obtain very good propulsive efficiencies at all forward speeds up to a Mach number of 0.78. Beyond that speed, orthodox propellers will be unsuitable. There was some uncertainty about the corrections to the experimental results.

N-14307*

Aeronautical Research Council (Gt. Brit.)
HIGH-SPEED WIND-TUNNEL TESTS ON MODELS OF FOUR SINGLE-ENGINED FIGHTERS (SPITFIRE, SPITEFUL, ATTACKER AND MUSTANG). Staff of the R.A.E. High Speed Wind Tunnel, edited by W. A. Mair. PART I. W. A. Mair, S. P. Hutton and H. E. Gamble. PART II. W. A. Mair, S. P. Hutton and H. E. Gamble. PART III. W. A. Mair and S. P. Hutton. PART IV. S. P. Hutton, D. A. Clark and D. J. Tremlett. PART V. J. Y. G. Evans, J. Caldwell and C. M. Britland. 1951. 79p. diagrs., tabs. (ARC R & M 2535; ARC 6739; ARC 7596; ARC 7045; ARC 9559; ARC 8707. Formerly RAE Aero 1810; RAE Aero 1908; RAE Tech.Note Aero 1247; RAE Aero 2112; RAE Aero 2038)

This report describes measurements of lift, drag, and pitching moment made in the RAE high-speed

wind tunnel on models of the Spitfire, Spiteful (F.1/43), Attacker (E.10/44), and Mustang. On the Spiteful model, pressure distributions on the front radiator flap were also measured. An introduction (written in 1949) gives a general account of the tests described in the separate parts of the report.

N-14308*

Aeronautical Research Council (Gt. Brit.)
TESTS ON A GLAS II WING WITHOUT SUCTION IN THE COMPRESSED AIR WIND TUNNEL. C. Salter, C. J. W. Miles and R. Owen. 1951. 21p. diagrs., 5 tabs. (ARC R & M 2540. Formerly ARC 11,269; Perf. 409; FM 1207)

The object of these tests was primarily the estimation of the behavior of the wing at high Reynolds numbers in the event of the failure of the suction, but the investigation was extended to the examination of the effect of main, split, and slotted flaps in order to obtain information concerning some reasonable method of countering any serious effects that might arise. Critical regions were observed and the scale effects were found to be large. The gain of maximum lift resulting from the use of main and split flaps was roughly 0.5 on C_L and has been shown to be less than half of the gain achieved on an NACA 0030 wing by the use of a similar split flap. The effect of slotting the main flap was found to be comparatively small and rather detrimental than otherwise.

N-14309*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE SOUTHWELL METHOD FOR ESTIMATING CRITICAL LOADS. H. L. Cox. 1951. 8p. diagrs. (ARC R & M 2696. Formerly ARC 9852, ARC 10,374, Strut 1054, Strut 1054a)

Draws attention to certain restrictions on the use of the "Southwell plot" to estimate critical loads in cases differing in conditions from those for which the method was first proposed. The effect on this plot of various stress distributions, of elastic failure of the material and of other variations of critical stress, however it may be occasioned, is examined. The Southwell plot is strictly applicable only to deflections which go to infinity at a definite critical load. In other cases the plot usually overestimates the buckling load, but the error should seldom be important.

N-14310*

Aeronautical Research Council (Gt. Brit.)
AN INVESTIGATION INTO THE EFFECT OF FORCED AND NATURAL AFTERBODY VENTILATION ON THE HYDRODYNAMIC CHARACTERISTICS OF A SMALL FLYING BOAT (SARO 37) WITH A 1:20 FAIRING OVER THE MAIN STEP. J. A. Hamilton. 1951. 18p. diagrs., photos., tab. (ARC R & M 2714; ARC 11,360. Formerly MAEE F/Res/206)

A continuation of tests reported in R & M 2463 (in which the fairing was 1:15). The hydrodynamic characteristics were investigated in taxi runs and take-offs over a range of fixed elevator positions and in landing over a range of touch-down attitudes, at a weight of 5,900 lbs. These tests were made with the ducts naturally ventilated. At 6,200 lbs the tests were confined to taxi runs with and without forced ventilation.

N-14402*

Aeronautical Research Council (Gt. Brit.)
A REVIEW OF THE ESSENTIALS OF IMPACT FORCE THEORIES FOR SEAPLANES AND SUGGESTIONS FOR APPROXIMATE DESIGN FORMULAE. R. J. Monaghan. 1952. 27p. diagrs. (ARC R & M 2720; ARC 11,245. Formerly RAE Aero 2230)

This report reviews the essential theory and assumptions underlying recent work, and puts forward an approximate design formula for the maximum deceleration during a main step impact which is directly a function of the initial impact conditions.

N-14403*

Aeronautical Research Council (Gt. Brit.)
A 24-WAY HIGH-SPEED ROTARY SWITCH FOR USE IN STATIC AND AIRBORNE STRAIN GAUGE MEASUREMENTS. D. H. Peirson. 1951. 10p. diagrs., photos. (ARC R & M 2232; ARC 10,398. Formerly RAE Tech. Note SME 381)

A mechanical switch operating at 25 times per second for each signal has been designed to record 24 strain-gage signals, using a single amplifier and cathode-ray oscillograph. This equipment has been used in the measurement of steady ground and varying air-borne signals. Reference is made to use of the switch in static laboratory measurements on a tail plane and wing. Technique as developed for the measurement of wing stresses in flight is described in some detail.

N-14404*

Aeronautical Research Council (Gt. Brit.)
AN EXAMPLE IN WING THEORY AT SUPERSONIC SPEED. H. B. Squire. 1951. 16p. diagrs., tab. (ARC R & M 2549; ARC 10,624; ARC 12,517. Formerly RAE Aero 2184)

Calculations of the pressure on a flat elliptic cone and on a flat elliptic hyper-cone at supersonic speeds and zero incidence are made for the case when the cones lie inside the Mach cone of the apex. The results are combined to give the pressure distribution and drag of a wing-like surface at zero incidence in a supersonic stream. It is found that the pressure is constant along straight lines on this surface which are normal to the wind direction. The drag results show the effect of sweepback on drag at supersonic speeds.

N-14405 *

Aeronautical Research Council (Gt. Brit.)
SOME DATA PERTAINING TO THE SUPERSONIC AXIAL-FLOW COMPRESSOR. I. M. Davidson. 1951. 38p. diagrs., photos., tab. (ARC R & M 2554; ARC 10,847; ARC 10,758. Formerly NGTE R.15; NGTE Memo. M.16)

Together with some random considerations concerning possible compressor development, data concerning the flow of air at high speeds is presented in this note in a form suitable for use in the design of supersonic axial-flow compressors. A brief history and description is also given of the work of the German pioneers Weise, Encke and Betz.

N-14406*

Aeronautical Research Council (Gt. Brit.)
TESTS ON A WORKING MODEL RAM JET IN A SUPERSONIC WIND TUNNEL. J. R. Singham, F. W. Pruden and R. C. Tomlinson. 1951. 16p. diagrs., photos., 4 tabs. (ARC R & M 2568; ARC 11,361. Formerly NGTE R.20)

The tests were made to ascertain the practicability of testing such a small-scale model in a wind tunnel and to determine to what extent the external drag of a model duct tested hot would differ from the same model tested cold. The tests were run at a Mach number of 1.4. It was concluded that satisfactory accuracy could be obtained by the use of a large tunnel of square or rectangular section, with a good velocity distribution and transparent walls large enough to view the whole model.

N-14409*

Aeronautical Research Council (Gt. Brit.)
DESIGNING TO AVOID DANGEROUS BEHAVIOUR OF AN AIRCRAFT DUE TO THE EFFECTS ON CONTROL HINGE MOMENTS OF ICE ON THE LEADING EDGE OF THE FIXED SURFACE. D. E. Morris. 1952. 10p. diagrs., tab. (ARC CP 66)

Results of wind-tunnel measurements of hinge moments of a Viking elevator with simulated ice on the tail-plane leading edge are used to explain uncontrollable pitching oscillations of the aircraft which occurred during a flight. It is suggested that the imposing of certain limitations on the control-surface hinge-moment coefficients will eliminate the difficulty.

N-14410*

Aeronautical Research Council (Gt. Brit.)
APPROXIMATE TWO-DIMENSIONAL AEROFOIL THEORY. PART III. APPROXIMATE DESIGNS OF SYMMETRICAL AEROFOILS FOR SPECIFIED PRESSURE DISTRIBUTIONS. S. Goldstein. 1952. 40p. diagrs., 3 tabs. (ARC CP 70)

It is shown that if the velocity distribution at the surface of a symmetrical airfoil, according to the purely linear theory, is known, that the airfoil shape may be easily calculated. General formulas are given for the airfoil ordinates, both in terms of a Fourier series and as an integral. Examples are given.

N-14411*

Aeronautical Research Council (Gt. Brit.)
FLIGHT TESTS ON THE YOUNGMAN-BAYNES HIGH-LIFT EXPERIMENTAL AIRCRAFT. D. Lean. 1952. 54p. diagrs., photos., 9 tabs. (ARC CP 65)

The tests showed that an increment of maximum lift coefficient of 1.32 can be obtained on an unswept wing with a low-drag section, whose basic maximum lift coefficient is 1.28. About 0.2 was lost due to wing-fuselage interference. Adequate lateral control is provided by ailerons inset in the full-span flap. The profile-drag increment at full flap is 0.07 for a lift-coefficient increment of 1.14, at an angle of attack of 10°. Changes in longitudinal trim due to flaps are small and easily controlled and the ground effect on longitudinal trim is negligible. The wing-flap-aileron structure is adequately stiff in torsion and the aileron reversal speed is estimated at 300 knots.

N-14412*

Aeronautical Research Council (Gt. Brit.)
DRAFT CORRECTIONS FOR WATER SURFACE DEFLECTION UNDER NO. 1 CARRIAGE OF THE R.A.E. SEAPLANE TANK. T. B. Owen. 1952. 15p. diagrs., photo., 3 tabs. (ARC CP 67)

The running draft and attitude of hulls under test are measured relative to the undisturbed water level, but at normal running speeds an appreciable deflection of the water surface is produced at the model testing position by the aerodynamic pressure field of the carriage. These deflections have been measured and data are given for the correction of measured draft and attitude values covering the normal range of model positions and conditions.

N-14413*

Aeronautical Research Council (Gt. Brit.)
APPROXIMATE TWO-DIMENSIONAL AEROFOIL THEORY. PART V. THE POSITIONS OF MAXIMUM VELOCITY AND THEORETICAL C_L-RANGE. S. Goldstein. 1952. 26p. diagrs. (ARC CP 72)

To calculate the theoretical critical compressibility speed for a given airfoil section at a given C_L we first compute the greatest velocity on the airfoil contour. Normal methods are often too long and thus a simplification is presented. This method is accurate enough for practical purposes. There is a discussion of the theoretical C_L-range for low-drag airfoils. The so called "roof-top" airfoils are considered in particular.

N-14414*

Aeronautical Research Council (Gt. Brit.)
THE MEASUREMENT OF HEAT TRANSFER AND SKIN FRICTION AT SUPERSONIC SPEEDS. PART II - BOUNDARY LAYER MEASUREMENTS ON A FLAT PLATE AT M = 2.5 AND ZERO HEAT TRANSFER. R. J. Monaghan and J. E. Johnson. 1952. 44p. diagrs., photo., 2 tabs. (ARC CP 64)

The measured rate of growth of the laminar layer was greater than theory would predict. Transition to turbulent flow occurred between 3 and 4 inches from the leading edge at a Reynolds number between 8×10^5 and 10^6. The thickness of the turbulent layer was approximately the same as in low speed flow. Skin friction was about 20 percent below that obtained with the heated plate of the preceding report. A preliminary investigation was made of the use of chemical methods for indicating transition.

N-14415*

Aeronautical Research Council (Gt. Brit.)
APPROXIMATE TWO-DIMENSIONAL AEROFOIL THEORY. PART II. VELOCITY DISTRIBUTIONS FOR CAMBERED AEROFOILS. S. Goldstein. 1952. 61p. diagrs., 5 tabs. (ARC CP 69)

Both thickness and camber are considered in this theory. The connection with the "vortex sheet" theory of infinitely thin airfoils is set out. In particular, the usual formulas for the no-lift angle and moment at zero lift are correct if account is taken of the thickness, so long as the thickness is not too large. Examples are given.

N-14416 *

Aeronautical Research Council (Gt. Brit.)
APPROXIMATE TWO-DIMENSIONAL AEROFOIL THEORY. PART I. VELOCITY DISTRIBUTIONS FOR SYMMETRICAL AEROFOILS. S. Goldstein. 1952. 59p. diagrs., 7 tabs. (ARC CP 68)

This part considers the velocity distribution at the surface of a given airfoil. The airfoils are assumed to have a thickness. Examples are given using the NACA 0012, NACA 16-012, Clark Y, EQH 1260, EQH 1250, and the EQH 1240 airfoils. The theory is especially designed to be applied to airfoils with ordinates given by algebraic formulas, or which can be fitted to such formulas.

N-14417*

Aeronautical Research Council (Gt. Brit.)
APPROXIMATE TWO-DIMENSIONAL AEROFOIL THEORY. PART IV. THE DESIGN OF CENTRE LINES. S. Goldstein. 1952. 49p. diagrs., 3 tabs. (ARC CP 71)

This report is concerned with the design of the center lines of cambered airfoils when a particular pressure or velocity distribution is desired. Examples are given.

N-14652*

National Gas Turbine Establishment (Gt. Brit.)
STUDIES ON THE SPONTANEOUS IGNITION OF FUELS INJECTED INTO A HOT AIR STREAM. PART V. IGNITION DELAY MEASUREMENTS ON HYDROCARBONS. B. P. Mullins. October 1951. 73p. diagrs., 46 tabs. (NGTE R.97)

Ignition delay measurements were made upon some pure hydrocarbons and petroleum products using the continuous method. The fuels were paraffins, aromatics, unsaturateds, naphthalene derivatives, cyclo-compounds, terpenes, and petroleum products. Although ignition delay curves of the petroleum products lie close together, considerable differences in positions and slopes of the curves for single hydrocarbon compounds were noted. Observations of flame color were made and activation energies of reaction were computed for each fuel.

N-14656*

National Gas Turbine Establishment (Gt. Brit.)
COMBUSTION OF DILUTE METHANE-AIR MIXTURES. H. Bruce Cox and N. P. W. Moore. January 1952. 21p. diagrs., photo., 2 tabs. (NGTE R.113)

Combustion of these fuels has been investigated in a conventional gas-turbine combustion chamber with a secondary reaction duct at outlet temperatures between 650° and 900° C and from 1 to 3 atmospheres static pressure. The efficiency reached 95 percent at 890° C. At lower temperatures, the efficiency fell due partly to the conversion to carbon monoxide of a considerable part of the methane which did react. Pressure has been shown to be unimportant within the range investigated except for causing a small reduction in the yield of carbon monoxide at the higher pressures. Oxidation in the secondary duct was slow. Extended residence time was found to be essential for high combustion efficiencies.

N-14706*

Royal Aircraft Establishment (Gt. Brit.)
METHOD OF QUALITATIVE BOUNDARY LAYER INVESTIGATION BY MEANS OF HOT WIRES PLACED IN THE WING BELOW STATIC PRESSURE ORIFICES. (Methode voor kwalitatief grenslaagonderzoek met behulp van gloeidraden zonder beinvloeding der stroming). P. C. A. Malotaux, J. J. Denier van der Gon and Yap Kie Jan. January 1952. 31p. diagrs. (RAE Library Trans. 397. Trans. from Technische Hoogeschool te Delft, Sub-Afd. Vliegtuigbouwkunde, Rapport VTH 45)

This report describes a method for qualitative boundary layer investigation, using hot wires, in which the flow remains undisturbed. Its application to the determination of the local character of the boundary layer flow past a wing surface is described. This can be deduced from the behavior of hot wires located not in the boundary layer itself but below static pressure orifices in the wing surface. As the flow remains undisturbed the method can be combined with measurements of the chordwise pressure distribution and wake measurements of the profile drag.

N-14712*

Ministry of Supply (Gt. Brit.)
AN INVESTIGATION OF METHODS OF DUPLICATION OF HYDRAULICALLY OPERATED IRREVERSIBLE FLYING CONTROLS. 132p. diagrs., photos., tab. (MOS S & TM 15/51; H. M. Hobson, Ltd., London)

The object of this report is to present an examination of methods of duplicating hydraulically operated irreversible flying controls of the piston and screw jack types, with assessments of the relative merits of the systems examined. Appendices to the report describe tests of assemblies and components such as hydraulic pumps, motors, piston jacks, screw jacks, and control valves, arranged to represent certain of the proposed methods.

N-14765*

Aeronautical Research Council (Gt. Brit.)
USE OF THE PROPOSED ELECTRIC ISOGRAPH. K. Mitchell. 1951. 24p. diagrs., 2 tabs. (ARC R & M 2411; ARC 9014. Formerly RAE Tech. Note Aero 1675)

This note examines in some detail the user's side of the electric isograph proposed by Diprose. It is concluded that a machine on these lines would be a most valuable practical tool. Numerical methods for improving approximate solutions determined by the isograph are also given, and in particular a further investigation of Bairstow's method shows it to be suitable for determining complex roots of small modulus. Where the modulus is large the method should be applied to the reciprocal equation.

N-14766*

Aeronautical Research Council (Gt. Brit.)
THE NO. 2 11-1/2 FT. x 8-1/2 FT. WIND TUNNEL AT THE ROYAL AIRCRAFT ESTABLISHMENT, FARNBOROUGH. D. C. MacPhail, J. G. Ross and E. C. Brown. 1951. 55p. diagrs., photos., 8 tabs. (ARC R & M 2424; ARC 1945. Formerly RAE Tech. Note Aero 1678)

Initially this fairly orthodox tunnel suffered from objectional flow characteristics common to many wind tunnels. The causes of the troubles were investigated and modifications recommended. These are described. Some general conclusions are reached which might be applicable to other wind tunnels.

N-14767*

Aeronautical Research Council (Gt. Brit.)
FLIGHT TESTS ON THE PERFORMANCE OF METEOR IV (A TWIN-ENGINED, SINGLE-SEAT JET FIGHTER). F. Smith, D. J. Higton and R. H. Plascott. 1951. 11p. diagrs., tab. (ARC R & M 2446; 10,190. Formerly RAE Aero 2148)

Tests were made to measure performance in level flight and climb. Engine thrust was also measured and nondimensional curves of net and gross thrust are given. From the engine thrust and level flight results the aircraft drag coefficient has been obtained up to a Mach number of 0.81. The drag is somewhat less than that calculated from dive tests on a Meteor I aircraft.

N-14768*

Aeronautical Research Council (Gt. Brit.)
SOME EXPERIMENTS ON THE RESISTANCE OF METALS TO FATIGUE UNDER COMBINED STRESSES. H. J. Gough. PART I. H. J. Gough and H. V. Pollard. PART II. H. J. Gough and W. J. Clenshaw. 1951. 141p. diagrs., photos., 28 tabs. (ARC R & M 2522; ARC 1397; 1873; 2575; 2684; 2685; 3168; 3703; 4041; 4270; 4585; 4755)

Presents information on fatigue under a combination of reversed bending and reversed torsional stresses (two independent variables). Next presents information on fatigue strength of a nickel-chromium-vanadium-molybdenum steel under a combination of reversed bending stresses, reversed torsional stresses, and superimposed static bending and torsional stresses (four independent variables).

N-14769*

Aeronautical Research Council (Gt. Brit.)
SUCTION-SLOT DUCTING DESIGN. A. G. Rawcliffe. 1952. 14p. diagrs. (ARC R & M 2580; ARC 9487. Formerly ARC 10,522; FM 1098; Perf. 304)

The ducting is to provide uniform suction through a narrow slot along the span of a wing, with the lowest possible losses, when the pump is situated at the root of the wing. Models were tested and modified in the light of results. A qualitative analysis is made and recommendations have been formulated. Investigations were confined to still air.

N-14770*

Aeronautical Research Council (Gt. Brit.)
CALCULATION OF THE INFLUENCE OF A BODY ON THE POSITION OF THE AERODYNAMIC CENTRE OF AIRCRAFT WITH SWEPT-BACK WINGS. H. Schlichting. 1952. 13p. diagrs., 3 tabs. (ARC R & M 2582; ARC 10,689. Formerly RAE Tech. Note Aero 1879)

From systematic three-component measurements of wing-body combinations with swept wings it has been found that the movement of the aerodynamic center due to the influence of the body is greater for a sweptforward than for a straight wing and less for a sweptback wing. The forward shift of the aerodynamic center due to the body for normal wing-body combinations is about 0.6 chord for a straight wing, about 0.12 chord for a sweptforward, but about 0 for a 45° sweptback wing. A method of calculation is presented.

N-14771*

Aeronautical Research Council (Gt. Brit.)
AN EXAMINATION OF THE TECHNIQUE OF THE MEASUREMENT OF THE LONGITUDINAL MANOEUVRING CHARACTERISTICS OF AN AEROPLANE, AND A PROPOSAL FOR A STANDARDISED METHOD. D. J. Lyons. 1952. 33p. diagrs. (ARC R & M 2597; ARC 11,159. Formerly RAE Aero 2223)

It is demonstrated that the "steady stick force per g" as defined by Gates and Lyon in R & M 2027 is the best criterion for the measurement of maneuverability of an aircraft because it indicates the minimum stick force that has to be exerted by the pilot to break the aircraft and its value is obtained in flight by a definite test procedure. It is further concluded that some additional criterion may be used to insure that unduly heavy forces are not encountered during sharp pull-outs. A method of measuring the steady stick force per g has been developed at the RAE which, it is suggested, should be standardized for such tests throughout the country. The results of this method have been demonstrated on two aircraft.

N-14773*

Aeronautical Research Council (Gt. Brit.)
PRESSURE PLOTTING TESTS IN THE ROYAL AIRCRAFT ESTABLISHMENT HIGH SPEED WIND TUNNEL ON A 21 PER CENT THICK, LOW DRAG AEROFOIL (BRABAZON I WING ROOT SECTION). A. B. Haines and W. Port. 1952. 24p. diagrs., 2 tabs. (ARC R & M 2617; ARC 11,116. Formerly RAE Aero 2224)

The subject tests covered a Mach number range up to 0.7 at a Reynolds number of about 3×10^6 and low speed tests were extended up to $R = 9.45 \times 10^6$. The results have shown that: (1) No serious compressibility effects on C_L and C_m occur in the cruising conditions (M up to 0.6, C_L up to 0.66). (2) $C_{L_{max}}$ remains roughly constant at about 1.15 up to M = 0.6, and then falls to 1.01 for M = 0.7. (3) For M = 0.2, $C_{L_{max}}$ increases from 1.17 for $R = 3 \times 10^6$ to 1.26 for $R = 9.45 \times 10^6$. (4) The reason for the maintenance of $C_{L_{max}}$ seems to be a backward movement of the peak suction which is not found on other sections. (5) Two distinct C_L versus α curves beyond the stall are obtained at low Mach number. It appears that there is adequate margin between the cruising and stalling conditions to provide maneuverability and safety in upgusts.

N-14865*

Signals Research and Development Establishment (Gt. Brit.) THE SINE SPRING. E. R. Wigan. February 1949. 35p. diagrs. (SRDE Rept.1029)

Part I deals with the basic differences which distinguish this sine spring from known types of springs, and describes a few of the unique mechanisms which arise out of its special properties. Part II describes the experimental evidence upon which rests the design data presented.

N-14997*

Marine Aircraft Experimental Establishment (Gt. Brit.) PICK-UP HOOK FOR MOORING FLYING BOATS. February 1952. 3p. diagrs. (MAEE FX/Eq/317)

This hook has been found to be easier to handle and lighter and stronger than the present standard "grabbit" hook used on flying boats. No significant corrosion has been noted. The only adverse comment is that the highly polished handle becomes slippery when wet. This difficulty could be remedied easily. The hook floats horizontally in water.

N-16002*

Royal Aircraft Establishment (Gt. Brit.)
A NULL METHOD FOR THE CALIBRATION OF FOUR-ARM STRAIN GAUGE BRIDGES. K. R. Maslen. February 1952. 12p. diagrs. (RAE Tech. Note Instn.130)

Describes a method by which the differential change of resistance of the four arms of a closed Wheatstone bridge may be measured directly by the use of an auxiliary bridge. Only one source of power is required, and the output is measured in terms of the differential change of resistance in the auxiliary bridge necessary for balance. The ratio of this change of resistance to the change in the strain-gage bridge is independent of the gage resistance, the galvanometer resistance, and the applied voltage.

N-16003*

Royal Aircraft Establishment (Gt. Brit.)
INVESTIGATIONS ON THE PRONE POSITION FOR PILOTS. (Versuche zur liegenden unterbringugn des flugzeugführers). L. Schmidt. January 1952. 25p. diagrs., photos. (RAE Library Trans.396. Trans. from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin. UM 1297, May 13, 1944).

Tactical and physiological requirements necessitate for certain purposes a prone position for pilots. To investigate this arrangement and the associated problems of piloting, the Flugtechnische Fachgruppe Berlin designed and constructed in its own workshop the B.9 experimental aircraft. The present report reviews the layout and design aspects and summarizes the experiences gained during the flight testing of the B.9.

N-16035*

Aeronautical Research Council (Gt. Brit.)
DESIGNING A SLOT FOR A GIVEN WALL VELOCITY. A. Thom and Laura Klanfer. 1952. 12p. diagrs., tab. (ARC CP 76)

Gives the results obtained arithmetically for the wall shape of an expanding passage with specified constant wall velocities. A slot is assumed to draw fluid from the passage at the velocity discontinuity and the shape of the slot entry is obtained. A cusp develops at the entrance to the slot and the effect of the remainder of the field of rounding this cusp is considered in detail.

N-16037*

Aeronautical Research Council (Gt. Brit.)
HIGH SPEED WIND TUNNEL TESTS ON AN AIRFOIL WITH AND WITHOUT TWO-DIMENSIONAL SPANWISE BULGES. J. A. Beavan, E. W. E. Rogers and R. Cartwright. 1952. 34p. diagrs., photos., 2 tabs. (ARC CP 78)

One bulge had a height of 0.004 chord and extended from 0.3-0.5 chord. The other bulge was one-half of both these dimensions. Pressure distributions at low speeds agreed with theory. The C_L is generally greater than for the plain airfoil, but the corresponding changes in C_m are small except at higher speeds. At low speeds and zero angle of attack, boundary-layer transition took place near the bulge centers compared with 0.75 chord for the plain airfoil. The resulting increase in C_D agrees with theory. With increase in Mach number, an initial rise in drag (due to shock waves on the bulge) occurs at angles of attack of 0° and 2°. This rise is halted as the main shock wave and transition point move back and the final drag rise takes place at about the same Mach number as on the plain airfoil. Shock waves are stronger and better defined on the warped than on the plain airfoil.

N-16040*

Aeronautical Research Council (Gt. Brit.)
N.P.L. AEROFOIL CATALOGUE AND BIBLIOGRAPLY. R. C. Pankhurst. 1952. 20p. (ARC CP 81)

Catalogues airfoils which have been designed (or substantially modified) at the NPL and which have been the subject of theoretical investigations, aircraft design studies, or wind-tunnel tests. Within these limits, it is intended to be complete with minor exceptions. Each airfoil has been assigned an NPL number. The arrangement follows broadly the successive stages in the development of the design theory. Each list is prefaced with a brief indication of the family character of the airfoils it contains.

N-16041*

Aeronautical Research Council (Gt. Brit.)
POWER REQUIREMENTS FOR DISTRIBUTED SUCTION FOR INCREASING MAXIMUM LIFT. R. C. Pankhurst and N. Gregory. 1952. 7p. diagr. (ARC CP 82)

Considers the power requirements for distributed suction. It appears that they are low for take-off and landing; no estimates can be made for the case of high-speed maneuvers until tests have been made under the conditions of compressible flow.

MISCELLANEOUS

NACA Rept. 1017

Errata No. 1 on "INVESTIGATION OF FREQUENCY-RESPONSE CHARACTERISTICS OF ENGINE SPEED FOR A TYPICAL TURBINE-PROPELLER ENGINE". Burt L. Taylor, III and Frank L. Oppenheimer. 1951.

NACA Rept. 1036

Errata No. 1 on "EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF VISCOSITY ON THE DRAG AND BASE PRESSURE OF BODIES OF REVOLUTION AT A MACH NUMBER OF 1.5". Dean R. Chapman and Edward W. Perkins. 1951.

NACA TN 2117

Errata No. 1 on "DESIGN AND APPLICATIONS OF HOT-WIRE ANEMOMETERS FOR STEADY-STATE MEASUREMENTS AT TRANSONIC AND SUPERSONIC AIRSPEEDS". Herman H. Lowell. July 1950.

NACA TN 2285

Errata No. 1 on "DAMPING IN ROLL OF CRUCIFORM AND SOME RELATED DELTA WINGS AT SUPERSONIC SPEEDS". Herbert S. Ribner. February 1951.

NACA TN 2548

Errata No. 1 on "EQUAL-STRENGTH DESIGN OF TENSION-FIELD WEBS AND UPRIGHTS". Ralph H. Upson, George M. Phelps and Tung-Sheng Liu. January 1952.

NACA TN 2575

Addendum No. 1 to "A FLIGHT INVESTIGATION OF THE EFFECT OF CENTER OF GRAVITY LOCATION ON GUST LOADS". Jack Funk and Earle T. Binckley. December 1951.

NACA TN 2614

Errata No. 1 on "ANALYTICAL INVESTIGATION OF SOME THREE-DIMENSIONAL FLOW PROBLEMS IN TURBOMACHINES". Frank E. Marble and Irving Michelson, California Institute of Technology. March 1952.

NACA TM 1286

Errata No. 1 on "METHOD OF SUCCESSIVE APPROXIMATIONS FOR THE SOLUTION OF CERTAIN PROBLEMS IN AERODYNAMICS". M. E. Shvets. April 1951.

UNPUBLISHED PAPERS

N-15019*

Massachusetts Inst. of Tech.
THE EIGENVALUES OF SOME STABILITY PROBLEMS INVOLVING VISCOSITY. Cathleen S. Morawetz. December 1951. 37p. diagrs. (Massachusetts Inst. of Tech.)

Small disturbances are assumed to occur in viscous flow between moving walls, with a symmetrical velocity profile between two fixed walls, and in a boundary layer along a flat plate. Corresponding to each such problem for the viscous fluid, there is a simpler problem with viscosity zero. It is natural to conjecture that, for large Reynolds numbers, the eigenvalues in the complete viscous problem are related to those in the corresponding inviscid problem. The present investigation justifies the relationship between viscous and inviscid eigenvalues in most cases and in fact expresses these viscous eigenvalues asymptotically with respect to the Reynolds number in terms of the inviscid eigenvalues.

DECLASSIFIED NACA REPORTS

NACA RM E8I20
National Advisory Committee for Aeronautics.
COMPARISON OF NATIONAL BUREAU OF STANDARDS CERAMIC COATINGS L-7C AND A-417 ON TURBINE BLADES IN A TURBOJET ENGINE. C. Robert Morse. December 22, 1948. photos., 5 tabs. (NACA RM E8I20) (Declassified from Restricted, 3/28/52)

An investigation was conducted to determine which of two ceramic coatings L-7C and A-417 developed by the National Bureau of Standards was the more suitable as a protective coating for gas-turbine blades. Four cast Vitallium blades, two coated with each of these ceramics, were installed in the turbine wheel of a turbojet engine and subjected to 20 minute cycles consisting of 5 minutes at idle and 15 minutes at rated speed. Ceramic coating A-417 showed no evidence of fusion during 100 operating cycles. Ceramic coating L-7C showed evidence of fusion and radial flow, indicating that the fusion temperature of the coating is too low for satisfactory service in the turbojet engine.

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA TN 2711

THE AERODYNAMIC DESIGN OF HIGH MACH NUMBER NOZZLES UTILIZING AXISYMMETRIC FLOW WITH APPLICATION TO A NOZZLE OF SQUARE TEST SECTION. Ivan E. Beckwith, Herbert W. Ridyard and Nancy Cromer. June 1952. 30p. diagrs., 5 tabs. (NACA TN 2711)

A method is given for the design of three-dimensional nozzles utilizing axisymmetric flow to produce uniform flow in a test chamber of arbitrary cross section. The method is applied to obtain the coordinates of a Mach number 10 nozzle for which a square test section is specified. Radial flow is used in a portion of the flow field to reduce the computation time. The remainder of the flow field is computed by the method of characteristics, but a simplified method is used near the axis. Tables which facilitate computation of the radial flow and the flow near the axis are included. Transition streamlines determined from the analytic expressions of Kuno Foelsch are compared with the streamlines obtained from the characteristic net of the Mach number 10 nozzle.

NACA TN 2720

EFFECTS OF ASPECT RATIO ON AIR FLOW AT HIGH SUBSONIC MACH NUMBERS. W. F. Lindsey and Milton D. Humphreys. July 1952. 10p. photos., diagrs. (NACA TN 2720. Formerly NACA RM L8G23)

Schlieren photographs were used in an investigation to determine the effects of changing the aspect ratio from infinity to 2 on the air flow past a wing at high subsonic Mach numbers. The results indicated that the decreased effects of compressibility on drag coefficients for the finite wing are produced by a reduction in the compression shock and flow separation.

NACA TN 2724

TRANSONIC SIMILARITY RULES FOR LIFTING WINGS. Keith C. Harder. June 1952. 26p. diagr. (NACA TN 2724)

Transonic similarity rules for lifting wings at small angles of attack are derived. These rules make it possible to present each aerodynamic coefficient for a family of wings of varying aspect ratio and thickness ratio in a single design chart for the transonic range.

NACA TN 2726

ON THE APPLICATION OF TRANSONIC SIMILARITY RULES. John R. Spreiter. June 1952. 45p. diagrs. (NACA TN 2726)

The transonic aerodynamic characteristics of wings of finite span are discussed from the point of view of a unified small perturbation theory for subsonic, transonic, and supersonic flows about thin wings. This approach avoids certain ambiguities which appear if one studies transonic flows by means of equations derived under the more restrictive assumption that the local velocities are everywhere close to sonic velocity. The relation between the two methods of analysis of transonic flow is examined, the similarity rules and known solutions of transonic flow theory are reviewed, and the asymptotic behavior of the lift, drag, and pitching-moment characteristics of wings of large and small aspect ratio is discussed. It is shown that certain methods of data presentation are advantageous for the effective display of these characteristics.

NACA TN 2727

EXPERIMENTS IN EXTERNAL NOISE REDUCTION OF A SMALL PUSHER-TYPE AMPHIBIAN AIRPLANE. John P. Roberts and Leo L. Beranek, Aeronautical Research Foundation. July 1952. 142p. diagrs., photos., 3 tabs. (NACA TN 2727)

As part of a program to find practicable ways of reducing the external noise level of light airplanes, noise measurements were made on a representative pusher-type amphibian airplane. Tests were made with a standard airplane and with modified versions of the airplane equipped with a geared engine, exhaust muffler, and propellers with various numbers of blades. Sound-level recordings were made of take-offs; of overhead flights at 100- and 500-foot altitude; and, for some configurations, of flights at 500-foot altitude passing 3000 feet away. The tests also included analyses of sound-frequency components with the airplane on the ground from a distance of 50 feet and at various positions around the airplane. The results are compared with measurements from a previous noise study of a tractor-type airplane.

NACA TN 2730

CHOKING OF A SUBSONIC INDUCTION TUNNEL BY THE FLOW FROM AN INDUCTION NOZZLE. W. F. Lindsey. July 1952. 20p. diagrs. (NACA TN 2730)

*AVAILABLE ON LOAN ONLY.

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A decrease in Mach number with increase in induction jet pressure has been shown experimentally, for one type of induction tunnel, to be associated with choking of the induced flow. The analysis of the flow conditions provides a means of predicting the occurrence of induction choking so that it can be adequately considered in design.

NACA TN 2732

THEORETICAL INVESTIGATION OF VELOCITY DIAGRAMS OF A SINGLE-STAGE TURBINE FOR A TURBOJET ENGINE AT MAXIMUM THRUST PER SQUARE FOOT TURBINE FRONTAL AREA. (Revised). Leo Cohen. June 1952. 34p. diagrs., tab. (NACA TN 2732)

The aerodynamic requirements of a single-stage turbine for a turbojet engine at maximum thrust per square foot turbine frontal area are presented in the form of velocity diagrams. An impulse diagram with supersonic velocities relative to the leading and trailing edges of the rotor is required for practically all blade speeds and turbine-inlet temperatures investigated.

NACA TN 2733

METHOD FOR CALCULATION OF HEAT TRANSFER IN LAMINAR REGION OF AIR FLOW AROUND CYLINDERS OF ARBITRARY CROSS SECTION (INCLUDING LARGE TEMPERATURE DIFFERENCES AND TRANSPIRATION COOLING). E. R. G. Eckert and John N. B. Livingood. June 1952. 71p. diagrs. (NACA TN 2733)

A method which permits approximation of local heat-transfer coefficients in the laminar-flow region around cylinders of arbitrary cross section from those for wedge-type profiles is extended to include the effects of large temperature differences and transpiration cooling. Charts prepared from exact solutions of the laminar boundary-layer equations for wedge-type profiles which allow for these effects yield results with a minimum of calculation. Application of the method to circular and elliptic transpiration-cooled cylinders is made to determine local heat-transfer coefficients and surface temperatures and to determine the variation in coolant flow required for maintaining a constant surface temperature.

NACA TN 2735

AN ANALYSIS OF THE NORMAL ACCELERATIONS AND AIRSPEEDS OF A TWO-ENGINE TYPE OF TRANSPORT AIRPLANE IN COMMERCIAL OPERATIONS ON ROUTES IN THE CENTRAL UNITED STATES FROM 1948 TO 1950. Walter G. Walker and Paul W. J. Schumacher. July 1952. 30p. diagrs., 4 tabs. (NACA TN 2735)

Normal-acceleration and airspeed data obtained from a two-engine type of transport airplane are analyzed to determine the gust and gust-load experiences of the airplane. The gust and gust-load experiences are compared with similar results from the same type of airplane during past operations. The influences of the gusts and the operating speeds in rough air on the gust-load experience are indicated.

NACA TN 2736

TWO-DIMENSIONAL SHEAR FLOW IN A 90° ELBOW. James J. Kramer and John D. Stanitz. July 1952. 44p. diagrs. (NACA TN 2736)

As part of an approach to a better understanding of the motion of real fluids in flow machinery, two-dimensional, incompressible, nonviscous shear flows in a 90° elbow have been investigated. Solutions are presented for linear and sinusoidal velocity distributions across the inlet of the elbow. The solutions with linear inlet velocity distributions indicate that as the negative vorticity of the flow increased: (1) the static-pressure drop through the elbow decreased, (2) the local deceleration along the outer channel walls increased, and (3) the magnitude of the velocities on the channel walls changed greatly, but the local pressure coefficient rose only gradually and the difference in pressure coefficient at corresponding points on the two walls was practically unchanged. In the case of a sinusoidal inlet velocity distribution, local decelerations occurred on both walls.

NACA TN 2738

A PROBABILITY ANALYSIS OF THE METEOROLOGICAL FACTORS CONDUCTIVE TO AIRCRAFT ICING IN THE UNITED STATES. William Lewis and Norman R. Bergrun. June 1952. 93p. diagrs., 11 tabs. (NACA TN 2738)

Meteorological icing data obtained in flight in the United States are analyzed statistically and methods are developed for the determination of (1) the various simultaneous combinations of the three basic icing parameters (liquid-water content, drop diameter, and temperature) which would have equal probability of being exceeded in flight in any random icing encounter, and (2) the probability of exceeding any specified group of values of liquid-water content associated simultaneously with temperature and drop-diameter values lying within specified ranges.

NACA TN 2740

EXPERIMENTAL INVESTIGATION OF THE LOCAL AND AVERAGE SKIN FRICTION IN THE LAMINAR BOUNDARY LAYER ON A FLAT PLATE AT A MACH NUMBER OF 2.4. Randall C. Maydew and Constantine C. Pappas. July 1952. 22p. diagrs. (NACA TN 2740)

Average and local skin-friction coefficients for laminar flow have been determined experimentally on a flat plate at a Mach number of 2.4 for a Reynolds number range of 0.72×10^6 to 2.8×10^6 and compared with the laminar-boundary-layer theory of Chapman and Rubesin. The average skin-friction data were considerably higher than values predicted by laminar-boundary-layer theory. Local skin-friction coefficients, evaluated by the two methods, agreed well with the theory when plotted against a momentum-thickness Reynolds number.

NACA TN 2742

BOUNDARY-LAYER DEVELOPMENT AND SKIN FRICTION AT MACH NUMBER 3.05. Paul F. Brinich and Nick S. Diaconis. July 1952. 49p. diagrs., photos. (NACA TN 2742)

Boundary-layer studies consisting of schlieren observations and momentum surveys were made on hollow cylinder models with their axes alined parallel to the stream. Results were obtained for three model diameters and for natural and artificially induced turbulent boundary-layer flows. Transition Reynolds numbers were found to decrease with decreases in leading-edge thickness and with reductions in tunnel pressure level. Turbulent temperature-recovery factors generally decreased with increasing Reynolds number and were a maximum for the smallest transition Reynolds numbers. The results of this investigation appeared to be consistent with the theoretical turbulent friction formulas of Wilson and with the extended Frankl-Voishel analysis of Rubesin, Maydew, and Varga. Velocity profiles in the outer portion of the boundary layer could be approximated reasonably with a 1/7 power profile and were found to be approximately similar in this region. Velocity profiles given by the Kármán universal turbulent boundary-layer profile parameters were found to be similar in the laminar sublayer and in the turbulent region.

NACA RM E52D17

EXPERIMENTAL INVESTIGATION OF AVERAGE HEAT-TRANSFER AND FRICTION COEFFICIENTS FOR AIR FLOWING IN CIRCULAR TUBES HAVING SQUARE-THREAD-TYPE ROUGHNESS. Eldon W. Sams. June 1952. 43p. diagrs., photos. (NACA RM E52D17)

A heat-transfer investigation was conducted with air flowing through electrically heated Inconel tubes having various degrees of square-thread-type roughness (conventional roughness ratios of 0 (smooth tube), 0.016, 0.025, and 0.037), an inside diameter of 1/2 inch, and a length of 24 inches over ranges of bulk Reynolds number up to 350,000 and average inside-tube-wall temperatures up to 1950° R. The data showed that both heat transfer and friction increased with increase in surface roughness (particularly at the higher Reynolds numbers) and were also influenced by tube wall-to-bulk temperature ratio. Good correlation of the heat-transfer data for all tubes was obtained by use of a modified Reynolds number including the friction velocity. Correlation of the friction data for the rough tubes was obtained for the complete turbulence region by use of a modified correlation incorporating a roughness parameter which excludes the conventional roughness ratio; no over-all correlation was obtained for the region of incomplete turbulence.

NACA RM E52D24

SOLUBILITY OF WATER IN HYDROCARBONS. R. R. Hibbard and R. L. Schalla. July 1952. 25p. diagrs., 3 tabs. (NACA RM E52D24)

An equation is presented which may be used to estimate the solubility of water in any nonolefinic hydrocarbon or hydrocarbon blend at any temperature. Only the temperature and the hydrogen-to-carbon ratio of the hydrocarbon need be known to calculate solubilities which are believed to be sufficiently accurate for most engineering purposes.

NACA RM E52E19

USE OF FENCES TO INCREASE UNIFORMITY OF BOUNDARY LAYER ON SIDE WALLS OF SUPERSONIC WIND TUNNELS. Rudolph C. Haefeli. July 1952. 15p. diagrs., photos., tab. (NACA RM E52E19)

An investigation of the use of solid fences installed on the side walls of a supersonic wind tunnel to retard the development of transverse flow and thus to increase the uniformity of the side-wall boundary layer is reported. Beneficial results were obtained with fences which had depths of the order of the boundary-layer displacement thickness and which followed potential-flow streamlines through the nozzle. Reduction of the number of fences on each side wall from four to two eliminated their effectiveness.

NACA TM 1223

SOME EXPERIENCES REGARDING THE NONLINEARITY OF HOT WIRES. (Quelques expériences sur la non-linéarité des fils chauds). R. Betchov and W. Welling. June 1952. 13p. diagrs. (NACA TM 1223. Trans. from Koninklijke Nederlandsche Akademie van Wetenschappen te Amsterdam, Verhandelingen, v.53, no.4, 1950, p.432-439; Technische Hoogenschool te Delft, Laboratorium voor Aero- en Hydrodynamica. Mededeling 66).

Hot-wire experiments illustrate some differences between the resistance characteristics as given by King's equation and those for a finite wire length. The experiments support previous theoretical work which accounted for a heat loss although the wire ends and a dependence of the convective heat loss on a nonlinear function of the temperature difference between the wire and the air.

NACA TM 1346

NONLINEAR THEORY OF A HOT-WIRE ANEMOMETER. (Théorie non-linéaire de l'anémomètre à fil chaud). R. Betchov. July 1952. 23p. diagrs. (NACA TM 1346. Trans. from Koninklijke Nederlandsche Akademie van Wetenschappen te Amsterdam, Verhandelingen, v. 52, no. 3, 1949, p. 195-207; Technische Hoogenschool te Delft, Laboratorium voor Aero- en Hydrodynamica. Mededeeling 61).

A theoretical analysis is presented for the hot-wire anemometer to determine the differences in resistance characteristics as given by King's equation for an infinite wire length and those given by the additional considerations of (a) a finite length of wire with heat loss through its ends and (b) heat loss due to a nonlinear function of the temperature difference between the wire and the air.

BRITISH REPORTS

N-6183

Ministry of Supply (Gt. Brit.)
THE MECHANICAL CHARACTERISTICS OF PNEUMATIC TYRES. R. Hadekel. March 1950. iii, 146p. diagrs., photos. (MOS S & TM 5/50)
RESTRICTED

The object of this report is to give an exposition of the existing knowledge of the mechanical properties, characteristics and behavior of pneumatic tires, insofar as they may be of interest to the user. Questions of tire technology are not discussed. The rolling process, vertical and horizontal load-deflection characteristics, behavior during braking and sideways motion, rolling resistance and high speed effects are all dealt with. Where possible, both theoretical treatment and empirical data are given. Recommendations are made with respect to further research. The primary object of the investigation was to provide data for aircraft purposes, but it is hoped that the information here presented will also be of use to land vehicle designers.

N-14407*

Aeronautical Research Council (Gt. Brit.)
SANDWICH CONSTRUCTION AND CORE MATERIALS. PART V. W. J. Pullen. 1952. 14p. diagrs., photos., 5 tabs. (ARC R & M 2686; ARC 10,501. Formerly ARC 9017; Strut 938; Plas. 57)

Tensile, compressive and creep tests have been carried out on four different samples of extruded cellular cellulose acetate. It is concluded that the material is comparable with calcium alginate and other low-density materials so far handled in the Engineering Division, N. P. L. In particular, the samples are not subject to the same degree of "softening" as has been the case with some similar materials. The "filled" samples are more efficient than the "unfilled" ones and are worth considering as possible low-density stabilizers in sandwich construction.

N-14772*

Aeronautical Research Council (Gt. Brit.)
A REVIEW OF SOME STALLING RESEARCH. A. D. Young. WITH AN APPENDIX ON WING SECTIONS AND THEIR STALLING CHARACTERISTICS. H. B. Squire and A. D. Young. 1951. 39p. diagrs., 5 tabs. (ARC R & M 2609; ARC 5751. Formerly RAE Aero 1718)

Over a period of years a considerable amount of stalling research on various airplanes was completed at the Royal Aircraft Establishment and it was considered desirable that the main results should be summarized and reviewed. The report includes a general discussion of the effect on stalling behavior of wing section, plan form, washout, flaps, nacelles, gills, slipstream, automatic wing-tip slots and Hudson-type slits. The important part that is played by the longitudinal trim and stability at incidences near the stall is emphasized. The relation between wing sections and their stalling characteristics is discussed and it is shown that the stalling characteristics can be broadly predicted from an examination of the form of the wing-section upper-surface pressure distribution at high incidences. The results indicate that vicious stalling behavior can be avoided by the use of wing sections towards the tip of fairly high camber (3 to 4 percent) and moderate thickness (> 12 percent). For some types of airplanes there are, however, serious objections to the use of high camber towards the tips; the designer is then advised to avoid wing sections which experiments and theory indicate have particularly bad stalling characteristics. The worst tip thickness for stalling appears to be in the region of 9 percent. High taper tends to worsen the stalling behavior and it is advisable to consider taper ratios greater than 2:1 only in conjunction with wing-tip sections having good stalling characteristics. The use of part-span flaps does not appear to cause any marked deterioration in stalling behavior, and frequently it improves the behavior; but there is some evidence, though not yet conclusive, that the use of full-span flaps may be accompanied by an appreciable worsening in stalling behavior. Attention is drawn to the advisability of examining the flow at high incidences in the neighborhood of the tail-plane of an airplane in the design stage, with a view to assessing its probable stalling behavior; in particular, the possibilities of designing for some stall warning can then be examined.

N-16033*

Aeronautical Research Council (Gt. Brit.)
THE DIFFUSION OF TRANSVERSE LOADS IN A REINFORCED CIRCULAR CYLINDER WITH NON-RIGID FRAMES. S. R. Lewis. 1952. 23p. diagrs. (ARC CP 74)

Explores the variation of shear stress distribution at a loaded frame consequent upon the variation of several geometric parameters such as frame stiffness, skin thickness, stringer spacing, etc. Figures indicate the shear distribution around a frame for a single concentrated radial load of 1000 lb. The parameters chosen are those common to aircraft design, and it is possible to obtain a reasonably accurate shear distribution around a frame from the data supplied, without doing the actual lengthy shear calculation. The work is confined to the particular case where the loaded frame is removed from the end of the cylinder. Gives method of obtaining the shear load due to a tangential load and moment from the radial load expressions.

N-16034*

Aeronautical Research Council (Gt. Brit.)
DIGITAL RECORDING AND ANALYSING OF FLIGHT TEST DATA: A PROPOSED SYSTEM. E. J. Petherick. 1952. 10p. diagrs. (ARC CP 75)

A small digital recorder is proposed, to punch 10,000 instrument readings on 100 feet of cine film, each

item to 3 decimal or 12 binary places. Any number of instruments could be recorded at 10 readings a second. A further unit is envisaged, to read the punched data; to correct each item for instrument errors; to display the corrected values; and to punch them on Hollerith cards or RAESCC tape.

N-16036*

Aeronautical Research Council (Gt. Brit.)
THE EFFECTS OF ATMOSPHERIC HUMIDITY AND TEMPERATURE ON THE ENGINE POWER AND TAKE-OFF PERFORMANCE OF A HASTINGS I. G. Jackson. 1952. 34p. diagrs., 9 tabs. (ARC CP 77)

Engine power decreases with increasing humidity and reduction is greatest at take-off engine speed and boost. Specific humidity will rarely exceed 2-1/2 percent and this will decrease take-off power approximately 10 percent as compared with dry air. The take-off distance to clear a 50 ft. obstacle would be increased about 17 percent. For take-off conditions, humidity is a parameter of the same order of importance as temperature. At constant humidity the rate of decrease of power with increase of temperature is not very different from the value given by the standard formula below full-throttle height. No effect of humidity on fuel consumption has been detected. Fuel consumption decreases with increase in temperature.

N-16038*

Aeronautical Research Council (Gt. Brit.)
AN EXPERIMENTAL INVESTIGATION OF THE PERFORMANCE OF A PILOT PLANT FOR DRYING AIR BY SOLID GRANULAR ADSORBENTS. P. J. Bateman. 1952. 44p. diagrs., 2 tabs. (ARC CP 79)

An investigation was undertaken to measure the performance on a pilot plant scale of uncooled beds of granular adsorbent when drying air to the low humidities required for supersonic wind tunnel operation. Two size grades of activated alumina and one of silica gel were tested in a bed 2-1/2 by 2-1/2 feet in plan, and of various depths between 12 and 25 inches. The bed was worked throughout at about atmospheric pressure and air was drawn from atmosphere without treatment for humidity or temperature. The results are presented, in the main, as graphs of mean bed concentration $\left(\frac{\text{mass of water adsorbed}}{\text{mass of activated adsorbent}}\right)$ against inlet humidity for two values of the outlet humidity, 0.0005 and 0.0002 lb water/lb air. It is shown that over the ranges of the variables encountered the mean bed concentration decreases with increasing inlet humidity, increases with increasing bed depth at a fixed contact time, and decreases with increasing grain size. Although a definitive comparison is not possible there does not appear to be much difference in the performance of silica gel and activated alumina of the same grain size.

N-16039*

Aeronautical Research Council (Gt. Brit.)
CALCULATED PRESSURE DISTRIBUTIONS FOR THE R.A.E. 100-104 AEROFOIL SECTIONS. R. C. Pankhurst and H. B. Squire. 1952. 20p. diagrs., 3 tabs. (ARC CP 80)

Gives the positions of maximum thickness, leading-edge radii, trailing-edge angles, coordinates, shapes, pressure distributions, and velocity distributions for the RAE 100-104 airfoil sections.

N-16042*

Aeronautical Research Council (Gt. Brit.)
WIND TUNNEL TESTS ON A 90° APEX DELTA WING OF VARIABLE ASPECT RATIO (SWEEPBACK 36.8°). PART I. GENERAL STABILITY. J. G. Ross, R. Hills and R. C. Lock. PART II. MEASUREMENTS OF DOWNWASH AND EFFECT OF HIGH LIFT DEVICES. R. C. Lock, J. G. Ross and P. Meiklem. 1952. 67p. diagrs., photos., 26 tabs. (ARC CP 83)

Part I. Longitudinal and lateral stability measurements have been made in a low speed tunnel on a delta wing of 90° apex angle with three different taper ratios. The tests included measurements with ground, the effect of a body, and measurements of elevon power. $C_{L_{max}}$ was 0.86 for all taper ratios but was reduced to a trimmed value of 0.65 with a static margin of $0.10\bar{c}$, due to the large loss of lift caused by the elevons. A tip stall starts on the wings at $\alpha \doteq 8^{\circ}$ to 12° depending on the taper ratio; this has comparatively little effect on pitching moments but a large effect on both rolling and yawing moments, n_v and $-l_v$ both decreasing after the tip stall. C.A.T. tests suggest that there is an appreciable favorable scale effect on the tip stall. Ground effects are small and can be estimated sufficiently accurately using existing theoretical work on unswept wings. Part II. Wind-tunnel measurements of downwash were made on delta wings of aspect ratios 4, 3, and 2.3, using a tail of delta plan form in three vertical positions at two chordwise stations behind the wing. The tests also included the effect of the tail, and of split flaps and nose flaps, on the stability near the stall and on $C_{L_{max}}$. The tip nose flaps proved effective in delaying the tip stall, and gave some increase in $C_{L_{max}}$. With split flaps untrimmed $C_{L_{max}}$ was 0.95 and 1.2 with the flap in the forward and rear position respectively. There was no change of trim with the flaps in the forward position with tail off; with the tail an intermediate flap position should give zero trim change. The downwash was large at high lift coefficients, owing to the early tip stall, and this caused a loss of tail efficiency with a corresponding slight instability near the stall, which should not be serious. A method is given of calculating the downwash at small incidences behind a delta wing, and the results show good agreement with the measured values, provided that the experimental lift-curve slope is used.

N-16047*

Aeronautical Research Council (Gt. Brit.)
A THEORETICAL INVESTIGATION OF THE RESPONSE OF A HIGH-SPEED AEROPLANE TO THE APPLICATION OF AILERONS AND RUDDERS. K. Mitchell, A. W. Thorpe and E. M. Frayn. 1952. 92p. diagrs., 6 tabs. (ARC R & M 2294; ARC 8831; ARC 9639. Formerly RAE Aero 2040; RAE Aero 1952)

The response of a fast moving airplane to a lateral gust, and to applied rolling and yawing moments, is examined by means of the differential analyzer, taking a range of values of the principal lateral stability parameters, and including sufficient ranges of the other stability and inertia parameters to make the conclusions of general validity for high-speed flight. The motion following a sharp-edged side-gust is shown to be a markedly oscillatory character, with an unpleasantly short period, particularly in small airplanes. The shortness of the period is probably the worst feature. A general survey is made of the dependence of the motion upon the various parameters, the differential analyzer results being supplemented by the use of approximate formulas, which were developed with a view to this application. Particular attention is paid to the amplitudes of the motion in roll, yaw, and sideslip, and it is seen that it may be difficult to make the motion less unpleasant. The period may be lengthened by reducing n_v, but the improvement that is possible in this way is limited. Damping can be improved by reducing dihedral, or by increasing body side area: the addition of a forward fin, ahead of the center of gravity, would therefore be doubly helpful, lengthening the period and improving the damping. In studying response to applied moments attention is chiefly concentrated upon response to ailerons, and the theoretical results are compared with a theoretical standard motion produced by a constant rolling moment together with a yawing moment varied so as to suppress sideslip. Response at high speeds is shown to be insensitive to changes in l_v and n_v within their normal ranges, and good response to pure rolling moment is assured for all lateral stability characteristics other than those associated with the combination of small fin with large dihedral: this combination is worst at high values of the lateral relative density. The effect of adverse yawing moment from the ailerons is detrimental, and becomes worse as the dihedral is increased or fin area decreased.

N-16048*

Aeronautical Research Council (Gt. Brit.)
LATERAL RESPONSE THEORY. K. Mitchell. APPENDICES. E. M. Frayn. 1952. 57p. 8 tabs. (ARC R & M 2297; ARC 7933; ARC 8278; ARC 8544. Formerly RAE Aero 1925; RAE Tech. Note Aero 1513; RAE Tech. Note Aero 1584)

It is usual, when investigating the response of an airplane to applied forces and couples, to examine its behavior when disturbed by rolling and yawing moments, instantaneously or linearly applied. The relevant curves can be readily obtained by means of a differential analyzer: their calculation by existing methods is extraordinarily tedious, and analysis of lateral response, on a basis of the curves alone, a matter of some difficulty. The need was therefore felt for some new approach to the subject which would offer an alternative method of assessing response. A method is now given, whereby the calculation of response to any forces whatever is made to depend upon the prior determination of a number of constants, for which the name "modal response coefficients" is proposed. The idea of the method is introduced by solving first by the method of variation of constants; later the relevant formulas are more simply obtained by operational methods. It is shown that the Laplace transformation scores over Heaviside's methods here in leading at once to a result of considerable generality and in a form more convenient for computation. Methods for calculating model response coefficients and response curves are examined in appendices, recommended methods being presented as routine computations to be carried out on printed computing sheets (given as tables 1 and 2). "Optimum-interval" tables of certain functions occurring in the calculation of response curves are also given (tables 3 to 8). As a method of calculating response curves, even with the tabular aids presented here, the method of modal response coefficients is probably slightly less laborious than the usual methods: this work should be handled mechanically by the differential analyzer. The calculation of the modal response coefficients themselves, however, is not tedious, and may usefully be undertaken to aid in the study of curves calculated by other means. It is hoped that, when a little experience has been gained, it may prove possible to discuss response in terms of the modal response coefficients alone.

N-16049*

Aeronautical Research Council (Gt. Brit.)
RELAXATION TIME EFFECTS IN GAS DYNAMICS. J. C. Gunn. 1952. 44p. diagrs., 12 tabs. (ARC R & M 2338. Formerly ARC 9536; FM 910; TP 145; TJR 89)

In the formulation of the equations of gas dynamics it is usual to make certain simplifying assumptions concerning the properties of the gas under consideration. Thus, the equations are greatly simplified if it can be assumed that the gas is a perfect one, satisfying the equation $p/\rho = RT$, and also that the specific heat, C_p, is a constant. A further assumption, generally made, is that the energy content of the gas is capable of instantaneous change following the external conditions, so that the internal energy is always a uniquely defined function of the temperature. These assumptions are, of course, often justified in practice, but there is need for caution in applying them to unfamiliar gases, or, as we shall see, to cases where the temperature range of the process is very wide. The object of this note, in particular, is to study the third of the assumptions referred to above, and we shall investigate the effect on various dynamical processes of

the known time lag in the picking-up, by the vibrational degrees of freedom of a gas, of their equilibrium energy. Three main cases will be considered: (1) flow in a wind tunnel, (2) flow round an airfoil, without shock waves, and (3) flow through shock waves. The case of propagation of sound in a medium exhibiting heat capacity lag is also briefly discussed. The aim of the consideration is twofold: firstly, to demonstrate how small the effects of heat capacity lag are in most aerodynamic phenomena, and secondly to indicate some special cases in which the effects become more important. The preliminary physical data concerning the vibrational energy of a gas, and its adjustment to equilibrium, have been fairly fully presented in papers by Kantrowitz, and, more particularly by Bethe and Teller[2]. As these papers may not be readily accessible the opportunity is first taken to summarize this basic physical knowledge. Some of the more general consequences of the heat-capacity lag are also deduced.

N-16050*

Aeronautical Research Council (Gt. Brit.)
WINGS OF FINITE ASPECT RATIO AT SUPERSONIC VELOCITIES. D. R. Taunt and G. N. Ward. 1952. 12p. diagrs. (ARC R & M 2421; ARC 9401. Formerly Department of Scientific Research and Experiment, Admiralty SRE/Airflow/29)

An error in the well-known work by Schlichting is corrected, and it is shown that the integral equation derived can be solved analytically. The main result is that for a plane rectangular wing of aspect ratio A, the lift coefficient is less than that for an infinite plane wing by a factor $1 - \frac{1}{2A\sqrt{M^2 - 1}}$ where M is the Mach number of the undisturbed stream. It is shown that the analytical solution can be extended to plane trapezoidal wings of any cutting-off angle.

N-16051*

Aeronautical Research Council (Gt. Brit.)
THE VALIDITY OF FULL-SCALE PROPELLER BRAKING TESTS IN THE R. A. E. 24-FT WIND TUNNEL. A. B. Haines and R. J. Monaghan. 1952. 9p. diagrs., 2 tabs. (ARC R & M 2473; ARC 10,309. Formerly RAE Tech. Note Aero 1851)

During tests at negative pitch air flow through the working section is considerably disturbed. To check the effect of tunnel interference, tests were made in both the 5-foot and 24-foot wind tunnels. Tests also provided information on Reynolds number effects and solidity. It was concluded that the effects of tunnel interference can be allowed for by a correction to J. Over the range of reliable measurements this additive correction decreases with J, becoming negligible for $J > 1.6$. For the tests an increase in Reynolds number had no appreciable effect on negative thrust. Correcting for a 2:1 increase in solidity by treating thrust and power as proportional to solidity may overestimate negative thrust for a given power by 30 percent.

N-16052*

Aeronautical Research Council (Gt. Brit.)
SUPERSONIC DIFFUSERS. J. Lukasiewicz. 1952. 30p. diagrs., photos., 3 tabs. (ARC R & M 2501; ARC 10,110. Formerly RAE Gas 8)

Various possible types of supersonic diffuser are considered theoretically and the available experimental evidence is reviewed. The most obvious type of an efficient supersonic diffuser is the reversed supersonic nozzle. A stability criterion for the reversed supersonic nozzle is developed, which shows that the contraction between the entry and the throat is so limited that if a normal shock at entry is to be avoided such a diffuser is of little practical use unless an artificial means of inducing and maintaining the less stable flow can be found. Test results of simple pitot entries show that, in the absence of the boundary layer, the one-dimensional theory holds for normal shocks. Since their efficiency is high for Mach number up to about 1.5, diffusers with normal shock at entry are quite satisfactory in this velocity range. The mechanism of the shock wave and boundary-layer interaction is considered. When normal shocks occur in the presence of the boundary layer, as in annular pitot entries and diffusers for supersonic wind tunnels, their compression efficiency is appreciably lower than the theoretical one. For very high velocities, exceeding $M = 2.5$, the multishock diffuser is practicable and offers high theoretical efficiency. The efficiencies of this type of diffuser are examined and shown to exceed 90 percent up to $M = 3.0$ for designs having three or four oblique shocks. Various geometrical arrangements are considered from the point of view of reduction of frontal area for a given mass flow, and improvements on the single focused wave system are obtained. The high performance of multishock diffusers is confirmed by Oswatitsch's tests at Göttingen, the results of which are here summarized. The operation of supersonic diffusers at other than the design Mach number is briefly considered.

N-16053*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE FRISE AILERON. H. H. B. M. Thomas and E. R. Crabbe. 1952. 16p. diagrs. (ARC R & M 2502; ARC 10,213. Formerly RAE Aero 2163)

In spite of its well known disadvantages the Frise aileron is still used and can yield a good aileron control when the balance required is not very close. There appears to be, therefore, a need for some means of estimating the hinge-moment characteristics of this type of aileron. The present note, besides giving a general discussion of the characteristics of Frise ailerons, includes a method of estimating the hinge moment from the hinge moment of the unbalanced ailerons. Means of improving the hinge moment characteristics, avoiding oscillation, and increasing the rolling power of Frise ailerons are also discussed. These include the use of differentially geared tabs and slats attached to the wing or the aileron.

N-16057*

Aeronautical Research Council (Gt. Brit.)
THE PREVENTION OF BINARY FLUTTER BY ARTIFICIAL DAMPING. R. A. Frazer. 1951. 16p. diagrs., 2 tabs. (ARC R & M 2552. Formerly ARC 7473; ARC 0.397)

Formulas are obtained which provide an estimate of the amount of artificial control needed to prevent binary flutter. Results are presented in terms of a "minimum damping multiplier" defined as the ratio of the least direct damping coefficient required for absolute flutter prevention to the "natural" direct aerodynamic damping coefficient of the control surface concerned. Numerical results are obtained for five different types of aircraft.

N-16058*

Aeronautical Research Council (Gt. Brit.)
WIND-TUNNEL TESTS ON THE SPOILING EFFECTS OF ENGINE COOLING GILLS ON RADIAL AIR-COOLED INSTALLATIONS ON A WING. J. Seddon and J. A. Kirk. 1952. 26p. diagrs., 6 tabs. (ARC R & M 2558; ARC 5659. Formerly RAE Aero 1724)

Spoiling drag associated with fully open gills at high C_L can be very large if the gill exit is nearer to the wing leading edge than about 10 percent of the local wing chord; but the effect diminshes rapidly as this distance is increased. The drag due to spoiling is reduced if the cooling air is kept away from the nacelle-wing junction by emitting it at specified regions around the exit, preferably at the bottom where the lift is a minimum. Larger gill angles would be needed to satisfy maximum-flow requirements in this way. The return-flow cooling system, with nose exit, shows no evidence of large spoiling drag at high cooling flow. The data obtained might be useful for estimating effects of other forms of discharge of low-energy air in front of a wing leading edge.

N-16059*

Aeronautical Research Council (Gt. Brit.)
THE PRODUCTION OF LIFT INDEPENDENTLY OF INCIDENCE - THE THWAITES FLAP, PARTS I AND II. B. Thwaites. 1952. 20p. diagrs. (ARC R & M 2611. Formerly ARC 10,100; FM 1020; Perf. 252; ARC 11,023; FM 1176, Perf. 378)

In Part I of this paper, the possibility of obtaining lift on a body in a uniform stream independently of the incidence is discussed, and a practical method which obtains this effect if given. It is shown that a small thin "flap" which may be moved about a well-rounded trailing edge through which, for example, continuous suction is applied will produce circulation about the airfoil. A necessary feature of this method is the prevention of separation of flow by boundary-layer suction, which is also used to reduce substantially the width of the wake. The method uses principles quite different from those which have been proposed in the past for obtaining increased lift on airfoils. The practical applications of the device are briefly discussed, and some interesting consequences pointed out. It will, for instance, be possible to fly with an airfoil always at zero incidence. Again, the stall in which the flow separates from near the leading edge may be completely avoided, for as the circulation and lift increase, the incidence may be decreased so that severe adverse velocity gradients occur nowhere but near the trailing edge.

In Part II of the paper, a report is given of a preliminary experiment which was set up to investigate whether the theoretical predictions made about the efficacy of the flap were largely confirmed. A wholly porous circular cylinder was fitted with the flap and measurements were made of the pressure distribution round the cylinder for various positions of the flap. These observations showed that for angular deflection of the flap of less than 20°, about 85 percent of the theoretical value of C_L was realized: a maximum C_L of about 5.6 was obtained. These results are taken to show that the physical principles of Part I are sound and that the Thwaites flap does, in fact, enable lift to be generated independently of incidence.

N-16060*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE CHARACTERISTIC CURVE FOR AN AIRSCREW OR HELICOPTER. C. N. H. Lock. 1952. 3p. diagr. (ARC R & M 2673. Formerly ARC 10,636; ARC H46)

Modifies the method of plotting the curves as given in R & M 1026 and R & M 1014. The new variables are the square roots of the variables used in these earlier reports. The change of variables has the following three advantages: (1) The three principal working states now correspond to three different quadrants, (2) the representation in the neighborhood of the x-axis and the y-axis is more definite since the curve has a finite slope at both these points, and (3) the formulas of the vortex theory take simple forms.

N-16061*

Aeronautical Research Council (Gt. Brit.)
TANK TESTS ON A HULL WITH THE MAIN STEP FAIRED IN PLANFORM AND ELEVATION. D. I. T. P. Llewelyn-Davies. 1952. 36p. diagrs., photos., 4 tabs. (ARC R & M 2708; ARC 8807. Formerly RAE Aero 2029)

Tank tests were required to find out whether the water characteristics of a hull with a main step, faired in both plan form and elevation, were comparable with those of a hull with a conventional Vee or transverse step. Stability diagrams and spray and resistance characteristics were obtained over a large range of loadings ($C_{\Delta 0} = 0.616$ to $C_{\Delta 0} = 1.440$). The fully faired step offers more possibility of designing a longitudinally stable flying boat hull than does the conventional transverse or Vee step, but a hull with such a step is 5 to 10 percent less efficient hydrodynamically except at high speed. In order to avoid running too fine at high speed, it is recommended that the center of gravity should not be more than 0.46b ahead of the

apex of the step. The modification to the step plan form makes little difference to the main spray characteristics, but increase in all-up-weight reduces wing, tail plane and propeller clearances. The effect of increase in load on the porpoising stability characteristics is to raise both limits, with a tendency for the upper limit to rise more rapidly, but less regularly, than the lower limit. The free-to-trim attitudes also rise with increase in all-up-weight. The planing efficiency of the hull increases with increase of load, especially at high speeds. There is evidence of a second resistance hump at high speeds and also of a critical variation of planing efficiency with attitude under similar conditions.

N-16313*

Royal Aircraft Establishment (Gt. Brit.)
CHARTS OF THE WAVE DRAG OF WINGS AT ZERO LIFT. T. Lawrence. January 1952. 18p. diagrs. (RAE Tech. Note Aero 2139)

Theoretical calculations of the wave drag at supersonic speeds of nonlifting wings of double wedge and biconvex section are reviewed, and the best method of presenting the results considered. Using this method, a representative selection of the available numerical evaluations of the theory is presented. These should be of value for wing drag estimation purposes.

MISCELLANEOUS

NACA TN 2657

Errata No. 1 on "SOME EFFECTS OF FREQUENCY ON THE CONTRIBUTION OF A VERTICAL TAIL TO THE FREE AERODYNAMIC DAMPING OF A MODEL OSCILLATING IN YAW". John D. Bird, Lewis R. Fisher and Sadie M. Hubbard. April 1952.

UNPUBLISHED PAPERS

N-8809*

THE PHUGOID OSCILLATION OF THE AIRPLANE WITH CONSIDERATION OF UNSTEADY AIR FORCES. (Die Phygoidschwingung des Flugzeugs bei Berücksichtigung instationärer Luftkräfte). J. Weissinger. March 1952. 33p. diagrs., 3 tabs. (Trans. from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin. FB 1430; Deutsche Versuchsanstalt für Luftfahrt E. V., Berlin. Institut für Aerodynamik, March 29, 1941).

An iteration method for determination of the influence of the unsteady air forces on the slow longitudinal oscillation of the airplane (to be calculated according to the method of small oscillations) is described and the results of a few numerical calculations are given.

N-9665*

SPECTRAL ENERGY DISTRIBUTION IN RADIATION DUE TO ENCOUNTERING SHOCK WAVES. (Répartition spectrale énérgetique dans la Lumière émise lors de la Recontre d'Ondes de Choc). A. Michel-Levy, H. Muraour and E. Vassy. April 1952. 19p. diagrs., photos. (Trans. from Revue d'Optique Theorique et Instrumentale, 1941, p.149-160).

This report deals with the determination of the energy distribution in a continuous spectrum obtained at the encounter with shock waves in the atmosphere of various gases: argon, helium, oxygen, etc. The reference source is the positive crater of a carbon arc. Various regions of the gas chamber were explored. The radiation is not that of a black body. The present status of the theory of continuous spectra offers no possibility for interpreting this phenomenon.

N-12762*

THE STRESS-STROKE DIAGRAM OF AIRPLANE SHOCK ABSORBER STRUTS. THIRD PARTIAL REPORT - THE LANDING IMPACT OF OLEO-PNEUMATIC SHOCK ABSORBERS. (Zur kenntnis der Kraftwegdiagramme von Flugzeugfederbeinen, 3. Teilbericht: Der Landestoss von Ölluftfederbeinen). K. Schlaefke. April 1952. 15p. diagrs., 3 tabs. (Trans. from Aerodynamische Versuchsanstalt Göttingen E.V., Technische Berichte, v. 11, no. 5, 1944, p. 137-141).

The stress-stroke diagram of an oleo-pneumatic leg under the first impact at landing can be obtained by superposing onto the diagram of the undamped compressed air leg, the damping diagram according to the second approximate method described in the preceeding partial report. The maximum stroke, maximum stress, and efficiency to be expected for divers damping, lift coefficients, and heights of drop are computed and represented diagrammatically for practical use. Lastly, it is indicated how the newly introduced damping factor for oleo-pneumatic legs can be determined by experiment.

N-12763*

ON THE RECIPROCAL EFFECTS BETWEEN SHOCK ABSORBER STRUT AND TIRE AT LANDING IMPACT OF AIRPLANE UNDERCARRIAGES. (Zur Kenntnis der Wechselwirkungen zwischen Federbein und Reifen beim Landestoss von Flugzeugfahrewerken). K. Schlaefke. May 1952. 18p. diagrs., 3 tabs. (Trans. from Aerodynamische Versuchsanstalt Göttingen E. V., Technische Berichte, v. 10, no. 11, 1943, p. 363-367).

This report deals with the reciprocal effects between shock-absorber strut and tire due to impact at landing. It was found that the tire reaches its maximum springing earlier than the strut and that at the first instant of landing impact the energy is taken up solely by the tire. The results are represented in diagrams which can be used for the conversion of experimental data to other combinations of tires and shock-absorber struts.

N-15440*

Massachusetts Inst. of Tech.
ASYMPTOTIC SOLUTIONS OF THE STABILITY EQUATIONS OF A COMPRESSIBLE FLUID. Cathleen S. Morawetz. July 1951. 47p. diagrs. (Massachusetts Inst. of Tech.)

Two conclusions of practical interest are reached here. It is proved rigorously that the proper branch of the multiple-valued asymptotic solutions has been used by Lees and Lin in NACA TN 1115. Establishes the existence or absence of an inner viscous region and its nature.

N-15499*

HOT-WIRE ANEMOMETER UTILIZING DIRECT-CURRENT AMPLIFIER. (Chokur Yū Zofukuki No Riyoseru Nessen-Fusokukei). 8p. diagrs. (Trans. of Jap. rept., February 26, 1944, Wright-Patterson Field microfilm, Jap/WTD/Re/336).

Describes the design of a hot-wire anemometer for measuring the instantaneous velocity fluctuations by means of a direct current amplifier and gives the properties of the instrument as determined experimentally.

DECLASSIFIED NACA REPORTS

NACA RM L8I02

INVESTIGATION OF TWO PITOT-STATIC TUBES AT SUPERSONIC SPEEDS. Lowell E. Hasel and Donald E. Coletti. November 19, 1948. 24p. diagrs. (NACA RM L8I02) (Declassified from Confidential, 6/4/52)

The results of tests at a Mach number of 1.94 of an ogival-nose cylindrical pitot-static tube and similar tests at Mach numbers of 1.93 and 1.62 of a service pitot-static tube to determine body static pressures and indicated Mach numbers are presented and discussed. The radial pressure distribution on the cylindrical bodies is compared with that calculated by an approximate theory.

National Advisory Committee for Aeronautics

Research Abstracts

NO. 27 AUGUST 15, 1952

CURRENT NACA REPORTS

NACA Rept. 1025

EXPERIMENTAL AND THEORETICAL STUDIES OF AREA SUCTION FOR THE CONTROL OF THE LAMINAR BOUNDARY LAYER ON AN NACA 64A010 AIRFOIL. Albert L. Braslow, Dale L. Burrows, Neal Tetervin and Fioravante Visconti. 1951. ii, 19p. diagrs., photos. (NACA Rept. 1025. Formerly TN 1905; TN 2112)

Low-turbulence wind-tunnel tests were made of an NACA 64A010 airfoil section having a porous surface to investigate continuous suction as a means of controlling the laminar boundary layer. Full-chord laminar flow and large net reductions in drag were obtained up to a Reynolds number of approximately 20×10^6. It seems likely from the experimental results and a related theoretical analysis that attainment of full-chord laminar flow by means of continuous suction through a porous surface will be possible at any value of the Reynolds number provided that the airfoil surfaces are maintained sufficiently smooth and fair and provided that outflow of air through the surface is prevented.

NACA Rept. 1029

COMPRESSIVE STRENGTH OF FLANGES. Elbridge Z. Stowell. 1951. 14p. diagrs., tab. (NACA Rept. 1029. Formerly TN 2020)

The maximum compressive stress carried by a hinged flange is computed from a deformation theory of plasticity combined with the theory for finite deflections for this structure. The computed stresses agree well with those found experimentally. Empirical observation indicates that the results will also apply fairly well to the more commonly used flanges which are not hinged.

NACA Rept. 1030

INVESTIGATION OF SEPARATION OF THE TURBULENT BOUNDARY LAYER. G. B. Schubauer and P. S. Klebanoff, National Bureau of Standards. 1951. 20p. diagrs., photos., 8 tabs. (NACA Rept. 1030. Formerly TN 2133)

An investigation was conducted on a turbulent boundary layer near a smooth surface with pressure gradients sufficient to cause flow separation. The Reynolds number was high, but speeds were entirely within the incompressible flow range. The investigation consisted of measurements of mean flow, three components of turbulence intensity, turbulent shearing stress, and correlations between two fluctuation components at a point and between the same component at different points. Results are given in the form of tables and graphs. The discussion deals first with separation and then with the more fundamental question of basic concepts of turbulent flow.

NACA Rept. 1035

ANALYSIS OF MEANS OF IMPROVING THE UNCONTROLLED LATERAL MOTIONS OF PERSONAL AIRPLANES. Marion O. McKinney, Jr. 1951. ii, 9p. diagrs., 3 tabs. (NACA Rept. 1035. Formerly TN 1997)

A theoretical analysis of means of improving the uncontrolled lateral motions of personal airplanes is presented. The purpose of this analysis was to determine whether such airplanes could be made capable of flying uncontrolled for an indefinite period of time without getting into a dangerous attitude and for a reasonable period of time without deviating excessively from the original course.

NACA Rept. 1037

GENERAL METHOD AND THERMODYNAMIC TABLES FOR COMPUTATION OF EQUILIBRIUM COMPOSITION AND TEMPERATURE OF CHEMICAL REACTIONS. Vearl N. Huff, Sanford Gordon and Virginia E. Morrell. 1951. ii, 57p., 45 tabs. (NACA Rept. 1037. Formerly NACA TN 2113, TN 2161)

A rapidly convergent successive approximation process is described that simultaneously determines both composition and temperature resulting from a chemical reaction. This method is suitable for use with any set of reactants over the complete range of mixture ratios as long as the products of reaction are ideal gases. An approximate treatment of limited amounts of liquids and solids is also included. This method is particularly suited to problems having a large number of products of reaction and to problems that require determination of such properties as specific heat or velocity of sound of a dissociating mixture. The method presented is applicable to a wide variety of problems that include (1) combustion at constant pressure or volume; and (2) isentropic expansion to an assigned pressure, temperature, or Mach number. Tables of thermodynamic functions needed with this method are included for 42 substances for convenience in numerical computations.

*AVAILABLE ON LOAN ONLY.

ADDRESS REQUESTS FOR DOCUMENTS TO NACA, 1724 F ST., NW., WASHINGTON 25, D. C, CITING CODE NUMBER ABOVE EACH TITLE, THE REPORT TITLE AND AUTHOR.

NACA Rept. 1038

WIND-TUNNEL INVESTIGATION OF AIR INLET AND OUTLET OPENINGS ON A STREAMLINE BODY. John V. Becker. 1951. ii, 21p. diagrs., photos., 3 tabs. (NACA Rept. 1038. Formerly ACR, November 1940)

Air inlet openings at the nose of a streamline body and outlets at the tail and at the 21-percent and 63-percent stations of the body were investigated with the objective of developing low-drag high-critical-speed configurations. Drag, pressure-distribution, and boundary-layer measurements were made. Inlet and outlet opening shapes were found which caused no increase in drag over that of the basic streamline body to which the openings were applied. The critical Mach number of the ducted body was also equal to that of the basic body over a wide range of internal air flow rates.

NACA Rept. 1042

SOME EFFECTS OF NONLINEAR VARIATION IN THE DIRECTIONAL-STABILITY AND DAMPING-IN-YAWING DERIVATIVES ON THE LATERAL STABILITY OF AN AIRPLANE. Leonard Sternfield. 1951. ii, 9p. diagrs., tab. (NACA Rept. 1042. Formerly TN 2233)

The effect of nonlinear stability derivatives on the lateral stability of an airplane is analyzed. Motions are calculated on the assumption that the values of the directional-stability derivative and the damping-in-yawing derivative are functions of the angle of sideslip. The application of the Laplace transform to the calculation of an airplane motion when certain types of nonlinear derivatives are present is described in detail.

NACA Rept. 1047

THE STABILITY OF THE COMPRESSION COVER OF BOX BEAMS STIFFENED BY POSTS. Paul Seide and Paul F. Barrett. 1951. ii, 16p. diagrs., 3 tabs. (NACA Rept. 1047. Formerly TN 2153)

An investigation is made of the buckling of the compression cover of post-stiffened box beams subjected to end moments. Charts are presented for the determination of the minimum post axial stiffnesses and the corresponding compressive buckling loads required for the compression cover to buckle with nodes through the posts. Application of the charts to design and analysis and the limitations of their use are discussed.

NACA Rept. 1049

EXPERIMENTAL INVESTIGATION OF THE EFFECT OF VERTICAL-TAIL SIZE AND LENGTH AND OF FUSELAGE SHAPE AND LENGTH ON THE STATIC LATERAL STABILITY CHARACTERISTICS OF A MODEL WITH 45° SWEPTBACK WING AND TAIL SURFACES. M. J. Queijo and Walter D. Wolhart. 1951. ii, 29p. diagrs., photos., 4 tabs. (NACA Rept. 1049. Formerly TN 2168)

Results are presented of an investigation to determine the effects of vertical-tail size and length and of fuselage shape and length on the lateral-static stability derivatives of a midwing airplane model with 45° sweptback wing and tail surfaces. Interference between the various model components also is evaluated.

NACA Rept. 1052

A SUMMARY OF LATERAL-STABILITY DERIVATIVES CALCULATED FOR WING PLAN FORMS IN SUPERSONIC FLOW. Arthur L. Jones and Alberta Alksne. 1951. ii, 35p. diagrs., 3 tabs. (NACA Rept. 1052)

Values of the lateral-stability derivatives for wings at supersonic speeds, calculated using the linearized theory for compressible flow, are presented in the form of design charts showing the variations of the derivatives with Mach number and aspect ratio for six plan forms. Limitations in the applicability and availability of the lateral-stability derivatives are discussed.

NACA Rept. 1059

A BIHARMONIC RELAXATION METHOD FOR CALCULATING THERMAL STRESS IN COOLED IRREGULAR CYLINDERS. Arthur G. Holms. 1952. ii, 19p. diagrs., 4 tabs. (NACA Rept. 1059. Formerly TN 2434)

A numerical method was developed for calculating thermal stresses in irregular cylinders cooled by one or more internal passages. The use of relaxation methods and elementary methods of finite differences was found to give approximations to the correct values when compared with previously known solutions for concentric circular cylinders possessing symmetrical and asymmetrical temperature distributions.

NACA Rept. 1060

DETAILED COMPUTATIONAL PROCEDURE FOR DESIGN OF CASCADE BLADES WITH PRESCRIBED VELOCITY DISTRIBUTIONS IN COMPRESSIBLE POTENTIAL FLOWS. George R. Costello, Robert L. Cummings and John T. Sinnette, Jr. 1952. ii, 14p. diagrs., 9 tabs. (NACA Rept. 1060. Formerly TN 2281)

A detailed step-by-step computational outline is presented for the design of cascade blades having a prescribed velocity distribution on the blade in a potential flow of the usual compressible fluid. This outline is based on the assumption that the magnitude of the velocity in the flow of the usual compressible nonviscous fluid is proportional to the magnitude of the velocity in the flow of a compressible nonviscous fluid with linear pressure-volume relation. The computational procedure includes several ways of adjusting the prescribed velocity to satisfy the restriction imposed by the method. Tables of coefficients are given for evaluating the necessary integrals, including the determination of the harmonic conjugate. Numerical examples are included.

NACA Rept. 1061

EFFECT OF INITIAL MIXTURE TEMPERATURE ON FLAME SPEED OF METHANE-AIR, PROPANE-AIR AND ETHYLENE-AIR MIXTURES. Gordon L. Dugger. 1952. ii, 12p. diagrs., photo., 3 tabs. (NACA Rept. 1061. Formerly TN 2170; TN 2374)

Flame speeds based on the outer edge of the shadow cast by the laminar Bunsen cone were determined as functions of composition for methane-air mixtures at initial mixture temperatures ranging from -132° to 342° C and for propane-air and ethylene-air mixtures at initial mixture temperatures ranging from -73° to 344° C. The data showed that maximum flame speed increased with temperature at an increasing rate. The percentage change in flame speed with change in initial temperature for the three fuels followed the decreasing order, methane, propane, and ethylene. Empirical equations were determined for maximum flame speed as a function of initial temperature over the temperature range covered for each fuel. For each fuel it was found that, with a fixed parallel-beam shadowgraph system, the ratio of flame speed based on the outer edge of the shadow cast by the flame cone to flame speed based on the inner edge of the shadow was a constant, independent of temperature or composition. The flame speed of propane-air flames was independent of tube diameter from 10 to 22 millimeters or stream-flow Reynolds number from 1500 to 2100. The observed effect of temperature on flame speed for each of the fuels was reasonably well predicted by either the thermal theory as presented by Semenov or the square-root law of Tanford and Pease. The importance of active radicals in flame propagation was indicated by a simple linear relation between maximum flame speed and equilibrium radical concentrations for all three fuels.

NACA TN 2643

SPAN LOAD DISTRIBUTIONS RESULTING FROM ANGLE OF ATTACK, ROLLING, AND PITCHING FOR TAPERED SWEPTBACK WINGS WITH STREAMWISE TIPS. SUPERSONIC LEADING AND TRAILING EDGES. John C. Martin and Isabella Jeffreys. July 1952. 143p. diagrs., 6 tabs. (NACA TN 2643)

On the basis of the linearized supersonic-flow theory the span load distributions resulting from constant angle of attack, from steady rolling, and from steady pitching were calculated for a series of thin sweptback tapered wings with streamwise tips and with supersonic leading and trailing edges. The results are valid for the Mach number range for which the Mach line from either wing tip does not intersect the remote half-wing. The results of the analysis are presented as a series of design charts. Some illustrative variations of the spanwise distributions of circulation with the various design parameters are also presented.

NACA TN 2656

A BLADE-ELEMENT ANALYSIS FOR LIFTING ROTORS THAT IS APPLICABLE FOR LARGE INFLOW AND BLADE ANGLES AND ANY REASONABLE BLADE GEOMETRY. Walter Castles, Jr. and Noah C. New, Georgia Institute of Technology. July 1952. 63p. diagrs., 7 tabs. (NACA TN 2656)

A blade-element analysis for lifting rotors is presented which is applicable for large inflow and blade angles and any reasonable blade geometry and should therefore be useful for convertaplane as well as helicopter calculations. Simple approximate relations between rotor thrust and flight-path velocity components and rotor blade angles, torque, and in-plane forces are derived and these solutions, based on the assumption of a triangular distribution of blade circulation and a parabolic variation of profile drag with lift, are sufficiently accurate for preliminary calculations and determination of equilibrium angle of attack and lateral tilt of the tip-path plane. More exact blade-element equations are then derived for the relations between thrust and flight-path velocity components and equilibrium blade angles, torque, and in-plane forces and moments.

NACA TN 2675

MEASUREMENTS OF FLYING QUALITIES OF AN F-47D-30 AIRPLANE TO DETERMINE LATERAL AND DIRECTIONAL STABILITY AND CONTROL CHARACTERISTICS. R. Fabian Goranson and Christopher C. Kraft, Jr. July 1952. 61p. diagrs., photos., 2 tabs. (NACA TN 2675)

Tests have been made of the flying qualities of an F-47D-30 airplane to determine the lateral and directional stability and control characteristics. Data are also presented of the aileron hinge-moment characteristics.

NACA TN 2715

THE THEORETICAL CHARACTERISTICS OF TRIANGULAR-TIP CONTROL SURFACES AT SUPERSONIC SPEEDS. MACH LINES BEHIND TRAILING EDGES. Julian H. Kainer and Mary Dowd King. July 1952. 76p. diagrs., 4 tabs. (NACA TN 2715)

By means of linearized theory, generalized expressions in closed form have been obtained for the characteristics due to control-surface deflection $\left(C_{L_\delta},\ C_{l_\delta},\ C_{m_\delta},\ \text{and}\ C_{h_\delta}\right)$ and due to wing angle of attack $\left(C_{h_\alpha}\right)$ for wing plan forms having triangular-tip control surfaces at supersonic speeds. The analysis considers wing trailing-edge sweep, control-surface geometry, and Mach number for the deflection characteristics. For C_{h_α}, the effects of wing leading-edge sweep and aspect ratio are also included. The analysis is limited to configurations where the trailing edges are supersonic and where the innermost Mach lines from the leading edge of the control-surface root chord do not intersect the wing root chord.

NACA TN 2737

PLASTIC STRESS-STRAIN RELATIONS FOR COMBINED TENSION AND COMPRESSION. Joseph Marin and H. A. B. Wiseman, Pennsylvania State College. July 1952. 61p. diagrs., photos., 2 tabs. (NACA TN 2737)

Plastic stress-strain relations for biaxial tension-compression principal stresses were determined for a 14S-T4 aluminum alloy. Constant-stress-ratio tests provided control data and information on the influence of biaxial stresses on the yield strength of the material. Variable-stress-ratio tests were made to determine whether the deformation or flow theory agrees better with actual plastic stress-strain relations and special tests were conducted to check the validity of various assumptions made in these theories.

NACA TN 2739

NUMERICAL DETERMINATION OF INDICIAL LIFT AND MOMENT FUNCTIONS FOR A TWO-DIMENSIONAL SINKING AND PITCHING AIRFOIL AT MACH NUMBERS 0.5 AND 0.6. Bernard Mazelsky and Joseph A. Drischler. July 1952. 37p. diagrs., 4 tabs. (NACA TN 2739)

Approximate values for the indicial lift and moment functions on a sinking and pitching airfoil are calculated for Mach numbers 0.5 and 0.6. The indicial lift function associated with an airfoil penetrating a sharp-edge gust is also determined approximately at Mach numbers 0.5, 0.6, and 0.7.

NACA TN 2741

INVESTIGATION OF THE INFLUENCE OF FUSELAGE AND TAIL SURFACES ON LOW-SPEED STATIC STABILITY AND ROLLING CHARACTERISTICS OF A SWEPT-WING MODEL. John D. Bird, Jacob H. Lichtenstein and Byron M. Jaquet. July 1952. 18p. diagrs., photo. (NACA TN 2741. Formerly RM L7H15)

Results are presented of a wind-tunnel investigation to determine influence of the fuselage and tail on static stability and rotary derivatives in roll of a model having 45° sweptback wing and tail surfaces. The wing alone and the model without the horizontal tail showed marginal longitudinal stability near maximum lift. The longitudinal stability of the complete model was satisfactory. The vertical tail produced larger increments of rate of change of lateral-force and yawing-moment coefficients with wing-tip helix angle than the fuselage or the horizontal tail.

NACA TN 2744

PRACTICAL CALCULATION OF SECOND-ORDER SUPERSONIC FLOW PAST NONLIFTING BODIES OF REVOLUTION. Milton D. Van Dyke. July 1952. 62p. diagrs., 2 tabs., 2 charts. (NACA TN 2744)

Calculation of second-order supersonic flow past bodies of revolution at zero angle of attack is described in detail, and reduced to routine computation. Use of an approximate tangency condition is shown to increase the accuracy for bodies with corners. Tables of basic functions and standard computing forms are presented. The procedure is summarized so that one can apply it without necessarily understanding the details of the theory. A sample calculation is given, and several examples are compared with solutions calculated by the method of characteristics.

NACA TN 2745

INFLUENCE OF CHEMICAL COMPOSITION ON RUPTURE TEST PROPERTIES AT 1500° F OF FORGED CHROMIUM-COBALT-NICKEL-IRON BASE ALLOYS. J. W. Freeman, J. F. Ewing and A. E. White, University of Michigan. July 1952. 69p. diagrs., photos., 2 tabs. (NACA TN 2745)

Sixty-two alloys involving systematic individual variations of 10 elements present in a forged chromium-cobalt-nickel-iron base alloy in the solution-treated and aged condition and simultaneous variation of molybdenum, tungsten, and columbium were rupture tested at 1500° F. It was found that the elements can be varied individually between quite wide limits without significantly changing the rupture properties. The results were similar to those previously obtained at 1200° F (NACA Rept. 1058) except that increased chromium was not beneficial at 1500° F and the saturation effect for molybdenum and tungsten did not occur at 1200° F.

NACA TN 2746

PREVIEW OF BEHAVIOR OF GRAIN BOUNDARIES IN CREEP OF ALUMINUM BICRYSTALS. F. N. Rhines and A. W. Cochardt, Carnegie Institute of Technology. July 1952. 40p. diagrs., photos. (NACA TN 2746)

Gliding of aluminum bicrystals along their mutual boundary was studied during creep tests at 200° to 650° C and 1 to 100 psi. The direction of motion depends only upon the direction of maximum resolved shear stress in the boundary plane. The magnitude of the motion increases with magnitude of resolved shear stress, temperature, and degree of mismatch between orientations of the crystals. Gliding rate is cyclic and for each temperature there is a stress below which gliding does not occur. At low temperature and small orientation difference an induction period precedes gliding. Gliding operates in a relatively thick zone of crystalline metal on both sides of the boundary. Portions of the grains away from the boundary degenerate into blocks that move with respect to each other, parallel to the tension axis, and that rotate about octahedral axes of the original crystal.

NACA TN 2750

MATRIX AND RELAXATION SOLUTIONS THAT DETERMINE SUBSONIC THROUGH FLOW IN AN AXIAL-FLOW GAS TURBINE. Chung-Hua Wu. July 1952. 65p. diagrs., 7 tabs. (NACA TN 2750)

A method recently developed for determining the steady flow of a nonviscous compressible fluid along a relative stream surface between adjacent blades in a turbomachine was applied to investigate subsonic through flow in a single-stage axial-flow gas turbine. For both incompressible and compressible flows, the variation in flow on the stream surface was determined by using both the relaxation and the matrix methods. In all solutions considered, convergence was obtained without difficulty. The compressibility of the gas and the radial twist of the stream surface had equally significant effects on the considerable amount of radial flow obtained. The results of these accurate calculations provide a basis for evaluation of simpler, more approximate methods for computing subsonic through flow in turbomachines.

NACA TN 2754

A METHOD OF SELECTING THE THICKNESS, HOLLOWNESS, AND SIZE OF A SUPERSONIC WING FOR LEAST DRAG AND SUFFICIENT BENDING STRENGTH AT SPECIFIED FLIGHT CONDITIONS. James L. Amick. July 1952. 38p. diagrs. (NACA TN 2754)

The method described, which is suitable for use in preliminary missile design, is based on simple beam theory and takes into account the effects of wing weight and type of skin thickness distribution. For cases in which the wing weight is negligible, a simplification of the general method gives the best lift-drag ratio consistent with the bending strength requirement of a given combination of plan form and profile shape at a given Mach number as a function of a single design parameter. An example of the application of the method to a diamond wing at Mach number 2.0, for a range of specified flight conditions, is presented.

NACA RM E52C31

TRUE AIRSPEED MEASUREMENT BY IONIZATION-TRACER TECHNIQUE. Bemrose Boyd, Robert G. Dorsch and George H. Brodie. July 1952. 37p. diagrs., photos. (NACA RM E52C31)

Ion bundles produced in a pulse-excited corona discharge are used as tracers with a radar-like pulse transit-time measuring instrument in order to provide a measurement of airspeed that is independent of all variables except time and distance. The resulting instrumentation need not project into the air stream and, therefore, will not cause any interference in supersonic flow. The instrument was tested at Mach numbers ranging from 0.3 to 3.8. Use of the proper instrumentation and technique results in accuracy of the order of 1 percent.

NACA RM E52E12

USE OF CHOKED NOZZLE TECHNIQUE AND EXHAUST JET DIFFUSER FOR EXTENDING OPERABLE RANGE OF JET-ENGINE RESEARCH FACILITIES. John H. Povolny. July 1952. 17p. diagrs. (NACA RM E52E12)

An investigation has been conducted to determine the increase in the useful ranges of flight conditions that may be obtained with a given jet-engine research facility when the choked nozzle technique or the exhaust jet diffuser, or both, are employed. This report describes these two methods, presents the considerations involved in their application, and gives typical results of their use as well as confirmation of the accuracy of data obtained by utilization of these techniques. The validity and accuracy of the choked nozzle technique and the associated area - pressure-differential thrust correction term were substantiated by turbojet-engine and exhaust-nozzle performance data covering a range of nozzle pressure ratios up to about 10. It was demonstrated by calculations for a typical turbojet engine installed in a typical altitude test facility that a considerable increase in the range of flight conditions that can be investigated may be obtained by use of the choked nozzle technique. It was also demonstrated that the range of facility exhaust pressures or exhauster flows may be increased by use of the exhaust jet diffuser.

BRITISH REPORTS

N-16326*

Aeronautical Research Council (Gt. Brit.)
PUBLISHED REPORTS AND MEMORANDA OF THE AERONAUTICAL RESEARCH COUNCIL. 1952. 5p. (ARC R & M 2350)

Lists R & M's 2251 through 2350 and gives the Council number, the title and the author for each.

N-16327*

Aeronautical Research Council (Gt. Brit.)
TUNNEL BLOCKAGE NEAR THE CHOKING CONDITION. A. Thom and Myra Jones. 1952. 16p. diagrs., 2 tabs. (ARC R & M 2385; ARC 8606; ARC 8878. Formerly RAE Aero 2020; RAE Aero 2056; ARC 9854; FM 968)

By a consideration of mass flow, blockage corrections are estimated up to the choking speed of the tunnel, and a curve is given showing the blockage for a Rankine oval in terms of the uncorrected choking Mach number. The theory of the method of determining blockage from wall pressures is examined more critically for the two-dimensional cases and extended to certain three-dimensional cases.

N-16328*

Aeronautical Research Council (Gt. Brit.)
BOUND AND TRAILING VORTICES IN THE LINEARISED THEORY OF SUPERSONIC FLOW, AND THE DOWNWASH IN THE WAKE OF A DELTA WING. A. Robinson and J. H. Hunter-Tod. 1952. 14p. diagrs. (ARC R & M 2409; ARC 11,296. Formerly *College of Aeronautics, Cranfield. Rept. 10*)

The field of flow round a flat airfoil at incidence can be regarded in linearized theory as the result of both bound and trailing vortices for supersonic as well as for low-speed flight. This leads to a convenient method, given the lift distribution over an airfoil, for calculating the flow round it at supersonic speeds. As an application of the results, the downwash is calculated in the wake of a delta wing lying within the Mach cone emanating from its apex. The downwash is found to be least just aft the trailing edge and is everywhere less than the downflow at the airfoil. It increases steadily to a limiting value which is attained virtually within two chord lengths of the trailing edge. The ratio of the downwash at any point in the wake to the downflow at the airfoil decreases with increasing Mach number and apex angle.

N-16329*

Aeronautical Research Council (Gt. Brit.)
THE AERODYNAMIC DERIVATIVES WITH RESPECT TO SIDESLIP FOR A DELTA WING WITH SMALL DIHEDRAL AT ZERO INCIDENCE AT SUPERSONIC SPEEDS. A. Robinson and J. H. Hunter-Tod. 1952. 14p. diagrs. (ARC R & M 2410; ARC 11,322. Formerly College of Aeronautics, Cranfield. Rept. 12)

Expressions are derived for the sideslip derivatives on the assumptions of the linearized theory of flow for a delta wing with small dihedral flying at supersonic speeds. A discussion is included in the Appendix on the relation between two methods that have been evolved for the treatment of aerodynamic force problems of the delta wing lying within its apex Mach cone. When the leading edges are within the Mach cone from the apex, the pressure distribution and the rolling moment are independent of Mach number but dependent on aspect ratio. When the leading edges are outside the apex Mach cone, the nondimensional rolling derivative is, in contrast to the other case, dependent on Mach number and independent of aspect ratio; the other derivatives and the pressure, however, are dependent on both variables.

N-16330*

Aeronautical Research Council (Gt. Brit.)
USE OF NEGATIVE CAMBER IN THE TRANSONIC SPEED RANGE. W. F. Hilton. 1952. 5p. diagrs. (ARC R & M 2460. Formerly ARC 10,421; FM 1077; S & C 2100)

Certain difficulties are experienced when attempting free flight in the transonic speed range (0.8 to 1.2 of the speed of sound). These difficulties fall into two main classes: namely, (1) overcoming the somewhat high air resistance by means of improvements in engine design, and (2) balancing the aircraft for stable horizontal flight. The latter problem is considered in this paper. Changes of trim are caused by sudden loss of wing lift in the transonic range, which decreases the downwash over the tail, and possibly results in an uncontrollable nose-heavy dive. The use of negative wing camber for minimizing these effects is suggested, and the suggestion is found to be supported by wind-tunnel experiments.

N-16331*

Aeronautical Research Council (Gt. Brit.)
EXPERIMENTS ON THIN TURNING VANES. C. Salter. 1952. 29p. diagrs., photo., 9 tabs. (ARC R & M 2469. Formerly ARC 10,039; TP 164)

The experiments recorded in this paper refer to a variety of tests made on corner vanes (mainly thin curved plates) in a tunnel 1 foot square, with the object of indicating whether and to what extent they would be suitable for deflecting the air stream around the corners of return-flow type wind tunnels. It was found that the air stream could be turned very satisfactorily by the use of thin vanes and that the loss of head in a 90° corner was not as great as had been expected. Taking the pitch of the vanes to be the geometrical pitch in a direction perpendicular to the axis of the tunnel and the chord to be the distance between the centers of radii of the leading and trailing edges, the optimum ratio of pitch to chord for minimum loss was shown to be about 0.25. At that P/C ratio and Reynolds number of 2×10^{5}, based on chord length and air velocity of approach, the loss of total head in the corner was found to be 0.12 of the dynamic head, while in the region outside the boundary layer the minimum value was only 0.06. To ensure stability of the stream, a P/C ratio of 0.2 is recommended and it appears that, in order to maintain a thin boundary layer, the actual number of vanes in any one corner should be not less than say 15 to 20. A clean entry of the streamlines into the vane unit can be established by giving the leading-edge tangents an incidence of about 5° relative to the upstream axis of the tunnel. The minimum corner loss with 45° deflection was found to be about 0.05 of the dynamic head with a P/C ratio of roughly 0.4. A set of "Collar" vanes with splitters gave very satisfactory turning of the stream with a loss of head in the corner of 0.17 of the dynamic head, at a Reynolds number of 150,000, the corresponding figure in the region outside the boundary layer being 0.12. As the effect of the walls in assisting the deflection of the stream is so large it is suggested that the static-pressure distribution is as good a criterion as any of the effectiveness of the corner. Uniformity of static pressure over both upstream and downstream cross-section to within a short distance from the walls is a good test for the correct shape and setting of the vanes.

N-16332*

Aeronautical Research Council (Gt. Brit.)
STRAIN GAUGE FLUTTER TESTS ON A 4-BLADE PROPELLER WITH DURALUMIN BLADES. J. Kettlewell and H. G. Ewing. 1952. 4p. diagrs. (ARC R & M 2471; ARC 9876. Formerly RAE Tech. Note SME 354)

This note describes tests made on a fluttering duralumin propeller with strain gages fitted. Three different blade settings in the stalling region were investigated. The flutter encountered was purely torsional; and the amplitude of strain recorded was at no time serious.

N-16333*

Aeronautical Research Council (Gt. Brit.)
WIND-TUNNEL TESTS ON THE 30 PER CENT. SYMMETRICAL GRIFFITH AEROFOIL WITH EJECTION OF AIR AT THE SLOTS. N. Gregory, W. S. Walker and W. G. Raymer. 1952. 11p. diagrs. (ARC R & M 2475. Formerly ARC 10,097; FM 1018, Perf. 251)

It has been shown by Preston (1946) that ejection of air at the point of velocity discontinuity on a 16.2 percent thick Griffith suction airfoil prevents separation, and that if sufficient air is ejected, the drag is reduced. The present tests were undertaken to apply this principle to the 30 percent Griffith airfoil and to investigate the effect on lift by pressure-plotting the airfoil. Ejection of air was found to prevent separation, but about 66 percent more air was required than with suction. Three times the suction quantity of air, when ejected, reduced the drag to the low values associated with suction. At R = 0.96 million, the range of the tests was 0°-18° incidence and 0°-14° flap angle. At 18° incidence and 14° flap angle, a C_{NF} of 2.5 was obtained, giving approximately the same lift-curve slope as with suction. Above this angle of incidence, the pump capacity was not large enough for unseparated flow to be attained. With separation prevented, the pitching moments were the same as with suction, but the hinge moments were sensitive to small changes of blowing quantity. At R = 2.88 million, the pump capacity was insufficient to prevent a partial stall at 6° incidence as occurred with suction. Curves of C_{NF}, C_Q, C_M, C_H, C_D and velocity distribution when blowing are given, and comparisons are made with corresponding curves obtained with suction and with no suction. The same lift and pitching moments are obtained at any incidence with blowing and with suction, but the suction quantities are about 40 percent less than the blowing quantities. The hinge moments are greatly different with blowing, and increase of the normal force.

N-16334*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF POINTED TIPS ON WING LOADING CALCULATIONS. V. M. Falkner. 1952. 4p. diagr., tab. (ARC R & M 2483. Formerly ARC 10,037; S & C 2063; Perf. 235)

The standard formulas for calculation of wing loading by vortex lattice theory, which involve a sequence starting with $\sqrt{(1 - \eta^2)}$, are not strictly valid for pointed wing tips. On the other hand, the use of a sequence starting with $1 - \eta^2$ leads to overcorrection. By considering the mean of these two solutions for a delta wing, it is shown that the error introduced by the use of the standard sequence is small and is on the safe side as regards bending moments.

N-16335*

Aeronautical Research Council (Gt. Brit.)
FLIGHT MEASUREMENTS OF THE PRESSURE DISTRIBUTION ON A TEMPEST WING UP TO A MACH NUMBER OF 0.8. K. Eyre. 1952. 15p. diagrs. (ARC R & M 2489; ARC 10,550. Formerly Hawker Aircraft, Ltd. Design Rept. 1131)

This investigation was to determine the effect of Mach number on the pressure distribution of the Hawker airfoil section as fitted to Tempest and Fury aircraft. The distributions show the typical supersonic flow conditions obtained over an airfoil of this type. The airfoil does not show any unusual characteristics and there are no large changes in pitching moment and position of the aerodynamic center below a Mach number of about 0.75. In all cases the favorable pressure gradient in front of the shock wave is fairly gradual, but changes rapidly at the shock wave. There is, however, no sign of a breakdown in flow at the trailing edge, where the distributions are similar for all values of Mach number. The values obtained for critical Mach number agree quite well with those given in the Royal Aeronautical Society data sheets. The variations of center-of-pressure position, pitching moment, and aerodynamic-center position are in quite good agreement with German wind-tunnel tests made on an approximately similar airfoil.

N-16336*

Aeronautical Research Council (Gt. Brit.)
24-FT. WIND-TUNNEL TESTS ON A "PADDLE-BLADE" PROPELLER. A. B. Haines. 1952. 15p. diagrs. (ARC R & M 2493; ARC 10,308. Formerly RAE Aero 2172)

The report contains the results of tests made in the Royal Aircraft Establishment 24-foot tunnel on a de Havilland propeller having conventional Clark Y sections and the paddle-blade type of plan form. The report describes analyses of the results made both by single-radius and full-strip theory methods. The data provided will enable estimates to be made of the performance of paddle-blade propellers under various flight conditions and, in particular, will give a quantitative idea of the improvements to be expected for high power loadings, that is, beyond the stall. The principal general conclusions are: (1) Use of the same lift/drag data in eight radius strip theory calculations for both paddle-blade and normal propellers is justified. (2) The gains found in flight tests for paddle-blade propellers must be principally ascribed to the effects of NACA 16 series sections. (3) RAE charts based on single-radius data may be pessimistic in predicting the peak efficiencies of paddle propellers at high tip speed (by 1.5 to 2 percent for $M_T = 0.85$). (4) The mean stalling performance is better than would be expected even on an activity factor basis. This enables other design modifications, for example, thin roots, 16 series sections, etc. to be made to improve the top speed performance without causing serious losses at take-off or climb. (5) Therefore, the general conclusion is that use of the paddle type of plan form is fully justifiable even though it does not appear to offer any direct shock-stalling relief.

N-16337*

Aeronautical Research Council (Gt. Brit.)
TESTS ON THREE EQUILATERAL TRIANGULAR PLATES IN THE COMPRESSED AIR TUNNEL.
R. Jones and C. J. W. Miles. 1952. 7p. diagrs., 4 tabs. (ARC R & M 2518. Formerly ARC 9973; Perf. 222)

The report gives C_L, C_D, and C_m on three equilateral triangular plates with sides 26, 36, and 47.8 inches. The object of the tests was to estimate the size of sweptback wings of that form, which can be tested in the compressed air tunnel without the application of excessive tunnel corrections. After applying the usual tunnel corrections and making small corrections due to dissymmetry in the models, it was found that C_L on the three models agreed if the results on the 36-inch and 47.8-inch models were multiplied by 1.01 and 1.05, respectively. Fair agreement was obtained on C_D for the three models. The mean position of the center of pressure is about 0.45 of the height of the triangle forward of the trailing edge.

N-16338*

Aeronautical Research Council (Gt. Brit.)
THE YAWING VIBRATIONS OF AN AIRCRAFT.
J. Morris and G. S. Green. 1952. 11p. diagrs. (ARC R & M 2525; ARC 9482. Formerly RAE SME 4027)

This report gives a theoretical method for calculating the natural frequencies and modes of yawing vibration of a complete aircraft. The basic feature of the treatment is the replacement of the continuous mass system by one consisting of a finite number of discrete masses elastically interconnected. In the course of the analysis, use is made of the deflection coefficient artifice in the formation of the equations of motion, and the escalator process in their marshalling and numerical solution. The method has been applied to a single-engined fighter aircraft, for which the results of a resonance test were available. These results appear to be some 40 percent in excess of their calculated counterparts and no satisfactory explanation occurs to the authors to account for this incompatability.

N-16339*

Aeronautical Research Council (Gt. Brit.)
AIRCRAFT LANDING GEAR: GROUND LOADS WHEN SPINNING-UP THE WHEELS AT TOUCH-DOWN. J. W. Blinkhorn. 1952. 13p. diagrs., 2 tabs. (ARC R & M 2588; ARC 11,627. Formerly RAE Tech. Note Mech. Eng. 16)

The investigation covers all combinations of landing speed, coefficient of friction between the tire and the ground, and harshness of landing, for any type of pneumatic tire and wheel unit. Particular attention has been given to landing speeds between 50 and 150 mph, coefficients of friction from 0 to 2.0, and landings giving vertical wheel accelerations of 1g, 2g, 3g, and 4g. It was found that for any landing, the vertical reaction, at any wheel which has just finished spinning up increases with increase in the moment of inertia of the wheel and tire unit, and the landing speed, and decreases with increase in the free tire radius, the aircraft weight, the time to reach the maximum vertical wheel reaction, and the coefficient of friction between the tire and the ground. It should be noted, of course, that there is a relation between the moment of inertia, the free tire radius and the aircraft weight - in general the free tire radius and the moment of inertia will increase with aircraft weight. For any wheel and tire unit, it is shown that there are various combinations of landing speed and coefficient of friction which cause the wheel spinning up to just cease at the same instant as the maximum vertical wheel reaction is reached, and except for very gentle landings, the maximum value of μ required is usually much less than 1.0.

N-16340*

Aeronautical Research Council (Gt. Brit.)
THE SOLUTION BY LIFTING-LINE THEORY OF PROBLEMS INVOLVING DISCONTINUITIES.
V. M. Falkner. 1952. 23p. diagrs., 15 tabs. (ARC R & M 2592. Formerly ARC 10,922; S & C 2158; Perf. 366)

The report, which has been written as a preliminary to a later account of similar work in lifting-plane theory, describes how wing loading problems involving discontinuities are solved by lifting-line theory. The four discontinuities considered are (a) direction of leading or trailing edge, (b) incidence, (c) two-dimensional lift slope, and (d) chord. As the effects of the first are of minor importance in lifting-line theory, attention is mainly confined to the last three, the solution being based on the use of a few terms of a Fourier series in conjunction with special functions tabulated elsewhere. The work is limited to straight unyawed flight and includes lift, induced drag, and pitching, rolling, and yawing moments, all with or without deflected landing flaps and ailerons. The method of formation of the equations, and the solutions of a representative range of problems for a hypothetical wing, including loading due to incidence, symmetrical wing twist, uniform roll, and deflected flaps and ailerons, are fully described. An indication is given of how induced drag and yawing-moment calculations will later be simplified by the use of special derived functions. Absolute values of wing properties as given by lifting-line theory are usually too high, but the specification of correction factors for viscosity is beyond the scope of the report.

N-16341*

Aeronautical Research Council (Gt. Brit.)
CALCULATED LOADINGS DUE TO INCIDENCE OF A NUMBER OF STRAIGHT AND SWEPT-BACK WINGS. V. M. Falkner. WITH APPENDIX. Doris Lehrian. 1952. 43p. diagrs., 43 tabs. (ARC R & M 2596. Formerly ARC 11,542; Perf. 449; S & C 2223)

In this report are collected together the calculated aerodynamic loadings due to incidence of a number of straight and sweptback wings. The calculations follow in the main the routine described previously in another report, but include additions concerned with induced camber and induced drag. An additional investigation is made of the effect of the NACA camber on the properties at zero lift of a rectangular wing of aspect ratio 6. A table is given of loading functions for use in auxiliary solutions when the wing plan has a discontinuity of direction at an arbitrary position along the span.

N-16342 *

Aeronautical Research Council (Gt. Brit.)
ON THE DESIGN OF AEROFOILS FOR WHICH THE LIFT IS INDEPENDENT OF THE INCIDENCE. B. Thwaites. 1952. 17p. diagrs. (ARC R & M 2612. Formerly ARC 10,294; FM 1057; Perf. 280)

It has been shown in R & M 2611 how lift may be obtained on airfoils independently of the incidence. In this paper mathematical processes are set out of designing such airfoils to have specified velocity distributions at certain incidences and lift coefficients. Approximate and exact methods are given, corresponding to the methods employed in the design of ordinary airfoils. Several shapes are worked out, some of them being the product of ideas not given in R & M 2611. A full discussion of the characteristics of such airfoils is given.

N-16343*

Aeronautical Research Council (Gt. Brit.)
SPEEDS AND NORMAL ACCELERATIONS OF BOEING CLIPPER AIRCRAFT ON NORTH AND SOUTH ATLANTIC ROUTES. D. T. Jones. 1952. 14p. diagrs., 6 tabs. (ARC R & M 2633; ARC 11,640. Formerly RAE Structures 25)

This report presents results obtained from V-g recorders fitted to Boeing Clipper aircraft on the North and South Atlantic routes between September 1944 and May 1946. The records cover about 3,300 flying hours and show that the maximum speed recorded is 215 mph (I. A. S.) and the maximum upward and downward accelerations are 2.3g and -0.3g, respectively. The two main groups of records considered differ from one another not only in respect of route but also in seasonal conditions and in proportion of flights made in wartime. Therefore, differences between the results cannot be simply ascribed to differences of route. It appears from the analysis that the maximum speed likely to be attained in a large flying time is somewhat greater in one group (North Atlantic) than in the other (South Atlantic) and that the maximum accelerations on the other hand are likely to be less for the former than the latter.

N-16353 *

Aeronautical Research Council (Gt. Brit.)
THE MEASUREMENT OF YAWING MOMENT OF AN ELLIPTIC WING ON THE WHIRLING ARM. A. S. Halliday. August 2, 1949. 8p. diagrs. (ARC 12,497; S & C 2320)

The report describes tests on an elliptic wing on the Whirling Arm to determine the yawing moment due to a continuous rate of yaw. The results have been compared with a theoretical estimation and the agreement found to be satisfactory.

N-16355*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE CONDITION OF MATRICES. Olga Todd. September 6, 1949. 3p. (ARC 12,561; 0.833)

The object of this note is to establish the following theorem: let A be a real n x n nonsingular matrix and A' its transpose. Then AA' is more "ill-conditioned" than A. This result confirms an opinion expressed by Dr. L. Fox which he based on his practical experience. The term "condition of a matrix" has been used in vague senses. The most common measure of a matrix has been the size of its determinant: ill-conditioned matrices being those with small determinants. With this interpretation, the theorem is clearly correct. More adequate measures of the condition of a matrix have been proposed recently by John von Neumann and H. H. Goldstine and A. M. Turing.

N-16356*

Aeronautical Research Council (Gt. Brit.)
A NOTE ON THE DESIGN OF A HIGH-SPEED WIND TUNNEL DRIVEN BY STEAM. T. R. Cave-Browne-Cave. September 15, 1949. 5p. diagrs. (ARC 12,577; TP 292)

A steam-driven supersonic wind tunnel has been designed for, and is being built by, the University College in Southampton. It has a 6 inch by 2-1/2 inch working section and will operate at a Mach number of 1.4 for a period of 3 minutes. Since it takes about 5 minutes for the boiler to return to pressure, a 3 minute test could be made every 8 minutes with this set-up. Because the boiler is already available at the school, this design permits a substantial saving in time and money. Another advantage will be the comparative lack of noise as compared with a drive using a compressor.

N-16459 *

Royal Aircraft Establishment (Gt. Brit.)
THE RHEOLOGY OF LUBRICANT FILMS. PART 2. E. Bielak and E. W. J. Mardles. February 1952. 27p. diagrs. (RAE Chem. 480)

This report presents further results on the rheological properties of thin lubricant films (including greases) moving between surfaces, with special regard to the influence of the material of the surfaces on the rate of flow. The limitation of Amontons' law to pressures above 100 g/sq cm for lubricants is described in relation to the phenomenon of the "wringing" together or "striction" of surfaces at light pressures, especially with indifferent lubricants, when film rupture occurs early during the thinning of the film. The latent period, observed and first described by Hardy, during which friction changes occur has been measured for several lubricants at low pressures. Explanations of hydraulic "striction" and the "latent period" are suggested.

MISCELLANEOUS

NACA TN 2310

Errata No. 1 on "GENERALIZATION OF BOUNDARY-LAYER MOMENTUM-INTEGRAL EQUATIONS TO THREE-DIMENSIONAL FLOWS INCLUDING THOSE OF ROTATING SYSTEM". Artur Mager. March 1951.

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1040

SPECTRA AND DIFFUSION IN A ROUND TURBULENT JET. Stanley Corrsin and Mahinder S. Uberoi. 1951. ii, 21p. diagrs., photos. (NACA Rept. 1040. Formerly TN 2124)

In a round turbulent jet at room temperature, measurement of the shear correlation coefficient as a function of frequency (through band-pass filters) has given a rather direct verification of Kolmogroff's local-isotropy hypothesis. One-dimensional power spectra of velocity and temperature fluctuations, measured in unheated and heated jets, respectively, have been contrasted. Under the same conditions, the two corresponding transverse correlation functions have been measured and compared. Measurements have been made of the mean thermal wakes behind local (line) heat sources in the unheated turbulent jet, and the order of magnitude of the temperature fluctuations has been determined.

NACA Rept. 1048

A STUDY OF EFFECTS OF VISCOSITY ON FLOW OVER SLENDER INCLINED BODIES OF REVOLUTION. H. Julian Allen and Edward W. Perkins. 1951. ii, 13p. diagrs., photos. (NACA Rept. 1048. Formerly TN 2044)

The observed flow field about slender inclined bodies of revolution is compared with the calculated characteristics based upon potential theory. The comparison is instructive in indicating the manner in which the effects of viscosity are manifest. Based on this and other studies, a method is developed to allow for viscous effects on the force and moment characteristics of bodies. The calculated force and moment characteristics of two bodies of high fineness ratio are shown to be in good agreement, for most engineering purposes, with experiment.

NACA Rept. 1051

AN ANALYSIS OF BASE PRESSURE AT SUPERSONIC VELOCITIES AND COMPARISON WITH EXPERIMENT. Dean R. Chapman. 1951. ii, 23p. diagrs., photos. (NACA Rept. 1051. Formerly TN 2137)

The pressure on the base of an object travelling at supersonic velocity is investigated for both two-dimensional and axially-symmetric bodies. Inviscid-fluid flow is analyzed first and the result obtained that a strictly inviscid-fluid theory is not satisfactory. An approximate semiempirical theory for the base-pressure flow in a viscous fluid is then developed from a correlation of certain experiment data.

NACA Rept. 1055

COMPARISON OF THEORETICAL AND EXPERIMENTAL HEAT-TRANSFER CHARACTERISTICS OF BODIES OF REVOLUTION AT SUPERSONIC SPEEDS. Richard Scherrer. 1951. ii, 15p. diagrs., photo. (NACA Rept. 1055. Formerly RM A8L28; TN 1975; TN 2087; TN 2131; TN 2148)

An investigation of the three important factors that determine convective heat-transfer characteristics at supersonic speeds, location of boundary-layer transition, recovery factor, and heat-transfer parameter has been performed at Mach numbers from 1.49 to 2.18. The bodies of revolution that were tested had, in most cases, laminar boundary layers, and the test results have been compared with available theory. Boundary-layer transition was found to be affected by heat transfer. Adding heat to a laminar boundary layer caused transition to move forward on the test body, while removing heat caused transition to move rearward. These experimental results and the implications of boundary-layer-stability theory are in qualitative agreement. Theoretical and experimental values of the recovery factor, based on the local Mach number just outside the boundary layer, were found to be in good agreement for both laminar and turbulent boundary layers on both of the body shapes that were investigated. In general, values of the heat-transfer parameter (Nusselt number divided by the square root of the Reynolds number) as determined for both heated and cooled cones with uniform and nonuniform surface temperatures, were in good agreement with theory. It was also found that the theory for cones could be used to predict the values of heat-transfer parameter for a pointed body of revolution with large negative pressure gradients with good accuracy.

NACA TN 2747

CHARTS AND APPROXIMATE FORMULAS FOR THE ESTIMATION OF AEROELASTIC EFFECTS ON THE LATERAL CONTROL OF SWEPT AND UNSWEPT WINGS. Kenneth A. Foss and Franklin W. Diederich. July 1952. 70p. diagrs., 2 tabs. (NACA TN 2747)

Charts and approximate formulas are presented for the estimation of static aeroelastic effects on the spanwise lift distribution, rolling-moment coeffi-

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cient, and rate of roll due to aileron deflections on swept and unswept wings at subsonic and supersonic speeds. Some design considerations brought out by the results of this paper are discussed.

NACA TN 2751

A SIMPLE APPROXIMATE METHOD FOR CALCULATING SPANWISE LIFT DISTRIBUTIONS AND AERODYNAMIC INFLUENCE COEFFICIENTS AT SUBSONIC SPEEDS. Franklin W. Diederich. August 1952. 63p. diagrs., tab. (NACA TN 2751)

Several approximate methods for calculating lift distributions at subsonic speeds are combined and extended to form a simple step-by-step procedure for calculating symmetric and antisymmetric lift distributions on swept and unswept wings. The extension of the method to the calculation of aerodynamic influence coefficients and of spanwise moment distributions is indicated.

NACA TN 2752

A STUDY OF THE STABILITY OF THE LAMINAR BOUNDARY LAYER AS AFFECTED BY CHANGES IN THE BOUNDARY-LAYER THICKNESS IN REGIONS OF PRESSURE GRADIENT AND FLOW THROUGH THE SURFACE. Neal Tetervin and David A. Levine. August 1952. 83p. diagrs., tab. (NACA TN 2752)

Calculations made by the Schlichting method for the computation of laminar-boundary-layer velocity profiles and the Lin method for the computation of their critical Reynolds numbers demonstrate that in a region of falling pressure on an impervious surface an increase in boundary-layer thickness can cause the velocity profile shape to be changed enough by the increase in effective pressure gradient so that the ratio of the local critical Reynolds number to the local boundary-layer Reynolds number is increased. Similar effects occur when there is flow through the surface; in this case the effects depend on the effective flow through the surface as well as on the effective pressure gradient. These calculations suggest that the disturbing effect of roughness particles can be decreased by a sufficient increase in boundary-layer thickness without a decrease in stability.

NACA TN 2753

EFFECTS OF MACH NUMBER VARIATION BETWEEN 0.07 AND 0.34 AND REYNOLDS NUMBER VARIATION BETWEEN 0.97×10^6 AND 8.10×10^6 ON THE MAXIMUM LIFT COEFFICIENT OF A WING OF NACA 64-210 AIRFOIL SECTIONS. James E. Fitzpatrick and William C. Schneider. August 1952. 34p. diagrs., photos., tab. (NACA TN 2753)

The effects of Mach number and Reynolds number on the maximum lift coefficient of a wing of NACA 64-210 airfoil sections are presented. The wing was tested with and without partial-span and full-span split flaps deflected 60°. Peak maximum lift coefficients were measured at Mach numbers between 0.12 and 0.20, depending on the Reynolds number range and flap configuration.

NACA TN 2755

ANALYSIS OF LANDING-GEAR BEHAVIOR. Benjamin Milwitzky and Francis E. Cook. August 1952. 98p. diagrs., photo., 3 tabs. (NACA TN 2755)

The behavior of the conventional oleo-pneumatic landing gear during impact is analyzed. The applicability of the analysis to actual landing gears is established by comparing calculated results with drop-test data. In addition to the more exact treatment, studies are made to determine the effects of variations in such parameters as the force-deflection characteristics of the tire, the orifice discharge coefficient, and the polytropic exponent for the air-compression process in the shock strut, which may not be known accurately in practical design problems. An investigation is also made to determine the extent to which representation of the system can be simplified and still yield useful results. Generalized solutions for the behavior of a simplified system, which may be useful in preliminary design, are presented for a wide range of landing-gear and impact parameters.

NACA TN 2756

NOISE FROM INTERMITTENT JET ENGINES AND STEADY-FLOW JET ENGINES WITH ROUGH BURNING. Leslie W. Lassiter. August 1952. 21p. diagrs. (NACA TN 2756)

Sound measurements were made on a pulse jet and a subsonic ram jet of the types used for helicopter rotor propulsion and on a turbojet with afterburner. The pulse jet was found to produce a discrete frequency spectrum in which the component corresponding to the engine firing frequency was generally predominant. An analysis of pulse jet noise, based on resonant-tube theory, is presented. The analysis allows a reasonable estimate of the noise level, if certain of the flow parameters of the engine are known. The small subsonic ram jet and the turbojet afterburner unit were found to produce discrete frequency spectrums somewhat similar to that of the pulse jet.

NACA TN 2757

EXPERIMENTAL STUDIES OF NOISE FROM SUBSONIC JETS IN STILL AIR. Leslie W. Lassiter and Harvey H. Hubbard. August 1952. 35p. diagrs., photos., tab. (NACA TN 2757)

Experimental studies have been made of the noise from a series of model subsonic jets ranging in diameter from 0.75 to 12.0 inches and the results are compared with data obtained for a turbojet engine. The effects of such parameters as jet size, exit gas

velocity, density, and turbulence level on the noise generated in the mixing region of a jet are evaluated. The velocity and turbulence level were found to have the greatest effect on the noise intensities and the frequency content was found to be a function of jet size and the observer's location. The noise generated by the turbojet engine was found to be closely related to that generated by simple model jets and an empirical relation is given to allow the extrapolation of available jet-noise data to other operating conditions.

NACA TN 2758

WEAR AND SLIDING FRICTION PROPERTIES OF NICKEL ALLOYS SUITED FOR CAGES OF HIGH-TEMPERATURE ROLLING-CONTACT BEARINGS. I - ALLOYS RETAINING MECHANICAL PROPERTIES TO 600° F. Robert L. Johnson, Max A. Swikert and Edmond E. Bisson. August 1952. 30p. diagrs., photos., 3 tabs. (NACA TN 2758)

Wear and sliding friction properties of a number of nickel alloys operating against hardened SAE 52100 steel were studied. These alloys include "L" nickel, wrought monel, cast monel, cast modified "H" monel, cast "S" monel, Invar, Ni-Resist 3, and Nichrome V. Some of the alloys studied may be useful as possible cage material for high-temperature, high-speed bearings for aircraft turbines or for bearings to operate in corrosive media. Desirable operating properties of all the materials could be associated with the development on the rider surface of a naturally formed film of nickel oxide. On the basis of wear and friction properties, Ni-Resist 3, modified "H" monel, and Invar were the best materials studied in this investigation although they did not perform as well as nodular iron. "L" nickel performed well with light loads but was not effective at higher loads when the surface film broke down.

NACA TN 2759

WEAR AND SLIDING FRICTION PROPERTIES OF NICKEL ALLOYS SUITED FOR CAGES OF HIGH-TEMPERATURE ROLLING-CONTACT BEARINGS. II - ALLOYS RETAINING MECHANICAL PROPERTIES ABOVE 600° F. Robert L. Johnson, Max A. Swikert and Edmond E. Bisson. August 1952. 29p. diagrs., photos., 3 tabs. (NACA TN 2759)

Wear and sliding friction properties of a number of nickel alloys operating against hardened SAE 52100 steel were studied. The alloys were cast beryllium nickel, heat-treated beryllium nickel, cast Inconel, Nimonic 80, Inconel X, Refractalloy 26, and Discaloy. Some of the alloys studied may be useful as material for cages of rolling-contact bearings that operate at high speeds with temperatures above 600° F in projected aircraft turbine engines or for bearings that operate in corrosive mediums. Desirable operating properties and the absence of extreme mass welding of all the materials studied could be associated with the development of the sliding surfaces of a naturally formed film of nickel oxide. On the basis of wear and friction properties, cast Inconel performed very well in these experiments and compares favorably with nodular iron. Nimonic 80 also showed promise as a possible cage material.

NACA TN 2760

DERIVATION OF STABILITY CRITERIONS FOR BOX BEAMS WITH LONGITUDINALLY STIFFENED COVERS CONNECTED BY POSTS. Paul Seide. August 1952. 21p. diagr. (NACA TN 2760)

An investigation has been made of the elastic stability of an idealized box beam with longitudinally stiffened covers connected by posts and subjected to end moments and axial loads. Stability criterions which give the axial stiffness of the posts required to achieve desired stress values in the box-beam covers are derived.

NACA TN 2761

INSTRUMENT-FLIGHT RESULTS OBTAINED WITH A COMBINED-SIGNAL FLIGHT INDICATOR MODIFIED FOR HELICOPTER USE. Almer D. Crim, John P. Reeder and James B. Whitten. August 1952. 13p. diagrs., photos. (NACA TN 2761)

A flight indicator which combines heading, altitude, bank-angle, and pitch-attitude information was modified for helicopter use and evaluated by means of instrument flights in a single-rotor helicopter. The modifications consisted of adding fuselage-rate-of-pitch signals to the instrument and increasing the ratio between heading and bank signals. The combined signal flight indicator enables the pilot to maintain more precise control of heading, altitude, and airspeed and required less concentration than with conventional instruments.

NACA TN 2764

ACCURACY OF APPROXIMATE METHODS FOR PREDICTING PRESSURES ON POINTED NONLIFTING BODIES OF REVOLUTION IN SUPERSONIC FLOW. Dorris M. Ehret. August 1952. 26p. diagrs. (NACA TN 2764)

The accuracy and range of applicability of the linearized theory, second-order theory, tangent-cone method, conical-shock-expansion theory, and Newtonian theory for predicting pressure distributions on pointed bodies of revolution at zero angle of attack are investigated. Various body shapes are included in the investigation and a wide range of supersonic Mach numbers and fineness ratios is included. It is found that, for most combinations of Mach number and fineness ratio, one of the approximate methods will give pressure drag within 10 percent.

NACA TN 2767

DYNAMICS OF MECHANICAL FEEDBACK-TYPE HYDRAULIC SERVOMOTORS UNDER INERTIA LOADS. Harold Gold, Edward W. Otto and Victor L. Ransom. August 1952. 63p. diagrs., photos. (NACA TN 2767)

An analysis of the dynamics of mechanical feedback-type hydraulic servomotors under inertia loads is developed and experimental verification is presented.

This analysis, which is developed in terms of two physical parameters, yields direct expressions for the following dynamic responses: (1) the transient response to a step input and the maximum cylinder pressure during the transient and (2) the variation of amplitude attenuation and phase shift with the frequency of a sinusoidally varying input. Close agreement was obtained between analytically determined responses and measured responses.

NACA TN 2768

SUPERSONIC FLOW WITH WHIRL AND VORTICITY IN AXISYMMETRIC CHANNELS. Ralph J. Eschborn. August 1952. 41p. diagrs. (NACA TN 2768)

Axially symmetric supersonic steady flow with vorticity and rotation about the axis is treated by the method of characteristics. Several cases are calculated for flow in annular channels.

NACA RM E52F05

ANALYSIS OF FULLY DEVELOPED TURBULENT HEAT TRANSFER AT LOW PECLET NUMBERS IN SMOOTH TUBES WITH APPLICATION TO LIQUID METALS. Robert G. Deissler. August 1952. 20p. diagrs. (NACA RM E52F05)

An analysis was made of heat transfer at low Peclet numbers for fluids flowing turbulently in smooth tubes. Previous analyses for flow of gases and liquid metals at low Peclet numbers gave higher heat-transfer coefficients than were indicated experimentally. When the mixing-length theory was modified in order to account for the heat transferred by conduction to a turbulent particle as it moves transversely, the predicted results were brought into agreement with the experimental results.

NACA RM E52F27

MINIMUM IGNITION ENERGIES OF SIX PURE HYDROCARBON FUELS OF THE C_2 AND C_6 SERIES. Allen J. Metzler. August 1952. 22p. diagrs., 3 tabs. (NACA RM E52F27)

Minimum spark-ignition energies at reduced pressures are reported for ethane, ethylene, acetylene, n-hexane, cyclohexane, and benzene; and the mean energy-pressure dependence is established to be $E \propto 1/P^{1.76}$. Minimum ignition energies E at 1 atmosphere predicted by this relation for these fuels correlate with the maximum fundamental flame velocity U_{max} and may be expressed approximately as $U_{max} \propto 1/E^{0.8}$. Such interdependence of the minimum ignition energy and maximum fundamental flame velocity permits a reasonable estimation of either from the other with an accuracy sufficient to discern large differences in various pure fuels.

BRITISH REPORTS

N-16746*

Royal Aircraft Establishment (Gt. Brit.)
THE FATIGUE SITUATION FOR CIVIL AIRCRAFT. P. B. Walker. May 1952. 4p. (RAE Structures 129)

This report is a reproduction for official use of a paper published in "The Aeroplane" for 25th April, 1952. The fatigue situation is reviewed briefly by eliminating all issues that appear to be secondary. There are found to be two main objectives: (a) to prevent fatigue accidents and (b) to obtain a long fatigue life. These are related to the broad technical picture which is also reviewed briefly. The conclusion reached is that the second objective is the more difficult to achieve.

N-16747*

Royal Aircraft Establishment (Gt. Brit.)
FLASH WELDING OF HIGH TENSILE STEEL TUBES - TEMPERATURE MEASUREMENTS. H. Brooks. December 1951. 28p. diagrs., photo., 6 tabs. (RAE Tech. Note Met. 153)

Measurements have been made to determine the effects of process variables on the temperatures produced in high tensile alloy steel tubes by the flashing phase of the welding cycle. The most important effects are those of flashing distance and speed. Initially, increases of flashing distance cause large temperature rises, but the effect diminishes as steady thermal conditions are approached. The steepness of the steady-state thermal gradients depends on the flashing speed, high speeds giving steep gradients. The effect is also apparent for nonsteady conditions if the gradients produced by different flashing speeds are compared on the basis of equal flashing distances. Average interface temperatures approximating to the steel melting point can only be attained at flashing speeds of about 1.0 in/min and higher. Machine secondary voltage was found to have a small inverted effect, higher temperatures being obtained with low voltages than with high. Within the range investigated, the effect of final die opening was negligible. Each particular set of flashing conditions produces very similar temperatures in tubes of different compositions and sizes.

N-16748*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) THE LOW SPEED PERFORMANCE OF A HELICOPTER. A. L. Oliver. May 15, 1952. 12p. diagrs. (AAEE Rept. A.A.E.E./Res/264)

The analysis and estimation of helicopter performance is dependent upon the accurate assessment of rotor induced velocity. An empirical curve relating the flow through the rotor to the flight speed is used for vertical flight and the momentum theory is sufficiently accurate for a tip speed ratio greater than

about 0.1, but no simple method has been generally available for the intermediary speed range. Sets of empirical curves covering this speed range and based on the analysis of low speed flight performance are given in this report. The charts give values of the rotor induced velocity varying smoothly from the verical flight state to the forward flight region in which the momentum theory becomes accurate. The charts are presented in forms suitable for determining steady flight performance and also for estimating rotor thrust during accelerated motion in, for example, take-off flight.

N-16754*

Royal Aircraft Establishment (Gt. Brit.)
A DEAD WEIGHT CALIBRATOR CAPABLE OF MEASURING PRESSURES GREATER OR LESS THAN ATMOSPHERIC FROM A VARIABLE DATUM PRESSURE. K. R. Honick and F. Solari. February 1952. 9p. diagrs., photo. (RAE Tech. Note IAP 1010)

A dead weight calibrator is described which is capable of measuring pressures both greater and less than atmospheric above or below a variable datum pressure. Possible applications to the service testing of airspeed indicators, Mach meters, and altimeters are discussed.

N-16760*

Royal Aircraft Establishment (Gt. Brit.)
THE DETERMINATION OF SKIN TEMPERATURES ATTAINED IN HIGH SPEED FLIGHT. F. V. Davies and R. J. Monaghan. February 1952. 65p. diagrs., 7 tabs. (RAE Aero 2454)

This report discusses the factors affecting skin temperatures attained by high-speed missiles and presents some methods of solution. These have been reduced to graphical or tabular form and are set out in order of complexity. Graphical or algebraic solutions may be quickly obtained if steady conditions are assumed, and for some flight cases these are reasonable approximations to corresponding transient solutions. If the temperature time variation is required, then longer numerical integration processes have to be performed. Account may be taken of external radiation and heat loss to the interior if their effects are considered significant. Although the emphasis of this report is on the calculation of average temperatures attained by thin skins, a method of calculating the temperature-space-time variation through three-dimensional bodies has been included assuming steady conditions at the surface. Numerical examples are included for each section of the report.

N-16787*

Aeronautical Research Council (Gt. Brit.)
EXPERIMENTS ON DISTRIBUTED SUCTION THROUGH A ROUGH POROUS SURFACE. Cambridge University Aeronautical Laboratory. 1952. 7p. diagrs. (ARC CP 84)

Flight tests in which suction was applied through a slightly rough porous surface to maintain laminar flow in the boundary layer have shown that when the pressure on the surface was uniform there was an upper limit to the airspeed outside the layer above which no reasonable suction would prevent transition to turbulence. Comparison between these and similar tests on a smoother surface suggest that there will be, associated with every porous surface, two limiting speeds, one above which no reasonable suction will maintain laminar flow and one below which the surface can be regarded as aerodynamically smooth. Consideration is given to the way in which these speeds will vary with the kinematic viscosity of the air, in conditions which lead to dynamical similarity.

N-16788*

Aeronautical Research Council (Gt. Brit.)
A BRIEF SURVEY OF SOME METHODS AND INFORMATION CONCERNING THE AERODYNAMIC DERIVATIVES OF WINGS IN UNSTEADY MOTION AT TRANSONIC AND SUPERSONIC SPEEDS. W. E. A. Acum. 1952. 17p. diagrs., tab. (ARC CP 85)

Reviews, briefly, present theories concerning the problem of the oscillating wing in supersonic flow and the methods by which it is handled. Includes discussions of two- and three-dimensional wings and of wings of various plan forms. It discusses not only simple-harmonic or continuous motions but discusses sudden motions as when a sharp edged gust is encountered. There is a bibliography.

N-16789*

Aeronautical Research Council (Gt. Brit.)
PRESSURE AND BOUNDARY LAYER MEASUREMENTS ON A 59° SWEPTBACK WING AT LOW SPEED AND COMPARISON WITH HIGH SPEED RESULTS ON A 45° SWEPT WING. PARTS I & II. Tunnel Staff of Aero Department & G. G. Brebner. 1952. 62p. diagrs., 19 tabs. (ARC CP 86)

The low speed pressure distributions has been measured over a range of incidence on a 59° swept wing of symmetrical section t/c 14 percent, aspect ratio 3.61, and taper ratio 4 to 1. These results have been compared, using the linear perturbation theory, with those on a 45° swept wing aspect ratio 5.87 at $M = 0.8$. There is fairly good agreement at zero incidence but lift distribution does not appear to be predicted so well. The results on the 59° wing show clearly the large effects of sweepback on both the pressure distribution at zero incidence and the lift distribution near the center section of the wing. Comparisons with theoretical estimates at zero incidence show good agreement.

N-16790*

Aeronautical Research Council (Gt. Brit.)
STRUCTURAL ASPECTS OF SUCTION WINGS. E. H. Mansfield. 1952. 24p. diagrs. (ARC CP 87)

This report considers the structural design problems arising directly from the use of distributed wing suction. Possible types of construction are discussed and estimates are made of the increase in aircraft all up weight due to these constructions and due to the extra power required for suction.

N-16791*

Aeronautical Research Council (Gt. Brit.)
FATIGUE TESTS ON TYPICAL TWO SPAR LIGHT ALLOY STRUCTURES (METEOR 4 TAILPLANES) UNDER REVERSED LOADING. K. D. Raithby. 1952. 24p. diagrs., photos., 3 tabs. (ARC CP 88)

Results are given for fatigue tests on six Meteor 4 tail planes vibrated in flexure under simple reversed loading, ranging from ±10 percent to ±30 percent of the static failing load. Corresponding endurances varied from about 5×10^6 to 0.06×10^6 cycles, for complete failure of a spar boom. In each test, the alternating load was kept constant, although progressive skin cracking caused a considerable change in alternating stress at the section where eventual failure of the spar boom occurred. The test results are discussed in relation to the establishment of endurance curves for a typical two-spar structure.

N-16792*

Aeronautical Research Council (Gt. Brit.)
NOTES AND GRAPHS FOR BOUNDARY LAYER CALCULATIONS IN COMPRESSIBLE FLOW. W. F. Cope. 1952. 22p. diagrs. (ARC CP 89)

Formulas are given for calculating the skin-friction coefficients and the various parameters associated with the boundary layer up to Mach numbers of 4. The calculations have been made for a laminar boundary layer with a sinusoidal velocity distribution; for a turbulent boundary layer with a "power law" velocity distribution, the distribution following "one-fifth," "one-seventh," "one-ninth," and "one-eleventh" power laws; and for a turbulent boundary layer with a "log law" velocity distribution.

N-16842*

Royal Aircraft Establishment (Gt. Brit.)
CORROSION AND FATIGUE TESTS ON MAGNESIUM ALLOYS TREATED BY A FRENCH GALVANIC PROCESS. H. G. Cole. February 1952. 13p. diagrs., 4 tabs. (RAE Tech.Note Met.156)

The Frasch galvanic process carried out in a solution of zinc dichromate containing a small amount of free chromic acid (Example I of B.P. Application 22986/46) gave good protection to three types of magnesium alloy and provided an excellent base for paint. Neither the Frasch galvanic process nor the RAE electrolytic chromate treatment caused any significant reduction of fatigue strength of magnesium alloy extruded bar to D.T.D.259. Chromate treatment in the RAE hot half hour bath caused an increase in fatigue strength.

N-16843*

Royal Aircraft Establishment (Gt. Brit.)
MEASUREMENT OF MAXIMUM LIFT COEFFICIENT OF AN AIRCRAFT WITH FLAPS AND LEADING EDGE SLATS (PRESTWICK PIONEER VL.516). R. Maine. January 1952. 14p. diagrs., 3 tabs. (RAE Tech.Note Aero 2143)

This note describes flight measurements of maximum lift coefficients with various combinations of flaps and slats. The maximum lift coefficient with flaps fully down and slats open was originally only 2.41 but this was increased to 2.71 by sealing some handholds in the wing leading edge. The measured increments in maximum lift coefficient due to the flaps and slats are compared with estimated values.

MISCELLANEOUS

NACA Rept. 1055

Errata No. 1 on "COMPARISON OF THEORETICAL AND EXPERIMENTAL HEAT TRANSFER CHARACTERISTICS OF BODIES OF REVOLUTION AT SUPERSONIC SPEEDS". Richard Scherrer. 1951.

UNPUBLISHED PAPERS

N-9717*

Calif. Inst. of Tech. Guggenheim Aeronautical Lab.
INVESTIGATION OF DIRECT AND ALTERNATING CURRENT GLOW ANEMOMETERS. A. J. A. Morgan and T. Vrebalovich. August 1950. ii, 49p. diagrs., photos. (Calif. Inst. of Tech. Guggenheim Aeronautical Lab.)

The glow anemometer is particularly suited for the measurement of turbulence in applications for which the hot-wire is unsuitable as in supersonic flow. The experimental work, so far, has been directed towards the perfection of a workable instrument with the desired characteristics. A résumé of this work is given in the present report and divides itself naturally into direct-, intermittent-, and alternating-glow studies.

N-12000*

Johns Hopkins U.
ASYMPTOTIC EXPANSION OF THE WHITTAKER'S FUNCTION $W_{k,m}(z)$ FOR LARGE VALUES OF k, m, z. Chieh-Chien Chang, Boa-Teh Chu and Vivian O'Brien. September 1951. i, 54p. diagrs. (Johns Hopkins U.)

This problem of behavior, although mathematical in nature, arises in approximating to the third order the hodograph solution of transonic flow as shown in a previous report of the senior author. Debye's method of steepest descent has been applied, with Langer's method used as a check and comparison. Subsonic, sonic and supersonic flows have been investigated.

Some numerical examples of the asymptotic solutions have been caluclated for comparison with exact values. The subsonic and sonic cases seem to check reasonably well even for fairly small eigenvalues; the supersonic case does not check nearly so well for moderate n.

N-12131*

ON THE ADDITIONAL LIFT CAUSED BY A COMPRESSION SHOCK. (Uber den durch einen Verdichtungsstoss verursachten Zusatzauftrieb). H. B. Helmbold. February 1952. 17p. diagrs. (Trans. from Ingenieur-Archiv, v. 17, 1949, pp. 280-287).

The additional lift of the compression may be calculated by interpreting the shock as a compression sink with which a system of spatially distributed expansion sources of opposite-equal total strength is connected. The lift-reducing influence of the expansion sources may be determined in the first approximation according to the streamline analogy.

N-12764*

ON THE PROBLEM OF ROLLING-IMPACT STRESS OF AIRPLANE LANDING GEARS. (Zur Frage der Rollstossbeanspruchung von Flugzeugfahrwerken). K. Schlaefke. May 1952. 25p. diagrs. (Trans. from Aerodynamische Versuchsanstalt Gottingen E. V., Technische Berichte, v. 11, no. 9, 1944, pp. 289-296).

In connection with a previous article on landing impact, this article deals with the behavior of airplane landing gears while rolling over ground obstacles. After a brief survey of past reports, the differential equation of the oscillation process is set up and generally solved. Subsequently, the numerical calculation is carried out far enough so that a number of questions about appropriate improvement of landing gears can be answered.

N-12823*

Washington U., Seattle. Aeronautical Lab.
AN APPROACH TO THE PROBLEM OF DEVELOPING FUNCTIONS SATISFYING BOUNDARY CONDITIONS OF PLATE THEORY. Harold C. Martin. 1951. 19p. diagrs. (Washington U., Seattle. Aeronautical Lab.)

An approach is made to the problem of selecting functions satisfying certain boundary conditions appearing in the theory of thin elastic plates. The problems used for illustrating the suggested method are: (1) stress function for the middle plane stresses of the clamped rectangular plate (large deflections), and (2) deflection function for the uniform cantilever plate (small deflections).

National Advisory Committee for Aeronautics

Research Abstracts

NO.29 **SEPTEMBER 16, 1952**

CURRENT NACA REPORTS

NACA Rept. 1028

EFFECT OF ASPECT RATIO ON THE AIR FORCES AND MOMENTS OF HARMONICALLY OSCILLATING THIN RECTANGULAR WINGS IN SUPERSONIC POTENTIAL FLOW. Charles E. Watkins. 1951. 17p. diagrs. (NACA Rept. 1028. Formerly NACA TN 2064)

The linearized velocity potential for a thin, flat, rectangular wing undergoing sinusoidal torsional oscillations simultaneously with sinusoidal vertical translations in a supersonic stream is derived in the form of an infinite series in terms of a frequency parameter. Simple closed expressions that include the reduced frequency to the third power are given for the velocity potential, components of total force and moment coefficients, and components of section force and moment coefficients. It is found that the components of force and moment coefficients for small-aspect-ratio wings may deviate considerably from those for an infinite-aspect-ratio wing. The method of solution can be utilized for other plan forms, that is plan forms for which steady-state solutions are known.

NACA Rept. 1053

INVESTIGATION OF TURBULENT FLOW IN A TWO-DIMENSIONAL CHANNEL. John Laufer, California Institute of Technology. 1951. 20p. diagrs., photos. (NACA Rept. 1053. Formerly TN 2123)

A detailed exploration of the turbulent flow characteristics in a two-dimensional channel is presented. The measurements were made at three Reynolds numbers, 12,300, 30,800, and 61,600, based on the half width of the channel and the maximum mean velocity. A channel of 5-inch width and 12:1 aspect ratio was used for the investigation.

NACA TN 2748

ON TRANSONIC FLOW PAST A WAVE-SHAPED WALL. Carl Kaplan. August 1952. 43p. diagrs. (NACA TN 2748)

The simplified nonlinear differential equation for transonic flow past a wavy wall is solved by the method of integration in series. A general procedure for the solution of the resulting recurrence formulas is shown and illustrated by a number of examples. A numerical test of convergence is applied to a key power series in k, the transonic similarity parameter, and leads to the conclusion that smooth symmetrical potential flow past the wavy wall is no longer possible when the critical value of the stream Mach number is exceeded.

NACA TN 2749

ANALYSIS OF FLOW IN A SUBSONIC MIXED-FLOW IMPELLER. Chung-Hua Wu, Curtis A. Brown and Eleanor L. Costilow. August 1952. 38p. diagrs. (NACA TN 2749)

A method recently developed for determining the steady flow of a nonviscous compressible fluid along a relative stream surface extending from hub to casing between two adjacent blades in a turbomachine is applied to investigate the through flow of air in an experimental mixed-flow impeller of high solidity. The shape of the stream surface is taken to be the same as that of the mean camber surface of the blade which consists of all radial elements. The principal equation governing the through flow is solved by the relaxation method with the use of fourth-degree differentiation formulas for unequally spaced grid points caused by the varying hub and casing wall radii.

A detailed analysis is made of both incompressible and compressible flow through the impeller, and contour plots of the stream function, velocity components, total enthalpy, static pressure, and Mach number are presented and discussed.

NACA TN 2762

AERODYNAMIC CHARACTERISTICS OF THREE DEEP-STEP PLANING-TAIL FLYING-BOAT HULLS AND A TRANSVERSE-STEP HULL WITH EXTENDED AFTERBODY. John M. Riebe and Rodger L. Naeseth. August 1952. diagrs., photos., 5 tabs. (NACA TN 2762. Formerly RM L8I27)

An investigation was made to determine the aerodynamic characteristics of three deep-step (92 percent of beam) planing-tail flying-boat hulls differing only in the amount of step fairing and of a transverse-step hull with extended afterbody. Minimum drag coefficients, which include the interference effects of the support wing, were 0.0066 for the transverse-step hull - about the same as for a conventional hull - and

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0.0057 or 14 percent less for the hull with a deep unfaired step. The hulls with step fairing had up to 44 percent less drag. Longitudinal and lateral stability was about the same as for a conventional hull.

NACA TN 2763

GUST-RESPONSE ANALYSIS OF AN AIRPLANE INCLUDING WING BENDING FLEXIBILITY. John C. Houbolt and Eldon E. Kordes. August 1952. 48p. diagrs., 3 tabs. (NACA TN 2763)

An analysis is made of the gust response (including bending moment) of an airplane having the degrees of freedom of vertical motion and wing bending flexibility and basic parameters are established. A convenient numerical solution of the response equations, well-suited for trend studies, is developed and used in an example. A method is indicated for determining the gust causing a known response and a procedure is given for determining the response of an airplane directly from the known response of another airplane.

NACA TN 2766

SOME EFFECTS OF AMPLITUDE AND FREQUENCY ON THE AERODYNAMIC DAMPING OF A MODEL OSCILLATING CONTINUOUSLY IN YAW. Lewis R. Fisher and Walter D. Wolhart. September 1952. 24p. diagrs., photo. (NACA TN 2766)

A fuselage—vertical-tail combination was oscillated in yaw through a range of amplitudes from $1/2^{\circ}$ to 4° and a low range of the reduced-frequency parameter. The phase angles between the tail force and the displacement were measured and converted to values of the damping in yaw which are compared with the damping predicted by the unsteady-lift theories and with the experimental steady-state damping value. These tests were conducted at a Reynolds number of 442,000.

NACA TN 2769

EXPERIMENTAL AND THEORETICAL DETERMINATION OF THERMAL STRESSES IN A FLAT PLATE. Richard R. Heldenfels and William M. Roberts. August 1952. 35p. diagrs., photo. (NACA TN 2769)

Thermal stresses induced in a flat, rectangular, 75S-T6 aluminum-alloy plate by nonuniform heating are determined both experimentally and theoretically. The characteristics of commercially available bonded resistance wire strain gages are first investigated to determine their suitability for measuring stresses under simple conditions of stress and temperature. The gages are then used to measure thermal stresses in the flat plate in order to study their suitability under more complicated conditions. The experimental results are found to be in satisfactory agreement (within ±5 percent of maximum calculated stress) with an approximate theoretical solution of the problem.

NACA TN 2770

STUDY OF THE PRESSURE RISE ACROSS SHOCK WAVES REQUIRED TO SEPARATE LAMINAR AND TURBULENT BOUNDARY LAYERS. Coleman duP. Donaldson and Roy H. Lange. September 1952. 20p. diagrs., photos., tab. (NACA TN 2770. Formerly RM L52C21)

Results are presented of a dimensional study and an experimental investigation of the pressure rise across a shock wave which causes separation of the boundary layer on a flat plate. The experimental part of the investigation was conducted at a Mach number of 3.03 for a Reynolds number range of 2×10^6 to 19×10^6. The available experimental data are compared with the predictions of the present study, and the significance of the results obtained is discussed relative to certain practical design problems.

NACA TN 2771

THERMAL BUCKLING OF PLATES. Myron L. Gossard, Paul Seide, and William M. Roberts. August 1952. 39p. diagrs. (NACA TN 2771)

An approximate method, based on large-deflection plate theory, for calculating the deflections of flat or initially imperfect plates subject to thermal buckling is outlined. The method is used to determine the deflections of a simply supported panel subjected to a tentlike temperature distribution over the plate surface. Experimental results for a particular panel are in good agreement with the theoretical results considered in the test.

NACA TN 2772

DRIVING STANDING WAVES BY HEAT ADDITION. Perry L. Blackshear, Jr. August 1952. 46p. diagrs., photos. (NACA TN 2772)

Types of burner instability are enumerated and the role of standing waves in burners is discussed. The status of the problem of flame-driven standing waves is reviewed and a one-dimensional flow theory giving the mechanism whereby a flame drives or damps a standing wave is presented. In this theory, the reflection, transmission, and amplification of waves passing through a flame region were determined from the continuity and momentum equations. For the model considered, waves were found to pass through the flame front with their velocity amplitudes unaltered so long as the flame area remained unchanged. A change in flame area acted as a source of waves propagating simultaneously into the hot and cold gases on either side of the flame zone. The one dimensional theory seems an adequate explanation of the experimental observations.

NACA TN 2774

A METHOD FOR FINDING A LEAST-SQUARES POLYNOMIAL THAT PASSES THROUGH A SPECIFIED POINT WITH SPECIFIED DERIVATIVES. Neal Tetervin. September 1952. 11p. (NACA TN 2774)

A method is presented for finding a mth-degree polynomial that passes through a specified point with (m - j) specified derivatives ($1 \leq j \leq m$) and is a least-squares polynomial for other points which are spaced at unequal intervals of the independent variable.

NACA TN 2775

EFFECT OF LINEAR SPANWISE VARIATIONS OF TWIST AND CIRCULAR-ARC CAMBER ON LOW-SPEED STATIC STABILITY, ROLLING, AND YAWING CHARACTERISTICS OF A 45° SWEPTBACK WING OF ASPECT RATIO 4 AND TAPER RATIO 0.6. Byron M. Jaquet. August 1952. 27p. diagrs., 2 tabs. (NACA TN 2775)

An investigation was made in the Langley stability tunnel at low scale to determine low-speed effects of linear spanwise variations of twist and circular-arc camber on static-stability and rotary-stability (rolling and yawing) derivatives of a 45° sweptback wing of aspect ratio 4 and taper ratio 0.6.

NACA TN 2776

THE EFFECT OF A SIMULATED PROPELLER SLIPSTREAM ON THE AERODYNAMIC CHARACTERISTICS OF AN UNSWEPT WING PANEL WITH AND WITHOUT NACELLES AT MACH NUMBERS FROM 0.30 TO 0.86. Gareth H. Jordan and Richard I. Cole. September 1952. 15p. diagrs., photo. (NACA TN 2776)

Results of an investigation are presented to show the effect of a simulated propeller slipstream on the lift, drag, and pitching-moment characteristics of an unswept wing panel with and without nacelles. The data were obtained in the Langley 24-inch high-speed tunnel through a range of Mach numbers from approximately 0.30 to 0.86 for angles of attack of 0° and 3°.

NACA TN 2777

THEORETICAL DISTRIBUTION OF SLIP ANGLES IN AN AGGREGATE OF FACE-CENTERED CUBIC CRYSTALS. John M. Hedgepeth. August 1952. 32p. diagrs. (NACA TN 2777)

An analysis of the relative frequency of occurrence of any given slip-line angle in a plastically deformed polycrystal composed of face-centered cubic crystals is presented for the case of simple tension. The results are compared with those obtained for a polycrystal composed of crystals which have but a single mode of slip and with experimental results. The comparisons show that the differences between the results obtained by the two theories become greater as the stress is increased. The comparison with experiment of the face-centered cubic theory is somewhat better than that of the single-slip-mode theory, but the errors are appreciable.

NACA TN 2778

STRESS AND STRAIN AT ONSET OF CRAZING OF POLYMETHYL METHACRYLATE AT VARIOUS TEMPERATURES. M. A. Sherman and B. M. Axilrod, National Bureau of Standards. September 1952. 21p. diagrs., photos., 3 tabs. (NACA TN 2778)

Stress and strain at the onset of crazing were determined for both general-purpose and heat-resistant grades of commercial cast polymethyl methacrylate. Tests were made at 23°, 50°, and 70° C on samples 0.15 inch thick. Other properties measured were tensile strength, total elongation, and modulus of elasticity. Results obtained indicate that a "critical-strain theory" for the threshold of crazing is not applicable to polymethyl methacrylate. Strain at the onset of crazing decreased with increase in temperature from 23° to 50° C whereas there was no consistent trend from 50° to 70° C. Stress at the onset of crazing was about 80 to 95 percent of the tensile strength at all three temperatures.

NACA RM E52F19

VISUALIZATION OF SECONDARY-FLOW PHENOMENA IN BLADE ROW. H. Z. Herzig, A. G. Hansen and G. R. Costello. August 1952. 20p. photos., diagrs. (NACA RM E52F19)

Flow-visualization methods were applied in a preliminary study of the streamline pattern of secondary flows in a blade row. The investigation demonstrated flow of the inlet-wall boundary layer in a blade passage into the corner between the blade suction surface and the wall to form a vortex. This vortex formation occurs well within the passage and is not a trailing-edge phenomenon. The magnitudes of the velocity gradients and angle deflections make the significance of quantitative measurements in this region questionable.

NACA RM E52G17

EFFECT OF FREE METHYL RADICALS ON SLOW OXIDATION OF PROPANE AND ETHANE. Glen E. McDonald and Rose L. Schalla. August 1952. 21p. diagrs., 4 tabs. (NACA RM E52G17)

A study of the effect of free methyl radicals on the slow oxidation of both ethane and propane was made by means of a photochemical decomposition reaction in a static system. The introduction of methyl radicals into a mixture of propane and oxygen or ethane and oxygen substantially lowered the initiation tem-

perature of the combustion of the hydrocarbon. Measurements were made of the amount of propane oxidized in the presence of free methyl radicals at temperatures ranging from 0° to 116° C and for two different concentrations of propane. Oxidation of ethane, which was induced by the free methyl radical, was investigated for only one concentration from 0° to 183° C. From a plot of the log percentage of propane oxidized against the reciprocal temperature ($^{\circ}$K), a zero activation energy was found for the reaction below 40° C. For ethane the activation energy was zero below 120° C. Above these two temperatures an increase in the activation energy was observed. A mechanism is proposed to account for the zero activation energy, but no attempt was made to interpret the higher temperature reactions.

NACA RM E52G24

INFLUENCE OF EXTERNAL VARIABLES ON SMOKING OF BENZENE FLAMES. Thomas P. Clark. August 1952. 17p. diagrs. (NACA RM E52G24)

Premixed benzene-air flames were burned with variations in initial gas temperature, fuel-flow rate, flame length, secondary-air-flow rate and burner-tube diameter. Fuel-air ratios were measured both at the initial appearance of incandescent carbon in the flame and at the point where smoke issued from the flame. Temperature alone affected the fuel-air ratio at which carbon first formed in the flame. The flame did not smoke under a fuel-air ratio of 164 percent of stoichiometric, regardless of the environment around the flame. Conditions which enhanced the diffusion of oxygen into the outer cone improved the smoke-burning characteristics of the flame.

NACA TM 1343

THE EXCITATION OF UNSTABLE PERTURBATIONS IN A LAMINAR FRICTION LAYER. (Die Anfachung instabiler Störungen in einer laminaren Reibungsschicht). J. Pretsch. September 1952. 63p. diagrs., 3 tabs. (NACA TM 1343. Trans. from Aerodynamische Versuchsanstalt Göttingen E. V., Institut für Forschungsflugbetrieb und Flugwesen; Jahrbuch der deutschen Luftfahrtforschung, August 1942, p. I 54-71).

With the aid of the method of small oscillations which was used successfully in the investigation of the stability of laminar velocity distributions in the presence of two-dimensional perturbations, the excitation of the unstable perturbations for the Hartree velocity distributions occurring in plane boundary-layer flow for decreasing and increasing pressure is calculated as a supplement to a former report. The results of this investigation are to make a contribution toward calculation of the transition point on cylindrical bodies.

NACA TM 1348

ON THE REPRESENTATION OF THE STABILITY REGION IN OSCILLATION PROBLEMS WITH THE AID OF THE HURWITZ DETERMINANTS. (Zur Darstellung des Stabilitätsgebietes bei Schwingungsaufgaben mit Hilfe der Hurwitz-Determinanten). E. Sponder. August 1952. 12p. diagrs. (NACA TM 1348. Trans from Schweizer Archiv für angewandte Wissenschaft und Technik, v. 16, no. 3, March 1950, p. 93-96).

This report concerns the use of the Hurwitz determinants in defining boundaries of regions where oscillatory phenomena are to be stable or unstable. A simplification is suggested as an aid in reducing the computations usually required, although it is emphasized that point checks in the various regions defined are required using the complete set of Hurwitz determinants or some other complete stability determination.

NACA TM 1352

TRANSITION CAUSED BY THE LAMINAR FLOW SEPARATION. (Sōryu-Hakuri ni tomonau Sen'i ni kansuru Kenkyū). T. Maekawa and S. Atsumi. September 1952. 14p. diagrs., 2 tabs. (NACA TM 1352. Trans from Society of Applied Mechanics of Japan, Journal, v. 1, no. 6, November 1948, p. 187-192)

An experimental investigation of the effects of the geometry of body surface, Reynolds number, stream turbulence, and a roughness element (wire) on the reattachment of separated laminar boundary-layer flow on a bent flat plate is presented and discussed. The flow mechanisms determining reattachment of the boundary layer are analyzed and discussed.

BRITISH REPORTS

N-16809*

Aeronautical Research Council (Gt. Brit.)
GROUND EFFECT ON DOWNWASH WITH SLIPSTREAM. P. R. Owen and H. Hogg. 1952. 12p. diagrs., 8 tabs. (ARC R & M 2449; ARC 7590. Formerly RAE Aero 1901)

It is shown in this report that given the downwash at the tail plane with slipstream, then the decrement in downwash at the same incidence and propeller thrust coefficient due to ground interference can be estimated by the formula of Piper and Davies (with certain slight modifications) with sufficient accuracy for most practical purposes.

N-16810*

Aeronautical Research Council (Gt. Brit.)
TESTS ON A CONTROL WITH FIXED TRAILING-EDGE ANGLE, AND SURFACES OF VARIABLE CAMBER. A. S. Halliday, H. Deacon and W. C. Skelton. 1952. 15p. diagrs., 3 tabs. (ARC R & M 2495. Formerly ARC 10, 598; S & C 2116)

The report describes experiments to determine the effect of surface distortion on the hinge moments of a control and to investigate the importance of a rigid trailing edge in the prevention of large changes in hinge-moment coefficient. The results show that by designing the control so that the surface at the trailing edge, extending over one-eighth of the chord, is incapable of distortion, then the value of b_2 remains almost constant within the limits on any possible distortion forward of the fixed portion. It has also been found that b_1 is more constant. Changes in center line camber of the deformed portion of the control can still produce an effective change in b_2 when the camber varies with the control angle, although the amount of this change may be roughly halved. Present practice of treating trailing-edge angle as an important parameter in specifying control characteristics is well justified.

N-16811*

Aeronautical Research Council (Gt. Brit.)
LIMITATIONS OF USE OF BUSEMANN'S SECOND-ORDER SUPERSONIC AEROFOIL THEORY. W. F. Hilton. 1952. 9p. diagrs. (ARC R & M 2524. Formerly ARC 9869; FM 971)

The author has found the Busemann theory very rapid in use for the determination of C_L, C_D, and C_m, and this report will enable the exact scope of its use to be determined. It has been tacitly assumed in the past that Busemann's second-order theory of airfoils at supersonic speeds was subject to the same limitations of wedge angle as the exact theory given by Lighthill and others, namely, the wedge angle at which the bow wave detaches. The range of angles for which Busemann's theory gives a pressure coefficient in error by less than 1 percent is shown to be smaller than the angle range for the shock wave to be attached. There is also a limit to the application of Busemann's method to angles of expansion as well as to angles of compression, unlike the exact theory, which can be extended to expansive angles of the order of one right angle without breaking down, in fact far beyond the useful range. The limits of angle given for the use of Busemann's theory are conservative, since they give the pressures to 1 percent, and the force coefficients will be more accurately determined since the errors tend to cancel out when integrating pressures to obtain forces.

N-16812*

Aeronautical Research Council (Gt. Brit.)
ABSTRACTS OF PAPERS PUBLISHED EXTERNALLY. 1952. 17p. (ARC R & M 2565)

Presents an index and related abstracts of papers discussed by the Aeronautical Research Council and recommended by them for external publication.

N-16813*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE EFFECT OF SIZE OF AIRCRAFT UPON THE DIFFICULTIES INVOLVED IN LANDING AN AIRCRAFT. D. Adamson. 1951. 13p. diagrs., tab. (ARC R & M 2567; ARC 10,903. Formerly RAE Aero 2202)

The effect of aircraft size upon the response of an aircraft during those maneuvers which are commonly employed in landing has been examined, and in this way an assessment has been made of the way in which the difficulties experienced by the pilot will go up as aircraft size increases. On the basis of the work summarized in this note, it is concluded that the problems associated with landing (from the pilot's point of view at any rate) are unlikely to be aggravated to such an extent, as the size of aircraft increases up to the limiting size considered in this report (300-ft span), as to make landing really difficult.

N-16814*

Aeronautical Research Council (Gt. Brit.)
ON THE MOMENTUM EQUATION IN LAMINAR BOUNDARY-LAYER FLOW. A NEW METHOD OF UNIPARAMETRIC CALCULATION. B. Thwaites. 1952. 9p. (ARC R & M 2587. Formerly ARC 11,155; FM 1193; Perf. 397)

The general method of Pohlhausen, discussed in detail in reference 1, uses a uniparametric system of velocity distributions of the form $u/U = f(y/\delta) + \lambda g(y/\delta)$. Pohlhausen, by choosing simple forms for the functions f and g, then uses the momentum equation to find the distribution of δ with x and thence the distributions with x of the other boundary layer characteristics. Several awkwardnesses exist in his method, especially when it is applied to problems dealing with a normal velocity at the boundary. In this paper, a new method is described of combining velocity distributions in the form $y/\theta = F(u/U) + \lambda G(u/U)$, and it is shown that such a combination avoids several difficulties. This method of combination also allows a second parameter apart from λ, which might be found valuable in certain problems. The method has been briefly described before as part of an investigation into the effect of continuous suction on laminar boundary-layer flow under adverse pressure gradients. In that paper (R & M 2514), a numerical example of its use was given. In this paper, no example will be given because, as far as the author can see, the practical use of the method is superseded by the generalized method of reference 1; however, it possessed considerable analytical interest.

N-16815*

Aeronautical Research Council (Gt. Brit.)
COMPARATIVE TESTS OF THICK AND THIN TURNING VANES IN THE ROYAL AIRCRAFT ESTABLISHMENT 4 x 3-FT WIND TUNNEL. K. G. Winter. 1952. 5p. diagrs., tab. (ARC R & M 2589; ARC 10,976. Formerly RAE Aero 2217)

The tests were made by replacing the existing center six thick vanes at the first corner of the 4- x 3-ft wind tunnel by vanes of sheet metal. The thin vanes reduced the corner loss, estimated from a wake traverse behind one vane, without any deterioration in outflow, and are therefore recommended for use in future wind tunnels.

N-16816*

Aeronautical Research Council (Gt. Brit.)
TABLES OF MULTHOPP AND OTHER FUNCTIONS FOR USE IN LIFTING-LINE AND LIFTING-PLANE THEORY. V. M. Falkner. WITH APPENDIX: CALCULATION OF THE CIRCULATION FROM THE DOWNWASH. E. J. Watson. 1952. 52p. diagrs., 8 tabs. (ARC R & M 2593. Formerly ARC 11,234; S & C 2187; Perf. 405)

The report gives the derivation and computed tables of two classes of functions suitable for the solution of problems of spanwise aerodynamic loading of wings either by lifting-line or lifting-plane theory. The functions are based on lifting-line theory, but, by a consideration of the connection between lifting-line and lifting-plane theory through the application of Munk's stagger theorem to the calculation of induced drag, it is deduced that the functions must be equally suitable for lifting-plane theory. The first range of functions, called Multhopp or M functions, is associated with discontinuities of induced downwash, while the second, called P functions because of the polygonal representation of induced downwash, is connected with discontinuities in rate of change of induced downwash. Examples are given of the combination of functions to produce given curves of induced downwash, and evidence of the close relation between the results for a continuous and stepped downwash curve suggests that the functions tabulated will be sufficient to cover almost any problem in wing loading.

N-16817*

Aeronautical Research Council (Gt. Brit.)
CALCULATED AERODYNAMIC CHARACTERISTICS OF TWO INFINITE WINGS WITH CONSTANT CHORD. V. M. Falkner. 1952. 10p. diagrs., 8 tabs. (ARC R & M 2594. Formerly ARC 10,628; S & C 2123; Perf. 325)

The report gives solutions obtained by the vortex lattice method for the aerodynamic loading of two infinite wings of constant chord with sweepback of 45°, one with a V-joint at the center, the other rounded off with arcs of radius four times the chord. The true mathematical solution for these problems is exceedingly difficult to find, and the accuracy has been verified by considering the convergence of solutions of varying complexity. The V-wing shows a reduction in circulation near the joint with accompanying backward movement of the local center of pressure, while the rounded wing has increased circulation without appreciable variation of the center of pressure from the 0.25-chord position. The results will be used to modify loading functions used in vortex lattice theory in order to improve solutions for wings of small aspect ratio, particularly when the leading or trailing edges meet at an included angle which differs considerably from 180°.

N-16818*

Aeronautical Research Council (Gt. Brit.)
APPLICATION OF THE LINEAR PERTURBATION THEORY TO COMPRESSIBLE FLOW ABOUT BODIES OF REVOLUTION. A. D. Young and S. Kirkby. 1952. 8p. diagrs. (ARC R & M 2624; ARC 11,033; FM 1177. Formerly College of Aeronautics, Cranfield Rept. 11)

The linearized theory is developed in some detail in order to clarify the difference between two dimensional flow and flow past slender three-dimensional bodies. In agreement with other authors, it is concluded that the perturbation velocity on a slender body in compressible flow is $1/\beta^2$ times the perturbation velocity in incompressible flow on a thinner body at reduced incidence obtained by reducing the lateral dimensions of the original body in the ratio β:1. This result is applied to a representative family of streamline bodies of revolution at zero incidence. It is found that, without an undue loss of accuracy, the results of the claculations can be presented in a relatively simple form in a diagram showing the variation of velocity with Mach number for a range of values of velocity on the surface of a streamline body in incompressible flow. This variation is always less than that predicted by the Glauert law but approaches it with increase in the basic incompressible flow velocity, being very close to it for basic incompressible velocity ratios, u/U_0, of 1.10 and higher. It is shown that the blockage factor for a body of revolution in a wind tunnel is increased in compressible flow in the ratio $1\beta^3$ and not $1/\beta^4$ as quoted in R & M 1909.

N-16819*

Aeronautical Research Council (Gt. Brit.)
MODEL TESTS IN THE 24-FT WIND TUNNEL TO DETERMINE THE OPTIMUM ANGLE FOR RELEASE OF A COCKPIT HOOD. R. Fail. 1952. 3p. diagrs. (ARC R & M 2644; ARC 11,494. Formerly RAE Tech. Note Aero 1947)

For some time now, it has been recommended that mechanical assistance be incorporated in jettisonable cockpit hood designs. Some firms have preferred designs in which the hood is constrained to rotate through a definite angle before the final release. A short series of tests has, therefore, been made in the 24-ft wind tunnel to determine the optimum angle for release. This was found to be about 10°, which is considerably less than has been suggested in the past.

N-16820*

Aeronautical Research Council (Gt. Brit.)
WIND-TUNNEL TESTS ON A THICK SUCTION AEROFOIL WITH A SINGLE SLOT. M. B. Glauert, W. S. Walker, W. G. Raymer and N. Gregory. 1952.

14p. diagrs., tab. (ARC R & M 2646; ARC 11,797. Formerly ARC 10,854; Perf. 348; FM 1150)

This report describes the two-dimensional wind-tunnel tests carried out in the National Physical Laboratory 13- by 9-ft wind tunnel on a 31.5-percent-thick suction airfoil, GLAS II, which has a single slot on the upper surface at 69 percent chord. Both suction and blowing were used to prevent separation. Lift, drag, pitching moment, and the flow through the slot were measured. Tests without suction were made at Reynolds numbers of 0.96 and 2.88 million. The results at the two Reynolds numbers were markedly different, and at the higher speed widely varying values of the drag coefficient were recorded in the same conditions, there apparently being several possible régimes of flow. With suction, the pump power available only enabled tests to be made at the lower Reynolds number, and with the boundary layer on the upper surface laminar to the slot. At low incidences, suction quantities agreeing well with theoretical estimates sufficed to maintain unseparated flow, but at higher incidences the flow tended to break down. Three or four times as much suction was required at all incidences to make the separated flow readhere. With blowing, still larger quantities were necessary, but the spanwise distribution of the flow from the slot was unsatisfactory. Two different slot shapes were tested on the model, one with a sharp beak to the front lip, the other with a rounded entry. Intermittent separation of the flow occurred in each case. The phenomena may be of a fundamental character and associated with the profile shape rather than with the shape of the slot entry.

N-16947C*

Aeronautical Research Council (Gt. Brit.)
CONTRIBUTIONS TO UNSTEADY AEROFOIL THEORY. IX. A NUMERICAL COMPARISON OF VARIOUS APPROXIMATE THEORIES FOR THE OSCILLATING AEROFOIL OF LARGE SPAN. Katterbach. August 24, 1948. 27p. diagrs., 6 tabs. (ARC 11,736; ARC 0.755)

The lift coefficients of an oscillating elliptical wing for the reduced frequencies $\Omega = i\nu b/v = 0, 0.5, 1.0, \ldots 6.5$, are calculated according to four well-known approximate theories which deal with the unsteady motion of an airfoil; the results, expressed in complex form, are compared with each other and with strip theory. The theories are described briefly, and the equations required for the calculation are derived.

N-16967*

Aeronautical Inspection Directorate (Gt. Brit.)
MECHANICAL THUMB HARD DRYING TIME TESTER FOR PAINTS. A. T. Josling. May 1952. 9p. photos., diagrs. (AID Rept. APP. 2)

An original mechanical thumb drying time tester, capable of reproducing results with varying types of paints, mention being made of protection coating and other metal finishes.

N-16968*

Aeronautical Inspection Directorate (Gt. Brit.)
APPARATUS FOR OBTAINING A WIDE RANGE OF HUMIDITY AND TEMPERATURE CONDITIONS IN A STREAM OF AIR. A. T. Josling. May 1952. 4p. diagrs., photos. (AID Rept. APP. 3)

A new type of apparatus for obtaining any desired humidity in a stream of air is described. It is based on the principle of saturating air at a suitable temperature and then heating it to the working temperature. Saturation is obtained by means of a special splashing device without atomization. Since the saturation temperature to give the desired humidity at the working temperature, which may be anywhere within its wide range, is known from hygrometric tables, an actual determination of the humidity achieved is rendered unnecessary. The apparatus is suitable for blushing tests on paints and dopes, corrosion tests on platings, protective coatings, oils and greases.

N-16969*

Aeronautical Inspection Directorate (Gt. Brit.)
DEVICE FOR COLD BEND TESTS ON PAINT TEST PANELS. A. T. Josling. May 1952. 3p. diagrs. (AID Rept. APP. 4)

A device enabling bend tests to be performed at correct temperatures. A hinged test panel holder is also shown.

N-16970*

Aeronautical Inspection Directorate (Gt. Brit.)
THE MEASUREMENT OF THE WALL THICKNESS OF A LONG TUBE. H. R. Davenport and E. W. Carter. December 5, 1951. 7p. diagrs., photos. (AID Rept. Metro 4)

The description of a method of measuring the wall thickness of a long tube by means of an alinement telescope and auxiliary equipment.

N-17019*

Forest Products Research Lab. (Gt. Brit.)
TRIALS OF TIMBER FOR PLYWOOD MANUFACTURE. PROGRESS REPORT SIXTEEN. June 1952. 9p. 5 tabs. (Forest Products Research Lab.)

Tests were made on three British Guiana species of wood. They were crabwood (carapa guianensis), kurokai (protium decandrum), and wamara (swarzia leiocalycina). It was found that the crabwood would be unsuitable for British mills but it may be of some use for conversion in the country of origin if freshly felled logs are less prone to splitting and shaking. Kurokai would also be unsuited to British mills but would be of use in the country or origin. Wamara is considered unsuitable because of its weight and processing difficulties.

MISCELLANEOUS

NACA Rept. 1037

Errata No. 1 on "GENERAL METHOD AND THERMODYNAMIC TABLES FOR COMPUTATION OF EQUILIBRIUM COMPOSITION AND TEMPERATURE OF CHEMICAL REACTIONS". Vearl N. Huff, Sanford Gordon and Virginia E. Morrell. 1951.

NACA TN 2277

Errata No. 1 on "EFFECTS OF COMPRESSIBILITY ON THE PERFORMANCE OF TWO FULL-SCALE HELICOPTER ROTORS". Paul J. Carpenter. January 1951.

NACA TN 2353

Errata No. 1 on "CHARTS AND TABLES FOR USE IN CALCULATIONS OF DOWNWASH OF WINGS OF ARBITRARY PLAN FORM". Franklin W. Diederich. May 1951.

UNPUBLISHED PAPERS

N-5292*

FORMS OF WING FLUTTER IN TWO-DIMENSIONAL COMPRESSIBLE POTENTIAL FLOW. (Flugelschwingungsformen in ebener kompressibler Potentialströmung). Nikolaus Rott. July 1952. 44p. diagrs. (Trans. from Zeitschrift für angewandte Mathematik und Physik, v. 1, 1950, p. 380-410)

On the basis of energy considerations, a survey is given of the possible forms of oscillations for flutter with two degrees of freedom in a plane compressible potential flow. It is found that the possible forms do not much depend on Mach number in the whole range from 0 to α, with some exceptions in the neighborhood of M = 1, where forms with only one degree of freedom (torsion) may occur. Conclusions are drawn for methods of preventing flutter. Limits of the reduced frequency are given for the possibility of flutter in two and one degree of freedom. Special care was given for the case of M = 1.

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1024
National Advisory Committee for Aeronautics.
CALCULATION OF THE LATERAL CONTROL OF SWEPT AND UNSWEPT FLEXIBLE WINGS OF ARBITRARY STIFFNESS. Franklin W. Diederich. 1951. ii, 19p. diagrs., 6 tabs. (NACA Rept. 1024. Formerly RM L8H24a)

A method similar to that of NACA Rept. 1000 is presented for calculating the effectiveness and the reversal speed of lateral-control devices on swept and unswept wings of arbitrary stiffness. Provision is made for using either stiffness curves and root-rotation constants or structural influence coefficients in the analysis. Computing forms and an illustrative example are included to facilitate calculations by means of the method. The effectiveness of conventional aileron configurations and the margin against aileron reversal are shown to be relatively low for swept wings at all speeds and for all wing plan forms at supersonic speeds.

NACA Rept. 1046
National Advisory Committee for Aeronautics.
A GENERAL INTEGRAL FORM OF THE BOUNDARY-LAYER EQUATION FOR INCOMPRESSIBLE FLOW WITH AN APPLICATION TO THE CALCULATION OF THE SEPARATION POINT OF TURBULENT BOUNDARY LAYERS. Neal Tetervin and Chia Chiao Lin. 1951. 19p. diagrs. (NACA Rept. 1046. Formerly TN 2158)

A general integral form of the boundary-layer equation, valid for either laminar or turbulent incompressible boundary-layer flow, is derived. By using the experimental finding that all velocity profiles of the turbulent boundary layer form essentially a single-parameter family, the general equation is changed to an equation for the space rate of change of the velocity-profile shape parameter. The lack of precise knowledge concerning the surface shear and the distribution of the shearing stress across turbulent boundary layers prevented the attainment of a reliable method for calculating the behavior of turbulent boundary layers.

NACA Rept. 1056
National Advisory Committee for Aeronautics.
THEORETICAL ANTISYMMETRIC SPAN LOADING FOR WINGS OF ARBITRARY PLAN FORM AT SUBSONIC SPEEDS. John DeYoung. 1951. 36p. diagrs., 9 tabs. (NACA Rept. 1056. Formerly TN 2140)

A simplified lifting-surface theory that includes effects of compressibility and spanwise variation of section lift-curve slope is used to provide charts with which antisymmetric loading due to arbitrary antisymmetric angle of attack can be found for wings having symmetric plan forms with a constant spanwise sweep angle of the quarter-chord line. Aerodynamic characteristics due to rolling, deflected ailerons, and sideslip of wings with dihedral are considered. Solutions are presented for straight-tapered wings for a range of swept plan forms.

NACA Rept. 1066
National Advisory Committee for Aeronautics.
ANALYSIS OF TEMPERATURE DISTRIBUTION IN LIQUID-COOLED TURBINE BLADES. John N. B. Livingood and W. Byron Brown. 1952. ii, 21p. diagrs. (NACA Rept. 1066. Formerly TN 2321)

Analytical methods are presented for computing temperature distributions in liquid-cooled turbine blades or in simplified shapes used to approximate sections of liquid-cooled turbine blades. Nondimensional charts are presented for use in the simplification of some of the calculations. Illustrative examples are also included to demonstrate the use of the various equations and nondimensional charts and to show trends of the various temperature distributions. One-dimensional spanwise temperature distributions gave satisfactory results near the coolant passages. One-dimensional chordwise distribution gave a good first approximation to the actual solution in cases when rim cooling was insignificant.

NACA TN 2734
National Advisory Committee for Aeronautics.
SUMMARY OF AVAILABLE HAIL LITERATURE AND THE EFFECT OF HAIL ON AIRCRAFT IN FLIGHT. Robert K. Souter and Joseph B. Emerson. September 1952. 162p. diagrs., photos., 6 tabs. (NACA TN 2734)

Available information on the hail phenomenon affecting aircraft in flight has been examined. This paper attemps to coordinate the present knowledge of hail

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with the effect of hail on aircraft in flight and includes (1) a digest of the literature on the physical properties, the occurrence, and the formation of hail; (2) a survey of the hail effect on aircraft in flight from analyses of 57 cases of airplanes damaged by hail; (3) a résumé of hail information for the benefit of pilots, forecasters, and ground operational personnel; and (4) an annotated hail bibliography of 552 articles for use of research personnel.

NACA TN 2765

A FLIGHT INVESTIGATION OF THE EFFECT OF SHAPE AND THICKNESS OF THE BOUNDARY LAYER ON THE PRESSURE DISTRIBUTION IN THE PRESENCE OF SHOCK. Eziaslav N. Harrin. September 1952. 13p. diagrs., photos. (NACA TN 2765)

An investigation was made in flight at free-stream Mach numbers up to about 0.77 to determine the effect of a laminar boundary layer and thin and thick turbulent boundary layers on the chordwise pressure distribution over an airfoil in the presence of shock at full-scale Reynolds numbers. Boundary-layer and pressure-distribution measurements were made on a short-span airfoil built around a wing of a fighter airplane. Boundary-layer Reynolds numbers (based on momentum thickness and flow parameters at the outer edge of the boundary layer) were about 3,000 for the laminar boundary layer and 10,000 for the thickest turbulent boundary layer with local Mach numbers ranging up to 1.3 and chord Reynolds numbers up to about 21×10^6.

NACA TN 2773

AN APPROXIMATE METHOD FOR DETERMINING THE DISPLACEMENT EFFECTS AND VISCOUS DRAG OF LAMINAR BOUNDARY LAYERS IN TWO-DIMENSIONAL HYPERSONIC FLOW. Mitchel H. Bertram. September 1952. 41p. diagrs., photos., tab. (NACA TN 2773)

A simplified approximate theory is presented by means of which the laminar boundary layer over an insulated two-dimensional surface may be calculated, a linear velocity profile being assumed, and an estimate made of its effect in changing the pressure distribution over the profile upon which the boundary layer is formed. Skin friction is also determined. Comparisons of results from this theory are made with experimental results at a Mach number of 6.86 and a Reynolds number of 980,000.

NACA TN 2780

FLIGHT INVESTIGATION OF TRANSIENT WING RESPONSE ON A FOUR-ENGINE BOMBER AIRPLANE IN ROUGH AIR WITH RESPECT TO CENTER-OF-GRAVITY ACCELERATIONS. Harry C. Mickleboro, Richard B. Fahrer and C. C. Shufflebarger. September 1952. 25p. diagrs., 3 tabs. (NACA TN 2780)

The results of a flight investigation on a four-engine bomber airplane to determine the transient-response effects of wing flexibility in gusts showed that the measured acceleration increments at the center of gravity were approximately 28 percent higher than the true airplane acceleration increments. This relationship appeared to be only slightly affected by the variations in speed and weight covered by the test conditions.

NACA TN 2783

USE OF A CONSOLIDATED POROUS MEDIUM FOR MEASUREMENT OF FLOW RATE AND VISCOSITY OF GASES AT ELEVATED PRESSURES AND TEMPERATURES. Martin B. Biles and J. A. Putnam, University of California. September 1952. 51p. diagrs., photos., 7 tabs. (NACA TN 2783)

Use of a consolidated porous medium as a gas-metering device and for determination of gas viscosity has been investigated over a moderate range of temperature and pressure. With normal laboratory techniques it appears possible to calibrate large porous Alundum filtering thimbles to meter gas with a probable error of 0.1 to 0.2 percent. The geometry of such elements permits an appreciable range of gas flow rate to be metered with small, accurately controlled, pressure drops. The advantages of such a device warrant its use as a laboratory instrument. Results of the flow tests have been employed in the determination of the viscosity of air up to approximately 900 pounds per square inch absolute at the two test temperatures of 75° and 517° F. These data appear to check sufficiently well with other published viscosity data to justify the use of this method as a recommended procedure.

NACA TN 2784

METHOD FOR CALCULATION OF COMPRESSIBLE LAMINAR BOUNDARY-LAYER CHARACTERISTICS IN AXIAL PRESSURE GRADIENT WITH ZERO HEAT TRANSFER. Morris Morduchow and Joseph H. Clarke, Polytechnic Institute of Brooklyn. September 1952. 43p. diagrs., 4 tabs. (NACA TN 2784)

The Kármán-Pohlhausen method is extended primarily to sixth-degree velocity profiles for determining the characteristics of the compressible laminar boundary layer over an adiabatic wall in the presence of an axial pressure gradient. It is assumed that the Prandtl number is unity and that the coefficient of viscosity varies linearly with the temperature. A general approximate solution which permits a rapid determination of the boundary-layer characteristics for any given free-stream Mach number and given velocity distribution at the outer edge of the boundary layer is obtained. A simple method based on the use of a seventh-degree velocity profile is derived for the special purpose of calculating the location of the separation point in an adverse pressure gradient. It is shown that for the special case of flow near a forward stagnation point the Kármán-Pohlhausen method with the usual forth-degree profiles leads to results of adequate accuracy, even for the critical Reynolds number.

NACA TN 2785

INTRODUCTION TO ELECTRICAL-CIRCUIT ANALOGIES FOR BEAM ANALYSIS. Stanley U. Benscoter and Richard H. MacNeal, California Institute of Technology. September 1952. 48p. diagrs., 5 tabs. (NACA TN 2785)

An application is described of the well-known analogy between electrical and mechanical systems to the calculation of stresses and deflections of beams. The object of the present paper is to give an explanation of the analogies in an elementary manner which will enable a structural engineer to understand the process of designing the electrical circuits. The analogies which are discussed are those that are now being used in the Cal-Tech analog computer. Analogies are given for beams in bending and torsion with static loads and in vibrational motion.

NACA TN 2786

EQUIVALENT PLATE THEORY FOR A STRAIGHT MULTICELL WING. Stanley U. Benscoter and Richard H. MacNeal, California Institute of Technology. September 1952. 32p. diagrs. (NACA TN 2786)

A structural theory is developed for the analysis of thin multicell wings with straight spars and perpendicular ribs. The analysis is intended to be suitable for supersonic wings of low aspect ratio. Deflections due to shearing strains are taken into account. The theory is expressed entirely in terms of first-order difference equations in order that analogous electrical circuits can be readily designed and solutions obtained on the Cal-Tech analog computer.

NACA TN 2787

AIRFOIL PROFILES FOR MINIMUM PRESSURE DRAG AT SUPERSONIC VELOCITIES - APPLICATION OF SHOCK-EXPANSION THEORY, INCLUDING CONSIDERATION OF HYPERSONIC RANGE. Dean R. Chapman. September 1952. 44p. diagrs. (NACA TN 2787)

A theoretical investigation employing shock expansion theory is made of the airfoil profile having minimum pressure drag at zero lift for various given auxiliary conditions. Curves are presented to facilitate the application of the theory, and typical optimum profiles are illustrated. A comparison of results obtained by the simpler linearized-theory method of a previous report indicates that the simpler method can be used with engineering accuracy to determine the shape, though not the drag, of the optimum profile at Mach numbers up to infinity. It is shown that considerable deviation from the optimum shape can be made without a large increase in drag except on thin airfoils at moderate supersonic Mach numbers.

NACA TN 2788

EFFECTS OF SOLVENTS IN IMPROVING BOUNDARY LUBRICATION OF STEEL BY SILICONES. S. F. Murray and Robert L. Johnson. September 1952. 23p. diagrs., 2 tabs. (NACA TN 2788)

Because of the known synthetic fluids, silicones best satisfy the viscometric requirements for lubricants for turbine engines, a study was conducted to establish the effect of solvents on boundary lubrication by silicones. Boundary-lubrication data were obtained which are considered substantiating evidence for a hypothesis that, in solutions of solvents blended with silicones, the silicones form a closely packed and oriented adsorbed film on ferrous surfaces. The solutions reduced friction and prevented surface failure even when the solvent as well as the silicone was an extremely poor lubricant. These data indicate that satisfactory lubrication is the result of a solvation effect rather than a lubrication additive effect of the solvent because 30 to 50 percent of solvent was necessary for good results. The best results were obtained with solvents having dipole moments. Solutions of diesters in silicones may be practical lubricants.

NACA TN 2789

SOME DYNAMIC EFFECTS OF FUEL MOTION IN SIMPLIFIED MODEL TIP TANKS ON SUDDENLY EXCITED BENDING OSCILLATIONS. Kenneth F. Merten and Bertrand H. Stephenson. September 1952. 35p. diagrs., photos., 2 tabs. (NACA TN 2789)

An exploratory investigation of the dynamic effects of fuel sloshing in tip tanks on wing bending motion was conducted with two simplified model beam-tank systems. Envelope curves to beam-displacement time histories obtained after release from a deflected position are compared and show the effects of variation in tank fullness, fluid density, fluid viscosity, and tank shape. Some variations of fluid weight effective from cycle to cycle are also presented. The results of these tests indicate that after several cycles substantial damping may be obtained from fuel sloshing in a tip tank and that the effective mass of the fuel may vary considerable under certain conditions of tank oscillation. The viscosity of the fluid did not affect the damping or inertia characteristics obtained but, for a given beam-tank system, the density of fluid and tank fullness were important parameters.

NACA TN 2791

CORRELATION OF TENSILE STRENGTH, TENSILE DUCTILITY, AND NOTCH TENSILE STRENGTH WITH THE STRENGTH OF ROTATING DISKS OF SEVERAL DESIGNS IN THE RANGE OF LOW AND INTERMEDIATE DUCTILITY. Arthur G. Holms and Andrew J. Repko. September 1952. 30p. diagrs., 3 tabs. (NACA TN 2791)

Burst tests were conducted on several designs of sound disks and disks with defects and results were compared with tensile strength, tensile ductility, and notch tensile strength. For the brittle materials, the disk strength did not correlate with tensile strength. For the brittle materials and for ductile materials for which notch strength data were available, the disk strength was found to correlate better with the combination of tensile strength and notch strength ratio than with the combination of tensile strength and elongation. For disks with defects, the notch tensile strength was superior to the conventional tensile strength.

NACA TN 2793

A METHOD FOR THE DETERMINATION OF THE TIME LAG IN PRESSURE MEASURING SYSTEMS INCORPORATING CAPILLARIES. Archibald R. Sinclair and A. Warner Robins. September 1952. 35p. diagrs., tab. (NACA TN 2793)

A method is presented for the determination of the time lag in pressure measuring systems incorporating capillaries; this method is a convenient and systematic means of selecting, designing, or redesigning a pressure measuring system to meet the time requirements of a particular installation. Experimental data are shown and a step-by-step sample application is presented.

NACA TN 2795

EFFECTS OF WING SWEEP ON THE UPWASH AT THE PROPELLER PLANES OF MULTIENGINE AIRPLANES. Vernon L. Rogallo. September 1952. 46p. diagrs. (NACA TN 2795)

An analysis is presented to give a qualitative picture of the effects of wing sweep on the upwash at the propeller planes of multiengine airplanes. In order to provide a basis for judging effects of sweep, comparisons are made of the upwash and upflow angles at the propeller planes of two hypothetical airplanes of the high-speed long-range type, one having an unswept wing and the other a sweptback wing. The effects of compressibility are considered. Charts are provided to enable the prediction of upwash in the chord-plane region ahead of wings of various plan forms.

NACA RM E52B12

IMPINGEMENT OF WATER DROPLETS ON AN NACA 65_1-212 AIRFOIL AT AN ANGLE OF ATTACK OF 4°. Rinaldo J. Brun, John S. Serafini and George J. Moshos. September 1952. 47p. diagrs., tab. (NACA RM E52B12)

The trajectories of droplets in the air flowing past an NACA 65_1-212 airfoil at an angle of attack of 4° were determined. The collection efficiency, the area of droplet impingement, and the rate of droplet impingement were calculated from the trajectories. The results are applicable under the following conditions: chord lengths from 2 to 20 feet, altitudes from 1000 to 35,000 feet, airplane speeds from 150 miles per hour to the critical flight Mach number, and droplet diameters from 5 to 100 microns.

NACA RM E52H15

PRESSURE LIMITS OF FLAME PROPAGATION OF PURE HYDROCARBON-AIR MIXTURES AT REDUCED PRESSURES. Adolph E. Spakowski. September 1952. 35p. diagrs., 2 tabs. (NACA RM E52H15)

An investigation was made of the pressure concentration limits of flame propagation in glass tubes for 18 high-boiling hydrocarbons mixed with air. The concentration limits were correlated with molecular weight. Relations were also derived between the flammability range and the molecular weight and between the rich and lean limits.

NACA RM L52G18

INVESTIGATION OF THE EFFECTS OF VARIATIONS IN THE REYNOLDS NUMBER BETWEEN 0.4×10^6 AND 3.0×10^6 ON THE LOW-SPEED AERODYNAMIC CHARACTERISTICS OF THREE LOW-ASPECT-RATIO SYMMETRICAL WINGS WITH RECTANGULAR PLAN FORMS. George W. Jones, Jr. September 1952. 13p. diagrs. (NACA RM L52G18)

The effects of Reynolds number on the aerodynamic characteristics of three symmetrical wings of aspect ratio 1, 2, and 3 each having a rectangular plan form and an NACA 0012 airfoil section is given for a range of seven Reynolds numbers between 0.4×10^6 and 3.0×10^6. The data show the effects of Reynolds number on the lift, the lift-curve slope, maximum lift coefficient, and the pitching moment about the quarter-chord point.

NACA TM 1337

ANALYTICAL STUDY OF SHIMMY OF AIRPLANE WHEELS. (Étude Théorique du Shimmy des Roues d'Avion). Christian Bourcier de Carbon. September 1952. 126p. diagrs., photos. (NACA TM 1337. Trans. from Office National d'Etudes et de Recherches Aéronautiques, Pub. 7, 1948).

The problem of shimmy of a castering wheel, such as the nose wheel of a tricycle gear airplane, is treated analytically. The flexibility of the tire is considered to be the primary cause of shimmy. The rather simple theory developed agrees rather well with previous experimental results. The author suggests that shimmy may be eliminated through a suitable choice of landing gear dimensions in lieu of a damper.

BRITISH REPORTS

N-17089*

Aeronautical Research Council (Gt. Brit.)
TWO-DIMENSIONAL WIND TUNNEL INTERFERENCE. L. G. Whitehead. June 17, 1950. 24p. diagrs. (ARC 13,198; FM 1451)

The present paper describes a contribution to the theory of two-dimensional wind-tunnel interference on bodies set at zero incidence in the center of the flow. The work is limited to incompressible flow. The irrotational flow has been found between parallel walls and also in a free jet past two cylindrical sections. The first of these is a circular cylinder and the second is a slender profile with a uniform pressure drop over the greater part of the boundary. No account is taken of the wake which exists behind a body in a real fluid so that the tunnel interference represented in the present paper is that usually referred to as solid blockage and the effects of wake blockage are not considered. The free streamline method is employed for the calculation of the flow of a jet past both bodies so that the outward displacement of the streamline is correctly represented and the approximations associated with the application of the method of images to these problems are avoided. The results are not limited therefore to examples in which the profile dimensions are small compared with the width of the jet. The free streamline method has an additional advantage as the solutions can readily be adapted to deal with problems in which the outer boundaries of the flow consist partly of parallel walls and partly of free streamlines.

N-17091*

Aeronautical Research Council (Gt. Brit.)
THE LAMINAR AXI-SYMMETRIC JET: EXACT SOLUTION. H. B. Squire. July 22, 1950. 7p. diagrs. (ARC 13,267; FM 1462)

A solution of the flow in a laminar axisymmetric jet was given by Schlichting in 1933, making use of the approximations of boundary-layer theory. The corresponding exact solution of the Navier-Stokes equations is derived in the present report. It is also shown that this solution can be interpreted as the flow resulting from a force applied at a point in a viscous fluid which is at rest at infinity.

N-17099*

Forest Products Research Lab. (Gt. Brit.)
TRIALS OF TIMBER FOR PLYWOOD MANUFACTURE. PRELIMINARY REPORT ON SIX AFRICAN SPECIES. PROGRESS REPORT SEVENTEEN. June 1952. 28p. 15 tabs. (Forest Products Research Lab.)

This report describes tests on six African species of wood to determine their suitability for plywood manufacture. The following species were tested: berlinia, brown sterculia, kokrodua, mguma, pterygota, and yellow sterculia.

N-17109*

National Gas Turbine Establishment (Gt. Brit.)
SOME EXPERIMENTS ON BREAKDOWN POTENTIAL IN HOT PRODUCTS OF COMBUSTION. N. A. Dimmock. May 1952. 14p. diagrs., tab. (NGTE Memo. M. 153)

The experiments described in this memorandum show that no general lowering of the breakdown potential is caused by the ionization present in the exhaust gases from a combustion chamber, although a slight drop in its value is noticeable very close to the chamber exit. The fuels used were aviation kerosene, gas oil (Marine reference B. 310) and gas oil with n-Butyl disulphide. The ceramic insulator used in the experiments was found to become semiconducting at elevated temperatures and this trouble would have to be overcome in designing an electrode for a hot gas electrostatic-cleaner.

N-17172*

Royal Aircraft Establishment (Gt. Brit.)
MEASUREMENT OF THE MOISTURE CONTENT OF HIGH PRESSURE OXYGEN FOR USE IN AIRCRAFT. I. A LOW PRESSURE HYGROMETER. M. E. Bedwell and W. G. Glendinning. March 1952. 9p. diagrs., 3 tabs. (RAE Tech. Note Chem. 1154)

A hygrometer has been devised which will give precise measurement of the moisture content of oxygen issuing from a cylinder. Test runs on samples from transport cylinders indicate that in every case the oxygen contained considerably less than the maximum amount of moisture allowed by specification. No anomalous changes of moisture content with decreasing pressure were observed in the cylinders selected.

N-17304*

Royal Aircraft Establishment (Gt. Brit.)
FREQUENCY REGULATOR FOR A MOTOR-ALTERNATOR. C. S. Hudson. January 1952. 17p. diagrs., photo. (RAE Tech. Note EL. 30)

The design of a frequency regular for a 2 kw 333 cps motor alternator is described and details given of the experimental measurements made. A two stage magnetic amplifier is used having a current gain of about 3000 and a power amplification of about 10^8. The design is intended to give regulation to within 0.1 percent; from approximate measurements made it is considered to be better than 0.3 percent. No attempt has been made to examine the stability of the frequency reference circuit and further work on this needs to be done.

N-17305*

Royal Aircraft Establishment (Gt. Brit.)
SOME MEASUREMENTS OF TAKEOVER TIME LAGS IN THE STRIKING OF COLD-CATHODE TRIODES. J. C. Le Grice. March 1952. 16p. diagrs., photos. (RAE Tech. Note EL. 32)

The design of time-delay circuits using cold-cathode triodes necessitated a knowledge of the magnitude of the takeover time by which striking of the anode circuit lags behind striking of the trigger circuit. A method of applying the trigger and anode voltage wave forms to the deflection plates of a C. R. O. is described which enabled the takeover time to be measured between the attainment of currents of 10^{-3} amps in the trigger and anode circuits respectively. Some measurements on miniature triodes with potassium cathodes gave takeover times of less than 50 μs for anode voltages between 100 and 200 volts. The takeover times were repeatable to better than 5 percent.

N-17314*

Royal Aircraft Establishment (Gt. Brit.)
TOWING TANK TESTS TO DETERMINE THE WATER DRAG AND PITCHING MOMENTS ON THE FINAL HULL FORM OF A LARGE FLYING BOAT SEAPLANE (PRINCESS, SPEC. 10/46). T. B. Owen and A. G. Kurn. April 1952. 33p. diagrs., photo., 5 tabs. (RAE Tech. Note Aero 2159)

The water drag, trim and hull wetted areas of the Princess flying boat hull model (final form) have been measured for all anticipated take-off weights and attitudes. The drag characteristics compare favorably with those obtained on other boat seaplanes. The measurements were made using new techniques for: model surface finish, drag measurements, and representation of the effect of air flow past the model. A method is given for correcting the model drag data to full scale to allow for the difference is Reynolds number.

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1026

NACA INVESTIGATION OF FUEL PERFORMANCE IN PISTON-TYPE ENGINES. Henry C. Barnett. 1951. vi, 102p. diagrs., photos., 32 tabs. (NACA Rept. 1026)

A compilation of many of the pertinent research data acquired by the NACA on fuel performance in piston engines. The following specific subjects are discussed: High-speed photographic studies of knocking combustion, by C. David Miller; correlations of knock-limited performance data; antiknock performance scales; preignition; hydrocarbons and ethers as antiknock blending agents; aromatic amines as fuel additives; tetraethyl lead as a fuel additive; antiknock blending characteristics of fuels; fuel volatility; and internal cooling.

NACA Rept. 1054

INTEGRALS AND INTEGRAL EQUATIONS IN LINEARIZED WING THEORY. Harvard Lomax, Max A. Heaslet and Franklyn B. Fuller. 1951. ii, 34p. diagrs. (NACA Rept. 1054. Formerly TN 2252)

The formulas of subsonic and supersonic wing theory for source, doublet, and vortex distributions are reviewed, and a systematic presentation is provided which relates these distributions to the pressure and to the vertical induced velocity in the plane of the wing. It is shown that care must be used in treating the singularities involved in the analysis and that the order of integration is not always reversible. Concepts suggested by the irreversibility of order of integration are shown to be useful in the inversion of singular integral equations when operational techniques are used. A number of examples are given to illustrate the methods presented, attention being directed to supersonic flight speeds.

NACA Rept. 1065

CORRELATION OF PHYSICAL PROPERTIES WITH MOLECULAR STRUCTURE FOR SOME DICYCLIC HYDROCARBONS HAVING HIGH THERMAL-ENERGY RELEASE PER UNIT VOLUME-2-ALKYLBIPHENYL AND THE TWO ISOMERIC 2-ALKYLBICYCLOHEXYL SERIES. Irving A. Goodman and Paul H. Wise. 1952. 10p. diagrs., 2 tabs. (NACA Rept. 1065. Formerly TN 2419)

Three homologous series of related dicyclic hydrocarbons are compared on the basis of the following physical properties: net heat of combustion, density, melting point, boiling point, and kinematic viscosity. The three series investigated are the 2-alkylbiphenyl, and the high- and low-boiling 2-alkylbicyclohexyl series through C_{16}. Comparisons are made on the following bases: (1) as members of an homologous series in which the compounds have similar structures and differ in molecular weight; (2) as isomers with the same molecular formula but different molecular structure due to brancning of the side chain or geometrical isomerism; and (3) as compounds with the same carbon skeleton but different molecular formula due to hydrogenation of the aromatic ring.

NACA TN 2743

LANDING-GEAR IMPACT. W. Flügge, Stanford University. October 1952. 91p. diagrs., 9 tabs. (NACA TN 2743)

The report deals with the impact forces in landing gears. Both the landing impact and the taxying impact have been considered, but drag forces have so far been excluded. The differential equations are developed and their numerical integration is shown, considering the nonlinear properties of the oleo shock strut. A way is shown for determining the dimensions of the metering pin from a given load-time diagram. A review of German literature on landing-gear impact is also presented.

NACA TN 2782

BENDING OF THIN PLATES WITH COMPOUND CURVATURE. H. G. Lew, Pennsylvania State College. October 1952. 49p. diagrs., 2 tabs. (NACA TN 2782)

A method is developed for analysis of deformations of doubly curved thin plates under edge or surface loads for small deflections. The problem is approached from thin-shell theory so that the plate is to form part of a shell of revolution. An analytical solution is presented completely for a plate with arbitrary meridian of small curvature loaded by normal edge loads on one pair of opposite edges and numerical calculations are given for the deflection and moment distribution for a particular meridian curve. The method developed may be applied to other problems of bending of doubly curved thin plates under edge or surface loads but the theory is limited to small deflections of the plate considered.

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NACA TN 2790

FLOW STUDIES IN THE VICINITY OF A MODIFIED FLAT-PLATE RECTANGULAR WING OF ASPECT RATIO 0.25. William H. Michael, Jr. September 1952. 33p. diagrs., photos. (NACA TN 2790)

Studies were made of the flow in the vicinity of a modified flat-plate rectangular wing of aspect ratio 0.25 by the use of photographs of a tuft grid located at various chordwise positions on the wing and behind the wing, supplemented by wake studies with a yaw-head pitot-tube installation. Evaluations were made concerning the rolling-up of the trailing vorticity, vorticity distribution in the wake, chordwise growth of lift, and locations of the vortex cores.

NACA TN 2794

A COMPARISON OF TWO METHODS OF LINEARIZED CHARACTERISTICS FOR A SIMPLE UNSTEADY FLOW. Roger D. Sullivan. September 1952. 28p. diagrs. (NACA TN 2794)

Two methods of using the concept of linearized characteristics are derived for the one-dimensional unsteady flow in a tube that is rotated about an axis perpendicular to the axis of the tube. One of the methods corresponds to that used by Ferri in his basic work on the subject. Solutions are made by both methods for boundary conditions that allow analytic solutions. Comparisons shows that both methods give the same results but there are significant differences in their application.

NACA TN 2796

EXPERIMENTAL STUDY OF THE EFFECTS OF FINITE SURFACE DISTURBANCES AND ANGLE OF ATTACK ON THE LAMINAR BOUNDARY LAYER ON AN NACA 64A010 AIRFOIL WITH AREA SUCTION. Milton A. Schwartzberg and Albert L. Braslow. October 1952. 35p. diagrs. (NACA TN 2796)

A Langley low-turbulence wind-tunnel investigation of a porous NACA 64A010 airfoil section has been made to determine the effectiveness of area suction in maintaining full-chord laminar flow behind finite disturbances and at angles of attack other than 0°. Area suction resulted in only a small increase in the size of a finite disturbance required to cause premature boundary-layer transition as compared with that for the airfoil without suction. Combined wake and suction drags lower than the drag of the plain airfoil were obtained through a range of low lift coefficient by the use of area suction.

NACA TN 2797

A STUDY OF THE TRANSIENT BEHAVIOR OF SHOCK WAVES IN TRANSONIC CHANNEL FLOWS. Robert V. Hess. October 1952. 32p. diagrs. (NACA TN 2797)

The accuracy of the result obtained in a fundamental paper by Kantrowitz (NACA TN 1225) that a small short-time lowering of the back pressure in steady, shock-free, transonic diffuser flow causes a stationary or trapped shock to form near the critical sonic channel throat is investigated by considering the contribution of a higher-order term in the short-time calculations which was neglected in Kantrowitz's paper. In this higher approximation to the short-time effects, the shock is no longer stationary or trapped unless it is supported by a negative steady-flow back pressure; the result thus is no longer in disagreement with steady-flow solutions for stationary shocks.

NACA TN 2798

AN EXPERIMENTAL INVESTIGATION OF THE BEHAVIOR OF 24S-T4 ALUMINUM ALLOY SUBJECTED TO REPEATED STRESSES OF CONSTANT AND VARYING AMPLITUDES. Herbert F. Hardrath and Elmer C. Utley, Jr. October 1952. 23p. diagrs., 4 tabs. (NACA TN 2798)

A device for adapting R. R. Moore rotating-beam fatigue testing machines for tests in which the amplitude of stress is continuously varied is described. Tests of 24S-T4 aluminum-alloy specimens subjected to stresses of constant amplitude and to stresses with amplitudes varying according to sinusoidal and exponential functions are reported. The results are analyzed by computing the summation of cycle ratios. The values obtained in this analysis were found to be influenced by the shape of the frequency-distribution curve.

NACA TN 2800

SOLUTIONS OF LAMINAR-BOUNDARY-LAYER EQUATIONS WHICH RESULT IN SPECIFIC-WEIGHT-FLOW PROFILES LOCALLY EXCEEDING FREE-STREAM VALUES. W. Byron Brown and John N. B. Livingood. September 1952. 36p. diagrs., 2 tabs. (NACA TN 2800)

Revised solutions of the laminar-boundary-layer equations for cases which involved cooling at the wall combined with large pressure gradients in the main stream produced specific-weight-flow profiles which locally exceeded free-stream values. Heat-transfer and friction coefficients, boundary-layer thicknesses, and velocity, temperature, and specific-weight-flow distributions resulting from the revised solutions are presented for Euler numbers of 0.5 and 1, stream-to-wall temperature ratios of 2 and 4, and cooling-air flow rates through porous walls designated by flow parameters of 0, -0.5, and -1.

NACA TN 2801

INVESTIGATION WITH AN INTERFEROMETER OF THE FLOW AROUND A CIRCULAR-ARC AIRFOIL AT MACH NUMBERS BETWEEN 0.6 AND 0.9. George P. Wood and Paul B. Gooderum. October 1952. 80p. diagrs., photos., tab. (NACA TN 2801)

The flow around a 12-percent-thick circular-arc airfoil at zero incidence was observed by use of an interferometer for small increments of free-stream Mach number from 0.609 to 0.896 with laminar and turbulent boundary layers. Mach number contours in the flow field and Mach number and pressure distributions on the airfoil were obtained. Conditions were determined along and at the bases of the shock waves that interacted with the turbulent boundary layer on the airfoil.

NACA TN 2802

BONDING OF MOLYBDENUM DISULFIDE TO VARIOUS MATERIALS TO FORM A SOLID LUBRICATING FILM. II - FRICTION AND ENDURANCE CHARACTERISTICS OF FILMS BONDED BY PRACTICAL METHODS. Douglas Godfrey and Edmond E. Bisson. October 1952. 16p. diagrs. (NACA TN 2802)

The use of molybdenum disulfide MoS_2 as a solid-film lubricant, in applications where designs or higher temperatures preclude liquid lubricants, is extended because of the good frictional and thermal characteristics of MoS_2. An investigation was conducted to determine (1) practical methods of bonding MoS_2 to materials to form solid-film lubricants and (2) friction and endurance characteristics of films so formed. The results indicated that satisfactory films can be formed by brushing on a mixture of MoS_2 powder and a resin-forming vehicles such as: thinned asphalt-base varnish, silicone-base varnish, or glycerol (1 part, by weight, MoS_2, 2 parts vehicle). Choice of vehicle is governed by application, cleaning, and temperature of curing. Friction and endurance data obtained under high sliding velocities and high surface stress showed that solid-film lubricants (between 0.0002 and 0.0005 in. thick) of MoS_2, bonded with the various resins including corn-syrup resin, resulted in good lubricating effectiveness.

NACA TN 2803

A THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE INFLUENCE OF TEMPERATURE GRADIENTS ON THE DEFORMATION AND BURST SPEEDS OF ROTATING DISKS. P. I. Wilterdink, A. G. Holms and S. S. Manson. October 1952. 45p. diagrs., photo., 2 tabs. (NACA TN 2803)

The purposes of this investigation were to evaluate the influence of temperature gradients and to test the validity of a recently developed method of calculating plastic flow in disks by comparing the calculated results with experimental observations. Short-time spin tests on parallel-sided, 10-inch-diameter disks were conducted under conditions that subjected the disks to a range of temperatures from 70° to 1440°F. The agreement between the theoretical and experimental results was good over the range of temperature conditions investigated. Temperature gradients produced little reduction in the burst speed of the disks which had a high ductility.

NACA TN 2804

THE PLANING CHARACTERISTICS OF A SURFACE HAVING A BASIC ANGLE OF DEAD RISE OF 20° AND HORIZONTAL CHINE FLARE. Walter J. Kapryan and Irving Weinstein. October 1952. 42p. diagrs., photos., 2 tabs. (NACA TN 2804)

A high-speed investigation was conducted to determine the hydrodynamic characteristics of a planing surface having an angle of dead rise of 20° and horizontal chine flare. The data indicate that the planing characteristics at a given trim depend only on lift coefficient. The ratio of center-of-pressure location to the mean wetted length can be considered approximately equal to 0.67 up to 18° of trim. This ratio decreases with further increase in trim. Pile-up of water at the keel of the model was substantial at trims above 12°. Friction drag is negligible at high trims. The resistances for trims of 18° and higher, therefore, may be assumed equal to the load times the tangent of the trim angle.

NACA TN 2807

MEASUREMENTS OF TEMPERATURE VARIATIONS IN THE ATMOSPHERE NEAR THE TROPOPAUSE WITH REFERENCE TO AIRSPEED CALIBRATION BY THE TEMPERATURE METHOD. Lindsay J. Lina and Harry H. Ricker, Jr. October 1952. 23p. diagrs., tab. (NACA TN 2807)

Measurements of temperature variations in the atmosphere near the tropopause over land in the vicinity of Langley Field, Va., are presented. This investigation was made for the purpose of obtaining information on the accuracy of the temperature method (NACA TN 2046) of airspeed calibration over the range of Mach number from 0.6 to 0.8. The temperature surveys and the description of a specially designed thermometer are also presented.

NACA TN 2808

SHORT-BEARING APPROXIMATION FOR FULL JOURNAL BEARINGS. F. W. Ocvirk. Cornell University. October 1952. 61p. diagrs. (NACA TN 2808)

A short-bearing approximation of pressure distribution in the oil film is presented which is an extension of the pressure-distribution function of Michell and Cardullo and includes end-leakage effects. Equations giving applied load, attitude angle, location and magnitude of peak film pressure, friction, and required oil flow rate as functions of the eccentricity ratio are also given. The capacity number, a basic nondimensional quantity resulting from this analysis, is the product of the Sommerfeld number and the square of the length-diameter ratio. Curves determined by this analysis are compared with previously published experimental data and theoretical curves of Sommerfeld and Cameron and Wood. Conclusions reached indicate that this approximation is of practical value for analysis of short bearings.

NACA TN 2810
National Advisory Committee for Aeronautics.
ONE-DIMENSIONAL ANALYSIS OF CHOKED-FLOW TURBINES. Robert E. English and Richard H. Cavicchi. October 1952. 53p. diagrs. (NACA TN 2810)

Flow conditions internal to chocked-flow turbines were subjected to a one-dimensional analysis. Factors affecting the design, operation, and manufacture of such turbines were investigated. Criteria are presented which will aid in analysis of test data from such turbines. The effect of turbine-stator adjustment on internal flow conditions was investigated for one application of turbine stator adjustment.

NACA RM E52H01
National Advisory Committee for Aeronautics.
LUMPED REFLECTOR PARAMETERS FOR TWO-GROUP REACTOR CALCULATIONS. Daniel Fieno, Harold Schneider and Robert B. Spooner. September 1952. 25p. diagrs., tab. (NACA RM E52H01)

Equations are developed to show that, for one-dimensional two-group neutron-distribution calculations, the properties of a neutron-reflector region can be combined in three parameters that effectively represent the action of the reflector. The use of these parameters and boundary conditions based on them for single and multizone reflectors is considered and from the results of computations, the following applications of the parameters are shown: (1) Use of the parameters in connection with reactor core properties for comparison of reflector configurations, (2) direct use of parameters as circuit constants in electrical analog, and (3) use of boundary conditions based on reflector parameters to obtain numerical solutions of two-group equations in a neutron-producing region.

NACA RM E52H11
National Advisory Committee for Aeronautics.
INVESTIGATION OF FLOW FLUCTUATIONS AT THE EXIT OF A RADIAL-FLOW CENTRIFUGAL IMPELLER. Joseph T. Hamrick and John Mizisin. October 1952. 20p. diagrs., photo. (NACA RM E52H11)

Surveys were made at the exit of a radial-flow centrifugal impeller to obtain instantaneous values of velocity from blade to blade and at various positions between the front and rear diffuser walls. Surveys were also made at several radial stations midway between the walls of the diffuser to observe the radial change in flow pattern. At the impeller exit, there were variations in velocity patterns across each passage from passage to passage, and for the same passage from revolution to revolution. The general flow patterns persisted into the diffuser and were still evident at a radius 23 percent greater than that of the impeller.

BRITISH REPORTS

N-17478*

Royal Aircraft Establishment (Gt. Brit.)
CABIN COOLING FLIGHT TESTS ON A TUDOR 2 AIRCRAFT. D. A. Hancock and T. J. Methven. March 1952. 45p. diagrs., photos., 4 tabs. (RAE Tech. Note Mech. Eng. 118)

This note describes a series of flight tests made on a Tudor 2 aircraft as the first stage of the practical determination of the heat loss or gain of aircraft cabins in flight. The prime object of these tests, which were made with an air cycle refrigerator (type C. A. 7.) fitted to the aircraft ventilation system was to obtain data on cabin cooling; but as the refrigerator installation was fully instrumentated, measurements of its performance were obtained. It was found that owing to the large number of variables present and the difficulty in obtaining identical ambient conditions for any two flights, the results obtained were not completely conclusive. It is possible, however, to make general deductions for this particular aircraft, and to indicate future investigations.

N-17479*

Royal Aircraft Establishment (Gt. Brit.)
INVESTIGATION OF RETRACTABLE AILERONS ON RECTANGULAR WING OF PROFILE S. O. 2915. (EXPERIMENTS IN THE BANLÈVE WIND TUNNEL NO. 777, FEBRUARY, 1948). May 1952. 22p. diagrs. (RAE Library Trans. 407. Trans. from Société Nationale de Constructions Aéronautiques du Sud-Ouest. G/9)

The present report completes the investigation of retractable ailerons for the SO. 8000 on a model of a rectangular wing of profile SO. 29 - 15, 1 metre span and 0. 50-m chord quoted in report G/7 of October 1947. The experiments were resumed with type II slotted spoiler (rake type) of which a detailed description is given.

N-17498*

Royal Aircraft Establishment (Gt. Brit.)
THE PERFORMANCE OF VARIOUS TYPES OF RESISTANCE THERMOMETERS FOR OUTSIDE AIR TEMPERATURE MEASUREMENTS FROM AIRCRAFT. D. C. Austin. April 1952. 17p. photos. (RAE Tech. Note EL. 28)

This note gives results and details of a number of flight tests carried out on eight variations of resistance thermometer installations for measurement of outside air temperature from service aircraft. The purpose of the tests was to determine the most suitable type of installation for general service use and to find an alternative thermometer to the existing flat plate type. The magnitude of the possible error due to the velocity of the aircraft is shown and the method of determining this error is given in detail for

information and also as a basis of comparison with similar tests carried out by other establishments. The errors which arise due to other causes are also detailed to indicate the over-all accuracy which can be expected. The thermometer bulbs tested and their associated indicators constitute systems which are considered suitable for installation in all types of aircraft as distinct from the more precise and accurate thermometric systems installed on meteorological aircraft.

N-17499*

Royal Aircraft Establishment (Gt. Brit.)
A MODULATOR CIRCUIT OF THE MAGNETIC AMPLIFIER TYPE. J. Baranowski. March 1952. 41p. diagrs. (RAE Tech. Note EL. 34)

A transductor type modulator with two cores and two cooper-oxide rectifiers which gives a duo-directional d-c. output is described. Current gains of 10 to 20 and power gains of up to a thousand are obtained in a single stage and the output may be fed into a similar modulator or into a conventional magnetic amplifier. A 400 c/s three stage amplifier is also described which incorporates two such modulator circuits and which has a power gain of 10^8 (current gain 1000) for a response time of 0.14 sec with a long term zero stability of 2×10^{-11} watt input power. With further development it is considered that this zero stability could be improved, possibly by a factor of 10.

N-17503*

Royal Aircraft Establishment (Gt. Brit.)
A SIMPLE ESTIMATE OF THE PROFILE DRAG OF SWEPT WINGS. J. Weber and G. G. Brebner. June 1952. 14p. diagrs., tab. (RAE Tech. Note Aero 2168)

It is shown that the profile drag of swept wings near zero lift can be calculated much more simple than might be expected in view of the complicated nature of the three-dimensional boundary layer. Following the approach of Young and Booth, simple charts are derived for obtaining a drag reduction factor due to sweep. The profile drag of a swept wing may be obtained by applying this factor to the results of Squire and Young for two-dimensional airfoils, if the transition position on the swept wing is known. Results of such a calculation are confirmed by experimental data from a 45° sweptback wing of aspect ratio 3.

N-17505*

Royal Aircraft Establishment (Gt. Brit.)
THEORETICAL LOAD DISTRIBUTION ON A WING WITH A CYLINDRICAL BODY AT ONE END. J. Weber. June 1952. 27p. diagrs. (RAE Aero 2467)

A method is derived for calculating the spanwise load distribution over a lifting wing having a long circular-cylindrical body at one end. The solution is derived for arrangements giving minimum induced drag, but can be generalized to obtain approximate results for other plan forms including those with sweepback. Charts are given for the case in which the sectional lift slope is constant along the span. The lift distribution over both wing and body can be determined quickly, or the over-all load obtained directly. The results are applicable to the determination of side forces on a fin in combination with the rear fuselage of an aircraft, or of the lift loading on a wing with a weapon or fuel tank at one tip.

MISCELLANEOUS

NACA TN 2599

Errata No. 1 on "EXPERIMENTAL DETERMINATION OF TIME CONSTANTS AND NUSSELT NUMBERS FOR BARE-WIRE THERMOCOUPLES IN HIGH-VELOCITY AIR STREAMS AND ANALYTIC APPROXIMATION OF CONDUCTION AND RADIATION ERRORS". Marvin D. Scadron and Isidore Warshawsky. January 1952.

UNPUBLISHED PAPERS

N-17248*

THE ROLE OF ELECTRIC POWER IN SUPERSONIC FLIGHT. A. G. Buck. 1952. 8p. (To be delivered before the San Francisco chapter of American Institute of Electrical Engineers on September 12, 1952).

This report gives a brief discussion of some of the many phases of electrical engineering which have gone into the achievement of supersonic flight.

N-17249*

MINIATURE PRESSURE CELLS. Taft Wrathall. 1952. 29p. diagrs., photos. (To be presented at Instrument Society of America conference & exhibit, Cleveland, Ohio, September 8, 1952).

It is the purpose of this paper to show in general terms what has been done by the National Advisory Committee for Aeronautics, in the development of small pressure cells. Construction details and characteristics are briefly discussed.

National Advisory Committee for Aeronautics

Research Abstracts

NO.32 NOVEMBER 7, 1952

CURRENT NACA REPORTS

NACA Rept. 1062

INVESTIGATION OF WEAR AND FRICTION PROPERTIES UNDER SLIDING CONDITIONS OF SOME MATERIALS SUITABLE FOR CAGES OF ROLLING-CONTACT BEARINGS. Robert L. Johnson, Max A. Swikert and Edmond E. Bisson. 1952. ii, 12p. diagrs., photos., tab. (NACA Rept. 1062. Formerly TN 2384)

The wear and the friction of brass, bronze, beryllium copper, monel, Nichrome V, 24S-T aluminum, nodular iron, and gray cast iron sliding against hardened SAE 52100 steel were studied.

NACA Rept. 1064

LUBRICATION AND COOLING STUDIES OF CYLINDRICAL-ROLLER BEARINGS AT HIGH SPEEDS. E. Fred Macks and Zolton N. Nemeth. 1952. ii, 15p. diagrs., 2 tabs. (NACA Rept. 1064. Formerly TN 2420)

Oil inlet distribution (5 methods were investigated) and oil inlet temperature (100° to 205° F) were found to be significant factors in the cooling effectiveness of a given quantity of oil. Dimensional analysis was used to generalize the test-rig results so that it is possible to predict the inner- or outer-race temperatures above oil inlet temperature from a single curve regardless of whether speed, load, oil flow, oil inlet temperature, oil-jet diameter or any combination of the parameters is varied.

NACA Rept. 1068

AUTOMATIC CONTROL SYSTEMS SATISFYING CERTAIN GENERAL CRITERIONS ON TRANSIENT BEHAVIOR. Aaron S. Boksenbom and Richard Hood. 1952. ii, 13p. diagrs. (NACA Rep. 1068. Formerly TN 2378)

An analytical method is presented for the design of automatic controls that starts from certain arbitrary criterions on the behavior of the controlled system and gives those physically realizable equations that the control system can follow in order to realize this behavior. The criterions used are in the form of certain time integrals. General results are shown for systems of second order and of any number of degrees of freedom. Detailed examples for several cases in the control of a turbojet engine are presented.

NACA TN 2779

EFFECTS OF MODERATE BIAXIAL STRETCH-FORMING ON TENSILE AND CRAZING PROPERTIES OF ACRYLIC PLASTIC GLAZING. B. M. Axilrod, M. A. Sherman, V. Cohen and I. Wolock, National Bureau of Standards. October 1952. 42p. photos., diagrs., 4 tabs. (NACA TN 2779)

Effects of approximately 50-percent biaxial stretch-forming on the tensile and crazing properties of polymethyl methacrylate were determined. Specimens from formed and unformed pieces of the same sheets were subjected to standard tensile tests, stress-solvent crazing with benzene, long-time tensile loading, and accelerated weathering. Results indicate that biaxial stretch-forming does not affect the tensile strength or modulus of elasticity but does significantly increase the total elongation and strain and stress at the onset of crazing.

NACA TN 2781

THE EFFECTS OF DYNAMIC LATERAL STABILITY AND CONTROL OF LARGE ARTIFICIAL VARIATIONS IN THE ROTARY STABILITY DERIVATIVES. Robert O. Schade and James L. Hassell, Jr. October 1952. 56p. diagrs., photo., 2 tabs. (NACA TN 2781)

The results of an experimental and theoretical investigation of the effects of large artificial variations of four rotary stability derivatives on the dynamic lateral stability and control of a 45° sweptback-wing airplane model are presented. The experimental results are presented mainly in the form of flight ratings for stability, control, and general flight behavior. Calculations of period and damping and of the response to rolling and yawing disturbances are also presented.

NACA TN 2799

SIMPLE GRAPHICAL SOLUTION OF HEAT TRANSFER AND EVAPORATION FROM SURFACE HEATED TO PREVENT ICING. Vernon H. Gray. October 1952. 19p. diagrs. (NACA TN 2799)

Equations expressing the heat transfer and evaporation from wetted surfaces during ice prevention have been simplified and regrouped to permit solutions by simple graphical means. Working charts for quick and accurate anti-icing calculations are also included.

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NACA TN 2805

AN ENGINEERING METHOD FOR ESTIMATING NOTCH-SIZE EFFECT IN FATIGUE TESTS ON STEEL. Paul Kuhn and Herbert F. Hardrath. October 1952. 35p. diagrs., 7 tabs. (NACA TN 2805)

Neuber's proposed method of calculating a practical factor of stress concentration for parts containing notches of arbitrary size depends on the knowledge of a "new material constant" which can be established only indirectly. In this paper, the new constant has been evaluated for a large variety of steels from fatigue tests reported in the literature, attention being confined to stresses near the endurance limit; reasonably satisfactory results were obtained with the assumption that the constant depends only on the tensile strength of the steel. Even in cases where the notches were cracks of which only the depth was known, reasonably satisfactory agreement was found between calculated and experimental factors. It is also shown that the material constant can be used in an empirical formula to estimate the size effect on unnotched specimens tested in bending fatigue.

NACA TN 2806

COMPARISON OF TWO- AND THREE-DIMENSIONAL POTENTIAL-FLOW SOLUTIONS IN A ROTATING IMPELLER PASSAGE. Gaylord O. Ellis and John D. Stanitz. October 1952. 61p. diagrs. (NACA TN 2806)

A solution is presented for three-dimensional, incompressible, nonviscous, potential flow in a rotating impeller passage with zero through flow. The solution is obtained for a conventional impeller with straight blades but with the inducer vanes removed and the impeller blades extended upstream parallel to the axis of the impeller. By superposition of solutions two additional examples are obtained for different ratios of compressor flow rate to impeller tip speed. The three-dimensional solutions are compared with corresponding two-dimensional solutions and it is concluded that, at least for the type of impeller geometry investigated, two-dimensional solutions can be combined to describe the three-dimensional flow in rotating impellers with sufficient accuracy for engineering analyses.

NACA TN 2811

ON THE CALCULATION OF FLOW ABOUT OBJECTS TRAVELING AT HIGH SUPERSONIC SPEEDS. A. J. Eggers, Jr. October 1952. 25p. diagrs. (NACA TN 2811)

A procedure for calculating three-dimensional steady and nonsteady supersonic flows with the method of characteristics is developed and discussed. An approximate method is deduced from the characteristics method and shown to be of practical value at high supersonic speeds.

NACA TN 2812

EFFECTS OF CYCLIC LOADING ON MECHANICAL BEHAVIOR OF 24S-T4 AND 75S-T6 ALUMINUM ALLOYS AND SAE 4130 STEEL. C. W. MacGregor and N. Grossman. Massachusetts Institute of Technology. October 1952. 53p. diagrs., photos., 4 tabs. (NACA TN 2812)

An investigation was conducted to determine the effects of cyclic loading on the mechanical behavior of 24S-T4 and 75S-T6 aluminum alloys and SAE 4130 steel. Specimens of the three materials were subjected to various numbers of prior fatigue cycles both below and above the fatigue limits. Special slow-bend tests were employed to show the effects of prior cycles of fatigue stressing on the transition temperature to brittle fracture for SAE 4130 steel and on the energy-absorption capacity of the aluminum alloys. Micrographic studies were made to observe and measure crack formation and propagation and additional special tests were conducted to supplement the results of the slow-bend tests. These included Charpy impact tests, microhardness surveys, tension tests, and fretting-corrosion studies.

NACA TN 2814

THE APPLICATION OF PLANING CHARACTERISTICS TO THE CALCULATION OF THE WATER-LANDING LOADS AND MOTIONS OF SEAPLANES OF ARBITRARY CONSTANT CROSS SECTION. Robert F. Smiley. November 1952. 37p. diagrs. (NACA TN 2814)

The general equations governing the fixed-trim water landing of a straight-keel seaplane of arbitrary constant cross section are presented in such a form that the landing motions and loads are expressed in terms of the steady-planing characteristics of the seaplane. In order to verify the general validity of these equations, solutions are made for the water landing of a rectangular flat plate and are compared with experimental impact data. Calculated and experimental time histories of draft, velocity, and load are in good agreement. A survey is made of the available information on seaplane planing characteristics which is suitable for use with the analysis of the paper.

NACA TN 2818

SECOND APPROXIMATION TO LAMINAR COMPRESSIBLE BOUNDARY LAYER ON FLAT PLATE IN SLIP FLOW. Stephen H. Maslen. November 1952. 38p. diagr., tab. (NACA TN 2818)

The first-order solution for the laminar compressible boundary-layer flow over a flat plate at constant wall temperature is given. The effect of slip at the wall as well as the interaction between the boundary-layer flow and the outer stream flow is taken into consideration. The solution is obtained explicitly in terms of the known zero order, or continuum, solution. No assumptions regarding the Prandtl number or viscosity-temperature law need be made. It is found that the first-order solution gives a decrease in

heat transfer and, for supersonic flow, an increase in skin friction. For subsonic flow there is no first-order shear effect. The change in heat transfer is due to slip and the change in friction is due to the interaction of the zero- and first-order velocities at the outer edge of the boundary layer.

NACA RM 52I09

A METER FOR TIMING THE FLOW OF VERY SMALL VOLUMES OF A GAS. J. C. Westmoreland, National Bureau of Standards. October 1952. 17p. diagrs., photos. (NACA RM 52I09)

A flowmeter has been developed which combines a volume-time measurement of the flow, regulation of the rate, and a determination or presetting of the pressure head producing the flow. This meter is capable of accurately metering and controlling very small rates of gas flow within a closed system such as those required in a small capillary tube gas viscosimeter.

NACA RM E52H26

EFFECT OF GEOMETRY ON SECONDARY FLOWS IN BLADE ROWS. A. G. Hansen, G. R. Costello and H. Z. Herzig. October 1952. 38p. photos. (NACA RM E52H26)

The influence of blade-row geometry on secondary flows in a two-dimensional cascade was investigated qualitatively by varying independently the stagger angle, aspect ratio, solidity, angle of attack, and by providing blade fillets. The influence of tip clearance and relative motion between blades and wall was also studied. Stagger angle and aspect ratio had no appreciable effect on this secondary flow, whereas solidity and angle of attack did affect the flow patterns indicating the turning as a major parameter. Blade-tip clearance induced a vortex produced by flow under the blade end which rotated opposite to the original secondary-flow passage vortex. The clearance vortex displaced but did not reduce the secondary-flow vortex. When the wall was moved relative to the blades, the blade leading surfaces "scraped" up entrained fluid near the wall and imparted a roll up motion to the air in this region. On the trailing surface the fluid was pulled off the blade onto the wall. The magnitude of the scraping effect was so large that it masked completely the secondary-flow and tip-clearance phenomena.

NACA TM 1351

ON THE DESIGN OF AIRFOILS IN WHICH THE TRANSITION OF THE BOUNDARY LAYER IS DELAYED. (Kyōkaiso no Sen'i o okuraseru Yokugata no tuite). Itiro Tani. October 1952. 74p. diagrs., 8 tabs. (NACA TM 1351. Trans. from Aeronautical Research Institute, Tokyo Imperial Univ., Rept. 250, v. 19, no. 1, January 1943).

A method is presented for designing suitable thickness distributions and mean camber lines for airfoils permitting extensive chordwise laminar flow. Wind tunnel and flight tests confirming the existence of laminar flow; possible maintenance of laminar flow by area suction; and the effects of wind tunnel turbulence and surface roughness on the promotion of premature boundary-layer transition are discussed. In addition, estimates of profile drag and scale effect on maximum lift of the derived airfoils are made.

BRITISH REPORTS

N-17215*

Aeronautical Research Council (Gt. Brit.) TWO-DIMENSIONAL COMPRESSIBLE FLOW PAST A SOLID BODY SYMMETRICALLY PLACED IN A CHANNEL. P. V. Abdurahiman. 1952. 6p. (ARC R & M 2443. Formerly ARC 11,243; FM 1205)

Goldstein and Lighthill have given a method of finding the effect of compressibility on the potential flow past a symmetrical body, either in unlimited fluid or symmetrically placed in a channel, when the irrotational incompressible flow is known. The object of this paper is to use this method to find the effect of compressibility on the velocity at the point C of an oval placed symmetrically in a channel of breadth h.

N-17216*

Aeronautical Research Council (Gt. Brit.) NOTE ON SIR GEOFFREY TAYLOR'S CRITERION FOR THE RATE OF BOUNDARY-LAYER SUCTION AT A VELOCITY DISCONTINUITY. N. Gregory. 1952. 12p. diagrs., photo. (ARC R & M 2496. Formerly ARC 10,630; Perf. 326; FM 1112)

Sir Geoffrey Taylor's criterion for the rate of boundary-layer suction at a velocity discontinuity is described, and is compared with experimental results obtained from boundary-layer explorations. It is found that, despite neglect of the pressure gradient due to the curvature of the flow, the criterion gives reasonable estimates of the suction quantity. On the other hand, close agreement with velocity profiles is only obtained when the pressure gradient is taken into account.

N-17217*

Aeronautical Research Council (Gt. Brit.) POSSIO'S SUBSONIC DERIVATIVE THEORY AND ITS APPLICATION TO FLEXURAL-TORSIONAL WING FLUTTER. PART I. POSSIO'S DERIVATIVE THEORY FOR AN INFINITE AEROFOIL MOVING AT SUBSONIC SPEEDS. R. A. Frazer. PART II. INFLUENCE OF COMPRESSIBILITY ON THE FLEXURAL-TORSIONAL FLUTTER OF A TAPERED CANTILEVER WING MOVING AT SUBSONIC SPEED. R. A. Frazer and Sylvia W. Skan. 1951. 22p. diagrs., 5 tabs. (ARC R & M 2553. Formerly ARC 4932; ARC 0.205; ARC 5916; ARC 0.274)

The derivative theory due to C. Possio for an infinite airfoil moving at subsonic speeds is reviewed, and certain modifications are proposed. Derivative values are calculated for a Mach number of 0.7 and for values of the frequency parameter λ ranging from 0 to 5.0. For $\lambda < 1$ the derivative values based on a three-point collocation method are in fair

agreement with those given by Possio. For the range $1.0 < \lambda < 2.0$ five-point collocation is necessary, while for $\lambda = 5.0$ even seven-point collocation may prove unsatisfactory. The numerical results obtained are applied in Part II to estimate the influence of compressibility and flying height on the critical speed for flutter of a tapered cantilever wing.

N-17218*

Aeronautical Research Council (Gt. Brit.)
BOUNDARY-LAYER AND WAKE INVESTIGATION IN SUPERSONIC FLOW. J. Lukasiewicz and J. K. Royle. 1952. 22p. diagrs., photos., 2 tabs. (ARC R & M 2613; ARC 12,130. Formerly RAE Aero 2292; SD 31)

The report describes the results of traverses of the boundary layer and wake encountered in a small supersonic tunnel at a Mach number of 2.5. The tunnel was arranged with two throats in parallel formed by two shaped walls enclosing a shaped central element. Both the laminar and turbulent boundary layers were encountered and compared with existing experimental and theoretical results. The frictional drag of the central element as deduced from the wake traverses is in close agreement with that calculated from considerations of laminar boundary-layer growth over the surface of the element. The tests also provide information relating to the design of nozzle profiles, particularly at the point of inflexion, where the changes of pressure gradient may have a serious effect on the boundary layer and on the velocity distribution.

N-17219*

Aeronautical Research Council (Gt. Brit.)
THE NUMERICAL METHOD OF CHARACTERISTICS FOR HYPERBOLIC PROBLEMS IN THREE INDEPENDENT VARIABLES. C. K. Thornhill. 1952. 13p. diagrs. (ARC R & M 2615; ARC 11,767. Formerly Armament Research Establishment Rept. 29/48; Theoretical Research Rept. 4/48)

Recent advances in electronic computing devices suggest that it may soon be feasible to attempt numerical solutions of problems involving three independent variables. In this paper, preliminary consideration is given to the extension of the numerical method of characteristics for hyperbolic equations to the case of three independent variables. A general quasi-linear second-order partial differential equation in three variables is first considered, and the characteristic surfaces and curves are derived, together with the differential relations which hold along them. It is shown that numerical integration should be possible along the faces or edges of a hexahedral grid. The equations are developed in more detail for two special cases of compressible flow, namely steady isentropic supersonic flow in three-dimensional space, and unsteady flow in two dimensions.

N-17227*

Aeronautical Research Council (Gt. Brit.)
TESTS ON A 'GLAUERT' NOSE-SUCTION AEROFOIL IN THE N.P.L. 4-FT. NO. 2 WIND TUNNEL. F. Cheers and Ola Douglas. 1952. 5p. diagrs. (ARC R & M 2356. Formerly ARC 10,507; FM 1096; Perf. 302)

Tests on an 8.65-percent-thick nose-suction airfoil designed by Glauert have been made in the 4-foot No. 2 wind tunnel at the National Physical Laboratory at Reynolds numbers 0.385 and 0.577×10^6. The results show that the section stalls at a lift coefficient of 1.13 without suction. With suction quantities of 0.003, 0.0045, 0.006, and (with a wider slot) 0.012, the values of $C_{L_{max}}$ were respectively 1.32, 1.34, 1.36, and 1.57.

N-17228*

Aeronautical Research Council (Gt. Brit.)
THE FLOW IN AN AXIALLY-SYMMETRIC SUPERSONIC JET FROM A NEARLY-SONIC ORIFICE INTO A VACUUM. P. L. Owen and C. K. Thornhill. 1952. 8p. diagrs. (ARC R & M 2616; ARC 11,768. Formerly Armament Research Establishment Rept. 30/48; Theoretical Research Rept. 5/48)

The numerical method of characteristics is used to calculate the flow in a steady supersonic jet of air issuing from a slightly supersonic circular orifice into a vacuum. The calculations are entirely numerical, and no recourse is made to graphical methods. The characteristic equations for steady supersonic flow with rotational symmetry are first derived, and then special consideration is given to the flow near the axis of symmetry, where the normal step-by-step numerical process breaks down. In the calculation, the Mach angle in the plane of the orifice is taken as 85° to obviate the difficulties of a sonic orifice at which the initial characteristics would be perpendicular to the flow, and the potential equation parabolic. The results should be practically the same as for a sonic orifice. An alternative method of dealing with a sonic boundary plane would have been the use of analytical solutions for the initial flow in this region. The results of the calculations are presented in diagrams. The solution is a universal solution insofar that it applies to any similar jet, flowing into any external pressure, in that region bounded by the orifice and the first wave front which registers the existence of an external pressure outside the jet. This fact allows the calculated pressure distribution along the axis of symmetry to be compared with experimental measurements in air jets with finite pressure ratios, and good agreement is obtained.

N-17229*

Aeronautical Research Council (Gt. Brit.)
PRESSURE DISTRIBUTIONS AT HIGH SPEED ON EC 1250 (DATA REPORT). J. A. Beavan and G. A. M. Hyde. 1952. 12p. diagrs. (ARC R & M 2625. Formerly ARC 10,729; Perf. 331; FM 1132)

This report puts on record, as data, pressure distributions measured on a 5-in. chord airfoil of EC 1250 section in the 20- by 8-inch rectangular high-speed tunnel at the National Physical Laboratory.

N-17230*

Aeronautical Research Council (Gt. Brit.)
FOUR- AND EIGHT-CHANNEL DESYNN GRAPHICAL RECORDERS. F. R. J. Spearman. 1952. 6p. photos. (ARC R & M 2636; ARC 11,495. Formerly RAE Tech. Note Instn. 119)

A four-channel recorder, providing continuous traces against time on photographic film, has been developed for use with any instruments embodying Desynn transmitters. It is suitable for the measurement of quantities which vary with a maximum frequency of 3 cps. It is made from F.24 camera component parts, and uses the standard magazine and 5-in. wide film. It has been successfully used for flight trials; manufacturing drawings are available. An eight-channel version, of which two or three may be coupled together, is under development.

N-17231*

Aeronautical Research Council (Gt. Brit.)
A THEORETICAL INVESTIGATION INTO THE LATERAL STABILITY OF AN AEROPLANE CONTROLLED BY AN AUTOMATIC PILOT, WITH PARTICULAR REFERENCE TO THE EFFECT OF FLIGHT PATH ANGLE. T. W. Prescott. 1952. 11p. diagrs. (ARC R & M 2640; ARC 11,409. Formerly RAE Tech. Note IAP 974)

Several autopilots produce aileron deflection proportional to the movement between the airplane and the outer gimbal of a vertical gyroscope. In nonlevel flight, this relative movement is not equal to the rotation of the airplane about its x-axis, and it was desirable to investigate the lateral stability for steep angles of climb and dive. Calculations show that instability does occur, but that stability can be restored either by making the rudder deflection dependent on aileron movement in order to counteract the aileron drag coefficient, or by adding a rate of yaw term to the rudder circuit. The addition of both aileron and rate terms to the rudder circuit is greatly superior to the addition of either term alone. The aileron drag coefficient can also have a detrimental effect at the start of an automatic turn, and response curves during entry into the turn have been calculated for various degrees of aileron drag compensation. The bank angle and sideslip response curves are unaffected by the compensation. The rate of turn response is improved during the first second but subsequently is little affected by aileron drag compensation.

N-17232*

Aeronautical Research Council (Gt. Brit.)
ON A THEORY OF SANDWICH CONSTRUCTION. W. S. Hemp. 1952. 9p. (ARC R & M 2672; ARC 11,568. Formerly College of Aeronautics, Cranfield Rept. 15)

The theory of sandwich construction developed in this paper proceeds from the simple assumption that the filling has only transverse direct and shear stiffnesses, corresponding to its function requirements. This supposition permits integration of the equilibrium equations for the filling. The resulting integrals are used to study the compression buckling of a flat sandwich plate. The formulas obtained are complex, but may be simplified in practical cases. A second approach to sandwich problems is made in section 5, where a theory of "bending" of plates is outlined. This generalizes the usual theory, making allowance for flexibility in shear. This approach is applied to over-all compression buckling of a plate and agreement with the previous calculations is found. This suggests the possibility of calculating buckling loads for curved sandwich shells. A simple example, the symmetrical buckling of a circular cylinder in compression, is worked out. The theory developed would seem applicable to all cases of buckling of not too short a wave length.

N-17233*

Aeronautical Research Council (Gt. Brit.)
SERVICE FAILURES IN AIRCRAFT STRUCTURES ASSOCIATED WITH FATIGUE, REPEATED OR DYNAMIC LOADS. J. B. B. Owen. 1952. 13p. diagrs., photos. (ARC R & M 2688; ARC 9426. Formerly RAE SME 3384)

This note gives examples and photographs of several structural defects which have occurred in service and shows that, although many failures may be due to fatigue or the application of excessive static loads, some are probably influenced by the repeated application of loads of high intensity, and by loads of a dynamic character. It is suggested that changes in design aimed at (1) eliminating the loads causing failure, for example, reducing in one case tab backlash, and (2) alleviating stress concentrations are ways of reducing the incidence of defects due to repeated loading.

N-17535*

Aeronautical Research Council (Gt. Brit.)
NOTES ON HELICOPTER ROTOR BEHAVIOUR AFTER ENGINE FAILURE IN HOVERING FLIGHT. W. Stewart and G. J. Sissingh. 1952. 6p. diagrs. (ARC R & M 2659; ARC 12,525. Formerly RAE Tech. Note Aero 1997)

Calculations have been made of the changes in rotor speed following engine failure on a typical helicopter in hovering flight. Various time functions for the collective pitch operation are considered. The results are in excellent agreement with the one recorded case of an actual power failure in hovering flight. Rapid pilot action in reducing the collective pitch after engine failure is essential to prevent dangerously low rotational speed of the blades. The possibilities of automatic pitch reduction or of a power failure warning to the pilot are considered.

N-17536*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE APPLICATION OF THWAITES' NUMERICAL METHOD FOR THE DESIGN OF CAMBERED AEROFOILS. A. R. Curtis. 1952. 13p. 6 tabs. (ARC R & M 2665. Formerly ARC 12,154; FM 1336; Perf.531)

Some minor developments in the technique of Thwaites' numerical method of airfoil design are

described. In particular, the process of obtaining the camber-line ordinates from the Goldstein approximation I velocity distribution is discussed in detail; the relevant tables of constants are given. An opportunity is taken to include a complete set of 20-point tables of conjugation factors needed in any actual application of the numerical methods. The theory underlying these tables is given by Watson in R & M 2716.

N-17537*

Aeronautical Research Council (Gt. Brit.)
A THEORETICAL EXAMINATION OF THE EFFECT OF DEADRISE ON WETTED AREA AND ASSOCIATED MASS IN SEAPLANE-WATER IMPACTS. R. J. Monaghan. 1952. 16p. diagrs. (ARC R & M 2681; ARC 12,395. Formerly RAE Tech. Note Aero 1989)

A theoretical examination is made of the dead rise effect on associated mass and wetted area in the two-dimensional impact case (vertical drop of an infinitely long wedge at zero attitude). Available estimates are summarized and a new theoretical formula is developed by means of an expanding prism flow which gives results for associated mass in very close agreement with those given by Wagner's semi-empirical formula (on which most of the estimates of three-dimensional associated mass have so far been based). In addition, the new treatment gives a formula for wetted area which is not available from Wagner's treatment except for very small values of dead rise angle. Comparison is made between these and other formulas in the light both of theory and experiment and a brief survey is made of the assumptions involved in applying associated mass methods to motions through a free surface.

N-17538*

Aeronautical Research Council (Gt. Brit.)
SYSTEMATIC WIND-TUNNEL TESTS WITH SLATS ON A 10 PER CENT THICK SYMMETRICAL WING SECTION (EQ 1040 PROFILE). G. F. Moss. 1952. 22p. diagrs., 6 tabs. (ARC R & M 2705; ARC 12,068. Formerly RAE Aero 2294)

It was thought that present rules for the design of Handley Page slats might be inadequate for modern high-speed airfoil sections. These tests were made on the EQ 1040 wing section to determine the optimum slat setting for this type of wing profile. Three slats were tested whose chords were 10 percent, 20 percent, and 30 percent of the wing chord, over a wide range of positions. Lift coefficients were measured over the stall in each case. Some tests were made with a split flap. Best results for the 10-percent chord slat are obtained with very small gap and large dip. Zero gap, that is, using the slat as a nose flap, may in fact give the optimum. Optimum positions for the larger chord slats are more conventional, but require larger forward extensions than are given by the old rules.

N-17539*

Aeronautical Research Council (Gt. Brit.)
NOTE ON SEMI-EXPERIMENTAL METHODS FOR THE DETERMINATION OF AERODYNAMIC DERIVATIVES FOR AN OSCILLATING WING-AILERON SYSTEM. P. F. Jordan. 1952. 6p. diagrs., tab. (ARC R & M 2706; ARC 12,042. Formerly RAE Tech. Note Structures 28)

A brief survey is given of existing semiexperimental methods for the determination of two-dimensional aerodynamic derivatives for unsteady motion of a wing-aileron system (and, in particular, for aerodynamically balanced controls); a comparison with (partly unpublished) experimental data is made. The result is encouraging for further investigations.

N-17540*

Aeronautical Research Council (Gt. Brit.)
TESTS ON A MODEL BODY-WING COMBINATION AT SUPERSONIC SPEED. P. J. Wingham. 1951. 4p. diagrs. (ARC R & M 2711. Formerly ARC 8229; Ae. 2663; FM 759)

The tests described in this report were made in the 1-foot circular tunnel at the National Physical Laboratory at a Mach number of about 1.4. The main object was to determine the lift obtainable from wings of very short span and in particular to see whether the lift curve departed much from a straight line at incidences up to about 12°, it being already known that the lift curve for a two-dimensional airfoil was sensibly straight up to 20° or so of incidence. Unfortunately it was not possible to measure the drag load, so that only normal-force and pitching-moment values are available.

N-17541*

Aeronautical Research Council (Gt. Brit.)
A METHOD FOR DETERMINING THE WATER STABILITY OF A SEAPLANE IN TAKE-OFF AND LANDING. H. G. White and A. G. Smith. 1952. 17p. diagrs. (ARC R & M 2719; ARC 6834. Formerly MAEE Rept. H/Res/163)

A direct method of determining the water stability in take-off and landing of full-scale seaplanes is described. The customary method of measuring full-scale stability is by steady runs over a range of speed and attitudes. This is tedious; it does not give the true take-off stability and does not give the landing stability. The steady-run stability is assumed to correspond very closely to the take-off stability but was originally used to obtain full-scale conditions comparable with model scale. This report gives a method of analysis of take-off records of attitude against speed, and results obtained by this method are compared with the steady-run results. Results on the Scion fitted with a 1/2-scale Sunderland hull and Saro with a 1/2.75-scale Shetland hull are used to establish the method, but it has also been checked against the available date on the full-scale Seal and Sunderland I. The take-off stability limits show remarkable agreement with the corresponding steady run limits (to within $1/2^{\circ}$) of the Scion and Saro. Evidence on the Seal and Sunderland is insufficient for a definite conclusion in these cases, but there is no disagreement

between the results obtained. The method is accurate and quick to use, but takes no account of the amplitude of porpoising so that a few steady runs would still be necessary to establish this where required. By use of this method, the investigation of the stability characteristics of a seaplane under different conditions of weight, c.g., and flap angle can proceed quickly on the evidence of about eight take-off records at each condition, these records covering the full attitude range. The method may also be applied to find landing stability from landing records.

N-17542*

Aeronautical Research Council (Gt. Brit.)
THE HULL LAUNCHING TANK (DESCRIPTIVE). A. G. Smith, G. C. Abel and W. Morris. 1952. 22p. diagrs., photos. (ARC R & M 2723; ARC 6804. Formerly MAEE Rept.H/Res/161)

The hull launching tank has been built in order that systematic measurements of impact pressures can be made on large model seaplane hulls to supplement full-scale tests, and to cover conditions of impact which would be dangerous full scale. The object is to obtain generalized formulas for the maximum local pressures, the total impact load, and the simultaneous distribution of pressure on any hull form for any impact condition. The report describes the hull launching tank and apparatus, the range of impact conditions possible for test, and the methods developed for measuring the parameters which affect the impact loads. Theoretical considerations, the results of tests and further developments, will be found in existing or in subsequent reports.

N-17543*

Aeronautical Research Council (Gt. Brit.)
SOME ELECTRICAL INTEGRATING CIRCUITS AND THEIR USE IN THE MEASUREMENT OF LOW FREQUENCY VIBRATION AMPLITUDES. G. R. Richards. 1952. 18p. diagrs. (ARC R & M 2724; ARC 11,639. Formerly RAE Tech.Note Instn.121)

The note investigates the possibility of making low frequency vibration measurements by the use of electronic acceleration measuring equipment in conjunction with electrical doubly integrating circuits. It is shown that by this method many of the disadvantages associated with the use of seismic displacement units can be obviated particularly over the frequency range 2 to 40 cps. Three electrical integrating methods are discussed, the correct circuit conditions for the integration of periodic sinusoidal, rectangular and triangular waveforms are derived. A description is given of an existing acceleration measuring equipment incorporating two of the described integration networks; its sensitivity, frequency response, and methods of increasing these factors are discussed in detail.

N-17544*

Aeronautical Research Council (Gt. Brit.)
AN EXPERIMENTAL INVESTIGATION OF THE FLOW THROUGH A HELICOPTER ROTOR IN FORWARD FLIGHT. P. Brotherhood and W. Stewart. 1952. 12p. diagrs., photos. (ARC R & M 2734; ARC 12,894. Formerly RAE Aero 2330)

Experiments have been made to determine the flow conditions through a helicopter rotor in forward flight using the smoke filament technique. This method consisted of flying the helicopter behind an aircraft from which smoke generators were suspended on a long wire. The smoke trails passed through the main rotor of the helicopter, and photographs were taken from another aircraft in a side position. Flow conditions at the rotor disk over a narrow bend on the side of the advancing blade were investigated in this way. The range of speeds covered was from 44 mph to 60 mph corresponding to a range of tip speed ratios 0.138 to 0.188. An increase in induced velocity from front to rear of the rotor disk was obtained. The results are in reasonable agreement with theoretical predictions.

N-17545*

Aeronautical Research Council (Gt. Brit.)
EFFECT OF RATE AND DURATION OF LOADING ON THE STRENGTH OF AIRCRAFT STRUCTURES. K. D. Raithby. 1952. 13p. photos., diagrs., 5 tabs. (ARC R & M 2736; ARC 12,600. Formerly RAE Structures 39)

The effects of rate and duration of loading on the structural strength of aircraft have been investigated by comparing the failing loads of both wooden and metal tail planes when tested at different rates of loading, the duration of test varying from about 6 seconds to 3-3/4 hours. With wooden structures, differences in strength due to rate of loading were much less than those predicted from the results of American tests on wood. With metal structures, neither rate of loading nor sustained high loading had any appreciable effect on the failing load.

N-17546*

Aeronautical Research Council (Gt. Brit.)
A DISTANT READING MANOMETER WITH PARTICULAR APPLICATION TO THE MEASUREMENT OF SMALL PRESSURES. A. S. Halliday and H. Deacon. 1952. 5p. diagrs., photos. (ARC R & M 2744. Formerly ARC 11,566; TP 247; S & C 2227; Perf. 457)

The function of the manometer is to enable small pressure differences to be measured at a distance. The instrument will measure either the difference of two pressures or a single pressure relative to atmosphere.

N-17547*

Aeronautical Research Council (Gt. Brit.)
FORCED FLOW AGAINST A ROTATING DISC. D. M. Hannah. 1952. 17p. diagrs., 7 tabs. (ARC R & M 2772. Formerly ARC 10,482; FM 1088)

The steady motion of an incompressible viscous fluid due to an infinite rotating plane lamina has been considered by von Kármán and by Cochran; the motion of fluid flowing with axial symmetry towards an infinite stationary plane lamina has been dealt with by Homann. The present paper deals with the general

question of steady irrotational flow with axial symmetry against an infinite rotating lamina, of which the above are two special cases.

N-17587*

National Gas Turbine Establishment (Gt. Brit.)
THE FOULING OF TURBINE BLADING BY THE PRODUCTS OF COMBUSTION OF PULVERISED FUEL. PART I. THE DESIGN AND DEVELOPMENT OF THE COMBUSTION SYSTEM. R. I. Hodge. June 1952. 35p. diagrs., photos. (NGTE Memo. M.154)

This memorandum describes the construction of the pulverized fuel combustion chamber and the ancillary equipment at present installed at the National Gas Turbine Establishment, Whetstone, to conduct an investigation into the effect on blading of the operation of an open cycle turbine fired with pulverized fuel. The developments found necessary to give effective flame stability in this particular combination of precombustion and balanced vortex chambers are set forth. Both the conditions assumed in the design and those calculated to be obtaining at what was subsequently found to be the point of optimum operation (based on combustion efficiency) are given. The analysis of the state of the exhaust products given at the end of this note is not complete but provides some idea of the basic medium of the blade-fouling test conditions.

N-17657*

Forest Products Research Lab. (Gt. Brit.)
REVISED MANUAL FOR CONDUCTING TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE.
R. A. G. Knight. June 1952. ii, 14p. (Forest Products Research Lab. PRP 8/1)

The Composite Wood Section of the Forest Products Research Laboratory is completely equipped with machinery and plant for the manufacture of plywood of all types. The peeler will take billets up to 5 ft 6 in. long and 4 ft 6 in. diameter and the press will make boards up to 5 ft square. With equipment of this scale, an appraisal can be made of the value of a timber for plywood manufacture, and problems at any stage of the process can be investigated under conditions comparable with those in commercial factories - but distinct from them in that the needs of continuous production are absent. These investigations are made to a prescribed plan so as to apply uniform standards to all timbers, and the results are issued by the Laboratory as Progress Reports in the series "Trials of Timbers for Plywood Manufacture." The plan was originally prepared in collaboration with the Plywood Research Panel, and circulated as Paper P. R. P. 5/1, "Manual for Conducting Trials of Timbers for Plywood Manufacture" in August 1950. After experience with the Manual in tests on 26 species, the Panel saw that improvements could be made that would simplify the work and increase the practical value of the data obtained, so the present Revised Manual was then compiled. The original Paper P. R. P. 5/1 is applicable to reports up to No. 15, but for No. 16 and onwards, the methods of P. R. P. 8/1 apply. The changes are not such as to nullify comparison between the earlier and later reports.

N-17722*

Royal Aircraft Establishment (Gt. Brit.)
HEAT TRANSFER AND PRESSURE LOSSES IN COOLING DUCTS OF GENERATORS. Mary D. Wright. June 1952. 17p. diagrs., 3 tabs. (RAE Tech. Note EL. 39)

In connection with the cooling of aircraft generators an investigation has recently been made to determine the pressure drop and heat transfer in the cooling channels of an armature. In this note an attempt has been made to correlate the results with theoretical and established empirical relationships. The description of the apparatus and experimental techniques which were used will be described in a later report.

N-17723*

Ministry of Supply (Gt. Brit.)
DEVELOPMENT OF A PRE-STALL DETECTOR FOR AIRCRAFT. R. T. Youngman. July 1952. 7p. diagrs. (MOS S & TM 6/52)

This report describes a stall warning detector which has been developed by the Ministry of Supply. It depends for its operation upon the pressure changes which occur on the undersurface of a wing. At certain points, the pressure increases at a fairly constant rate with increase in angle of incidence. A detector which operates on this principle has the advantage that there are no external parts.

N-17726*

Royal Aircraft Establishment (Gt. Brit.)
FATIGUE PROPERTIES AT LOW TEMPERATURE ON TRANSVERSE AND LONGITUDINAL NOTCHED SPECIMENS OF D. T. D. 363A ALUMINIUM ALLOY. N. J. F. Gunn. June 1952. 23p. diagrs., photo., 11 tabs. (RAE Tech. Note Met. 163)

Tests have been made to ascertain the effect of a specified subnormal temperature (-40° C) on the notched and unnotched fatigue strength of the material. The test pieces were machined from a 5-inch diameter, extruded D. T. D. 363A bar so that their axes coincided with the longitudinal and transverse directions of the parent bar. The results of the tests showed that some increase in fatigue strength is evident at -40° C for longitudinal specimens but no appreciable change for transverse specimens is apparent.

MISCELLANEOUS

NACA ARR L4F26

Errata No. 1 on "DESIGN OF POWER-PLANT INSTALLATIONS PRESSURE-LOSS CHARACTERISTICS OF DUCT COMPONENTS". John R. Henry. June 1944.

National Advisory Committee for Aeronautics

Research Abstracts

NO. 33 DECEMBER 3, 1952

CURRENT NACA REPORTS

NACA Rept. 1050

FORMULAS FOR THE SUPERSONIC LOADING, LIFT AND DRAG OF FLAT SWEPT-BACK WINGS WITH LEADING EDGES BEHIND THE MACH LINES. Doris Cohen. 1951. iii, 40p. diagrs. (NACA Rept. 1050)

The method of superposition of linearized conical flows has been applied to the calculation of the aerodynamic properties, in supersonic flight, of thin flat, swept-back wings at an angle of attack. The wings are assumed to have rectilinear plan forms, with tips parallel to the stream, and to taper in the conventional sense. The investigation covers the moderately supersonic speed range where the Mach lines from the leading-edge apex lie ahead of the wing. The trailing edge may lie ahead of or behind the Mach lines from its apex. The case in which the Mach cone from one tip intersects the other tip is not treated. Formulas are obtained for the load distribution, the total lift, and the drag due to lift. For the cases in which the trailing edge is outside the Mach cone from its apex (supersonic trailing edge), the formulas are complete. For the wing with both leading and trailing edges behind their respective Mach lines, a degree of approximation is necessary. It has been found possible to give practical formulas which permit the total lift and drag to be calculated to within 2 or 3 percent of the accurate linearized-theory value. The local lift can be determined accurately over most of the wing, but the trailing-edge-tip region is treated only approximately. Charts of some of the functions derived are included to facilitate computing, and several examples are worked out in outline.

NACA Rept. 1063

AIRFOIL PROFILES FOR MINIMUM PRESSURE DRAG AT SUPERSONIC VELOCITIES-GENERAL ANALYSIS WITH APPLICATION TO LINEARIZED SUPERSONIC FLOW. Dean R. Chapman. 1952. ii, 14p. diagrs. (NACA Rept. 1063. Formerly TN 2264)

A derivation is presented of the basic equations which determine the supersonic airfoil profile having minimum pressure drag for certain prescribed structural requirements. The basic equations are applicable to a variety of practical structural requirements, and can be used with either linear, second order, or shock-expansion airfoil theory. A solution of the basic equations is found in closed form using linear airfoil theory. The results show that in most cases the optimum profile has a blunt trailing edge. The optimum distribution of thickness depends on the Mach number, airfoil-thickness ratio, and base pressure coefficient. The pressure drag of the optimum profile is compared to that of the biconvex and double-wedge profiles. A graphical method of determining an optimum airfoil is developed and applied to several examples.

NACA Rept. 1067

GENERALIZATION OF BOUNDARY-LAYER MOMENTUM-INTEGRAL EQUATIONS TO THREE-DIMENSIONAL FLOWS INCLUDING THOSE OF ROTATING SYSTEM. Artur Mager. 1952. ii, 16p. diagrs. (NACA Rept. 1067. Formerly TN 2310).

Boundary-layer equations for application in three-dimensional flows are developed. With the use of a fixed velocity profile and an empirical friction law an approximate solution in closed integral form is obtained for a generalized boundary-layer momentum-loss thickness and flow deflection at the wall in the turbulent case. A numerical evaluation of this solution carried out for data obtained in a curving non-rotating duct shows a fair quantitative agreement with the measured values.

NACA TN 2809

EXPERIMENTAL INVESTIGATION OF ECCENTRICITY RATIO, FRICTION, AND OIL FLOW OF SHORT JOURNAL BEARINGS. G. B. DuBois and F. W. Ocvirk, Cornell University. November 1952. 79p. diagrs., photos., 4 tabs. (NACA TN 2809)

An experimental investigation was conducted to obtain performance data on bearings of length-diameter ratios of 1, 1/2, and 1/4 for comparison with theoretical curves. A 1.375-inch-diameter bearing was tested at speeds up to 6000 rpm and with unit loads from 0 to 900 pounds per square inch. Experimental data for eccentricity ratio and friction followed single lines when plotted against a theoretically derived capacity number, which is equal to Sommerfeld number times the square of the length-diameter ratio. The form of the capacity number indicates that under certain conditions the eccentricity ratio is theoretically independent of bearing diameter. A method of plotting oil flow data as a single line is shown. Methods are also discussed for approximating a maximum bearing temperature and evaluating the effect of deflection or misalinement on the eccentricity ratio at the ends of the bearings.

NACA TN 2813

THEORY AND PROCEDURE FOR DETERMINING LOADS AND MOTIONS IN CHINE-IMMERSED HYDRODYNAMIC IMPACTS OF PRISMATIC BODIES. Emanuel Schnitzer. November 1952. 51p. diagrs. (NACA TN 2813)

*AVAILABLE ON LOAN ONLY.

ADDRESS REQUESTS FOR DOCUMENTS TO NACA, 1724 F ST., NW., WASHINGTON 25, D. C., CITING CODE NUMBER ABOVE EACH TITLE, THE REPORT TITLE AND AUTHOR.

A theoretical method is derived for computing the motions and hydrodynamic loads during water landings of prismatic bodies involving appreciable immersion of the chines. A simplified method of computation covering flat-plate and V-bottom bodies with beam-loading coefficients greater than unity is given as a separate section. Comparisons of theory with experiment are presented as plots of impact lift coefficient and maximum draft-beam ratio against flight-path angle and as time histories of loads and motions. Fair agreement is found to exist for chine-immersed landings for angles of dead rise of 0° and 30°, beam-loading coefficients from 1 to 36.5, flight-path angles from 2° to 90°, and trims from 6° to 45°.

NACA TN 2815

A THEORETICAL INVESTIGATION OF THE EFFECT OF PARTIAL WING LIFT ON HYDRODYNAMIC LANDING CHARACTERISTICS OF V-BOTTOM SEAPLANES IN STEP IMPACTS. Joseph L. Sims and Emanuel Schnitzer. November 1952. 20p. diagrs. (NACA TN 2815)

A theoretical investigation is made of the loads and motions in water-landing impacts of wide prismatic V-bottom seaplanes for constant partial wing-lift conditions where the resultant velocity of the seaplane is normal to the keel. An approximate method is given for applying the results of this investigation to the more general case of oblique impact. The increase in vertical hydrodynamic load factor due to wing-lift reduction is shown to be approximately 133 percent of the decrease in air load.

NACA TN 2816

WATER-PRESSURE DISTRIBUTIONS DURING LANDINGS OF A PRISMATIC MODEL HAVING AN ANGLE OF DEAD RISE OF $22\text{-}1/2^{\circ}$ AND BEAM-LOADING COEFFICIENTS OF 0.48 AND 0.97. Robert F. Smiley. November 1952. 37p. diagrs., 6 tabs. (NACA TN 2816)

As part of an over-all program, smooth-water landing tests of a prismatic float having an angle of dead rise of $22\text{-}1/2^{\circ}$ were made. Water-pressure, velocity, draft, and acceleration data are presented. Landings were made for beam-loading coefficients of 0.48 and 0.97 at fixed trims between 0.2° and 30.3° for a range of flight-path angles from 4.6° to 25.9° and also for 90°. The experimental pressure distributions are found to be in fair agreement with the predictions of the available theory; however, better agreement is obtained by modification of the theory.

NACA TN 2817

A THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF YAW ON PRESSURES, FORCES, AND MOMENTS DURING SEAPLANE LANDINGS AND PLANING. Robert F. Smiley. November 1952. 98p. diagrs., 7 tabs. (NACA TN 2817)

A theory for the side force, rolling moment, yawing moment, and pressure distribution during yawed landings and planing of seaplanes was developed. For the special case of the straight-sided wedge without chine immersion, the results of the theoretical analysis are presented in the form of generalized curves covering all step landing conditions. Experimental impact and planing data are presented for a prismatic wedge having an angle of dead rise of 22.5° and are shown to be in reasonable agreement with the theoretical predictions.

NACA TN 2819

EFFECT OF HIGH-LIFT DEVICES ON THE STATIC-LATERAL-STABILITY DERIVATIVES OF A 45° SWEPTBACK WING OF ASPECT RATIO 4.0 AND TAPER RATIO 0.6 IN COMBINATION WITH A BODY. Jacob H. Lichtenstein and James L. Williams. November 1952. 50p. diagrs., photos., 5 tabs. (NACA TN 2819)

This paper contains the results of wind-tunnel tests to determine the effects of plain and split trailing-edge flaps, with and without leading-edge slats, on the low-speed static-lateral-stability derivatives of a 45° sweptback-wing—body configuration. Comparisons between the increments obtained from experiment and those evaluated by simple sweep theory in combination with measured lift and drag increments are also made.

NACA TN 2820

AN ANALYSIS OF THE ERRORS IN CURVE-FITTING PROBLEMS WITH AN APPLICATION TO THE CALCULATION OF STABILITY PARAMETERS FROM FLIGHT DATA. Marvin Shinbrot. November 1952. 29p. diagrs., 2 tabs. (NACA TN 2820)

The problem of assessing the errors in the parameters obtained from a curve-fitting process is considered, and a scheme which may be applied toward the solution of such problems is obtained. This method is then specialized to the problem of finding the errors in the calculated stability parameters of an airplane, and an example is given.

NACA TN 2821

TORSION TESTS OF ALUMINUM-ALLOY STIFFENED CIRCULAR CYLINDERS. J. W. Clark and R. L. Moore, Aluminum Company of America. November 1952. 38p. diagrs., photos., 2 tabs. (NACA TN 2821)

Results are presented for the second series of torsion tests on aluminum-alloy stiffened circular cylinders, the first series having been reported in NACA ARR 4E31. The cylinders were similar in construction except that the wall thickness was 0.020 inch for the first series and 0.032 inch for the second series. The significant observation from both series of tests are summarized and some comparisons are made with more recent theoretical work.

NACA TN 2823

LANGLEY FULL-SCALE-TUNNEL INVESTIGATION OF THE MAXIMUM-LIFT AND STALLING CHARACTERISTICS OF A TRAPEZOIDAL WING OF ASPECT RATIO 4 WITH CIRCULAR-ARC AIRFOIL SECTIONS. Roy H. Lange. November 1952. 24p. diagrs., photos. (NACA TN 2823. Formerly RM L7H19)

Results are given of an investigation at high Reynolds numbers and low Mach numbers to determine the maximum-lift and stalling characteristics of a trapezoidal wing of aspect ratio 4 with 10-percent-thick, circular-arc airfoil sections. The tests included measurements of the lift, the drag, and the pitching-moment coefficients of the basic wing and of the wing with 0.20-chord droop-nose and trailing-edge flaps deflected both alone and in various combinations. Scale effects were investigated at Reynolds number ranging from 3.27×10^6 to 7.67×10^6.

NACA TN 2824

EFFECTS OF INDEPENDENT VARIATIONS OF MACH NUMBER AND REYNOLDS NUMBER ON THE MAXIMUM LIFT COEFFICIENTS OF FOUR NACA 6-SERIES AIRFOIL SECTIONS. Stanley F. Racisz. November 1952. 32p. diagrs., 2 tabs. (NACA TN 2824)

The NACA 65-006, 64-009, 64-210, and 64_2-215 airfoil sections were tested in the Langley low-turbulence pressure tunnel to determine the effects of independent variations of Mach number and Reynolds number on the maximum-lift characteristics for the smooth and rough conditions. The lift characteristics were determined at constant Reynolds numbers ranging from 1.5×10^6 to 9.0×10^6 for Mach numbers which varied from 0.1 to approximately 0.5 for each Reynolds number.

NACA TN 2825

A COMPARATIVE EXAMINATION OF SOME MEASUREMENTS OF AIRFOIL SECTION LIFT AND DRAG AT SUPERCRITICAL SPEEDS. Gerald E. Nitzberg and Stewart M. Crandall. November 1952. 30p. diagrs. (NACA TN 2825)

Systematic trends in the lift- and drag-coefficient variation with Mach number for a number of relatively thick airfoil sections at moderately supercritical speeds are pointed out. Shortcomings of transonic similarity rules are discussed and a semi-empirical correlation of drag data is presented. Differences between the drag curves for various airfoils are reduced by basing drag coefficient on total pressure rather than dynamic pressure. The initial supercritical loss of lift of airfoil sections having supersonic flow over the upper surface only is shown to result primarily from pressure changes on the lower surface.

NACA TN 2826

SIMULATION OF LINEARIZED DYNAMICS OF GAS-TURBINE ENGINES. J. R. Ketchum and R. T. Craig. November 1952. 25p. diagrs., photo. (NACA TN 2826)

A general method of simulation is presented, whereby linearized dynamics of gas-turbine engines may be simulated in most orderly fashion with greatest economy of equipment and with most direct use of engineering data. Correlation of experimental and simulated responses of a turbojet engine are shown. Use of generalization factors in determining the coefficients necessary for simulation of engine dynamics is discussed.

NACA TN 2827

INVESTIGATION OF A DIFFRACTION-GRATING INTERFEROMETER FOR USE IN AERODYNAMIC RESEARCH. James R. Sterrett and John R. Erwin. November 1952. 36p. photos., diagrs. (NACA TN 2827)

A low-cost interferometer that is easy to adjust and has a large field of view is described. This instrument, which is based on a principle discovered by Kraushaar, uses small diffraction gratings to produce and recombine separate beams of light. The usual two-parabolic-mirror schlieren system can be converted inexpensively into a diffraction-grating interferometer. Experimental data are presented to verify the ability of the instrument to provide valid and reliable measurements of air density. Photographs of the flow in a supersonic cascade tunnel are included to indicate the quality of the interferograms obtained.

NACA TN 2828

EFFECT OF A FINITE TRAILING-EDGE THICKNESS ON THE DRAG OF RECTANGULAR AND DELTA WINGS AT SUPERSONIC SPEEDS. E. B. Klunker and Conrad Rennemann, Jr. November 1952. 26p. diagrs. (NACA TN 2828)

The effect of a finite trailing-edge thickness on the pressure drag of rectangular and delta wings with truncated diamond-shaped airfoil sections with a given thickness ratio is studied for supersonic Mach numbers, linearized theory being used to evaluate the surface pressures. In order to facilitate comparison with wings having sharp trailing edges, the position of maximum thickness and base height are determined for least pressure drag as functions of a base-pressure parameter. Comparison is then made between the drag of these wings and similar wings with a sharp trailing edge for various aspect ratios and thickness ratios as a function of stream Mach number. The calculations of the drag characteristics for these wings show that significant drag reductions are possible under some conditions at high supersonic speeds. These reductions are relatively independent of aspect ratio for the rectangular wings but depend considerably on aspect ratio for the delta wings; the smaller aspect ratios show the larger drag reductions. Calculations of the spanwise distribution of drag are included to compare further the effect of a base on the drag for different aspect ratios.

NACA TN 2829

EXPERIMENTS ON TRANSONIC FLOW AROUND WEDGES. George P. Wood. November 1952. 34p. diagrs., photos., tab. (NACA TN 2829)

Several aspects of transonic flow around the forward portions of wedge profiles were studied by means of interferometry. Measurements were made of the two kinds of flow pattern that occur at the leading edge of a wedge at an angle of attack. The growth of the supersonic region at a sharp convex corner formed by two flat surfaces was observed. The pressure-drag coefficients of a wedge of 14.5° semi-angle were measured at Mach numbers of 0.768, 0.819, and 0.854 and were shown to be consistent with those of wedges of smaller angle when plotted according to the transonic similarity law. Conditions at the bases of the shock waves that interacted with boundary layers on the wedge were measured. The method of characteristics was used to calculate the flow behind an experimentally determined sonic line, and the calculated flow field was compared with the measured flow field. The accuracy in the location of the sonic line necessary to give correctly the pressure distribution on the surface behind it was determined.

NACA TN 2830

SEVERAL COMBINATION PROBES FOR SURVEYING STATIC AND TOTAL PRESSURE AND FLOW DIRECTION. Wallace M. Schulze, George C. Ashby, Jr. and John R. Erwin. November 1952. 64p. diagrs., photos., tab. (NACA TN 2830)

An investigation has been conducted to provide a basis for design of combination probes intended to survey static and total pressure and direction of flow with special reference to subsonic turbomachine testing. Static-pressure probes, yaw-element probes, claw-type yaw probes, and combination probes were tested in an 8-inch-diameter calibration tunnel at air velocities up to 445 feet per second. From the results of this investigation, the factors which determine the sensitivity of claw-type yaw probes were determined. Satisfactory combination survey probes for sensing static and total pressure and direction of flow in one or two planes were devised.

NACA TN 2834

FLOW SURFACES IN ROTATING AXIAL-FLOW PASSAGES. John D. Stanitz and Gaylord O. Ellis. November 1952. 31p. diagrs. (NACA TN 2834)

In order to investigate the deviation of flow surfaces from their assumed orientation in the usual type of two-dimensional solution, three-dimensional, incompressible, nonviscous, absolute irrotational fluid motion is determined for flow through rotating axial-flow passages bounded by straight blades of finite spacing and infinite axial length lying on meridional planes. Solutions are obtained for five passages with varying blade spacing and hub-tip ratio. The results are presented in such a manner as to apply for all ratios of axial velocity to passage tip speed. It is concluded that, for conditions in typical axial-flow blade rows, the deviation of flow surfaces from their assumed orientation in two-dimensional solutions is small.

NACA TN 2835

EFFECT OF CHANGING PASSAGE CONFIGURATION ON INTERNAL-FLOW CHARACTERISTICS OF A 48-INCH CENTRIFUGAL COMPRESSOR. II - CHANGE IN HUB SHAPE. John Mizisin and Donald J. Michel. November 1952. 35p. diagrs., photo., tab. (NACA TN 2835)

The passage contour of a 48-inch centrifugal compressor was modified by changing the shape of the hub to control the deceleration rates along the blade surfaces in order to improve the internal efficiency of the impeller. A comparison of internal-flow characteristics at design flow rate was made with the original impeller and with a modified-blade impeller that had the same area variation in the passage. In addition, flow characteristics of the modified-hub impeller over a flow range from maximum flow to near surge at a corrected tip speed of 700 feet per second are presented. At design flow, even though the deceleration rate along the trailing face was less for the modified-hub impeller than for the original impeller, the clearance losses (increased by the larger ratio of clearance to passage height) caused the total-pressure losses (and thus the relative adiabatic efficiency) to be about the same at the impeller exit for the two configurations, thus precluding any improvement in over-all performance. As in the original modified-blade impellers, large losses occurred at the driving-face inlet at negative angles of attack and in regions of large decelerations along the trailing-face flow surface.

NACA RM 52I25

TORSION, COMPRESSION, AND BENDING TESTS OF TUBULAR SECTIONS MACHINED FROM 75S-T6 ROLLED ROUND ROD. R. L. Moore and J. W. Clark, Aluminum Company of America. November 1952. 33p. diagrs., photos., 4 tabs. (NACA RM 52I25)

Tests were made of tubular sections machined from 75S-T6 aluminum-alloy rolled rod and having ratios of tube diameter to wall thickness D/t ranging from 2 to 150. The purpose of the investigation was to establish curves of strength in torsion, compression, and bending against D/t for the tubular sections and to show to what extent these strengths may be correlated with the mechanical properties of the material. In view of the acceptable mechanical properties obtained for the material, the relations obtained between these strengths and D/t may be used as a tentative basis for design of members of the type investigated.

NACA RM E52I09

EFFECT OF RADIANT ENERGY ON VAPORIZATION AND COMBUSTION OF LIQUID FUELS. A. L. Berlad and R. R. Hibbard. November 1952. 46p. diagrs., 2 tabs. (NACA RM E52I09)

The radiative processes involved in combustion were investigated to determine the present role of radiant energy transfer in combustors. It was shown that at present the amount of radiant energy transfer from flame to fuel is quite small in a turbojet combustor. In order to find techniques for making this radiant energy transfer from flame to fuel significant, methods of increasing the equivalent gray-body emissivities of the fuel drops and the flame, as well as the efficiency of the energy transfer itself, were examined. The equivalent gray-body emissivity of a hydrocarbon fuel may be increased by the use of liquid or solid, soluble or nonsoluble, additives. It was found that the nonsoluble solid additive was the most desirable one. In addition to the fact that a slurry-type drop may have a greater emissivity, the suspended solid additive may also greatly contribute to the emissivity of the flame. An approximate equation was derived from which the equivalent gray-body emissivities of such slurry-type drops may be calculated. Data necessary for these calculations were obtained by spectrophotometric analysis of thin slurry films. In addition to the fuel additive, the use of radiation-reflecting walls in a combustor was considered as a means of maintaining the efficiency of the radiative transfer of energy from flame to fuel drop. It was then shown that more than half the heat of evaporation of the hydrocarbon constituent of this slurry-type drop might be supplied by radiant energy transfer in such a modified turbojet combustor.

NACA RM E52I26

EXAMINATION OF SMOKE AND CARBON FROM TURBOJET-ENGINE COMBUSTORS. Thomas P. Clark. November 1952. 12p. photos., 2 tabs. (NACA RM E52I26)

Smoke and carbon from turbojet-engine combustors were studied by the methods of electron microscopy, chemical analysis, and X-ray diffraction. The smoke exhausting from a combustor was found to consist of carbon black, agglomerated into soot. The carbon black had been partially burned in its passage through the flame zone. The smoke resulted from the incomplete combustion of the vaporized fuel; it was not the result of the pyrolysis of fuel droplets. The soft carbon in the dome of the combustor liner was found to consist of carbon black and soot intermixed with indeterminate complexes such as high-boiling fuel ends and partly polymerized and pyrolyzed heavy hydrocarbons. The hard carbon on the walls of the combustor liner was found to be largely a petroleum coke. The coke was apparently formed by the liquid phase cracking, pyrolysis, and subsequent coking on the liner wall of fuel from the spray nozzle.

BRITISH REPORTS

N-17658*

Forest Products Research Lab. (Gt. Brit.)
THE 'LEVER AID' IN THE KNIFE TEST OF PLYWOOD. P. Burgess. (Forest Products Research Lab.; Reprint from Wood, v. 17, Sept., 1952, p. 340-341)

This report describes a tool to aid in the conduction of forcible separation or knife tests for assessing the quality of the glue bond between the veneers of plywood.

N-17728*

Royal Aircraft Establishment (Gt. Brit.)
MEASUREMENT OF THE MOISTURE CONTENT OF HIGH PRESSURE OXYGEN FOR USE IN AIRCRAFT. II. A HIGH PRESSURE HYGROMETER. M. E. Bedwell and W. G. Glendinning. May 1952. 18p. diagrs., 3 tabs. (RAE Tech. Note Chem. 1175)

The gas flow bridge principle has been used in designing an all-metal hygrometer to measure the moisture content of oxygen gas at transport cylinder pressure. The method could be applied to a producing plant, to give a warning if the moisture content of the gas exceeded the maximum permitted in the specification. Both glass-capillary and metal-capillary bridges have given satisfactory results at pressures approaching that of the atmosphere. A magnetically operated pressure sensitive device has been made to function at the pressure-differential available, but would not operate in the bridge because of slight gas-leakage past the float, which upset the bridge off-balance.

N-17729*

Royal Aircraft Establishment (Gt. Brit.)
THE DEVELOPMENT OF FREQUENCY AND VOLTAGE CONTROL SYSTEMS, EMPLOYING TRANSDUCTOR AMPLIFIERS, FOR A 1.75 KVA, 115 V, 1600 C/S MOTOR-ALTERNATOR, WITH SPECIAL REFERENCE TO DYNAMIC CONSIDERATIONS. C. W. Cooper, W. N. Corn and E. W. Eaton. April 1952. 76p. diagrs., photos. (RAE EL. 1480)

This report describes the design, development, construction and performance of Voltage and Frequency control systems for a 1.75 KVA, 115 V, 1600 c/s Motor-Alternator intended for air-borne applications. The control amplifiers employ transductors for power amplification. Details are given of the static and dynamic performances of the amplifiers, and the transient responses of the control systems.

N-17750*

Aeronautical Research Council (Gt. Brit.)
FREE STREAMLINE JETS IN SHEAR FLOW, AND THEIR APPLICATION TO THE DESIGN OF SUCTION SLOTS. W. T. Lord. June 20, 1950. 79p. diagrs. (ARC 13,197; FM 1450)

Solutions for the shapes of free streamline jets issuing from a gap between two flat parallel surfaces may serve as a basis for designing slots for sucking away the boundary layer on an airfoil. A brief description is given of some unsuccessful attempts to obtain analytical solutions for such jets when the flat surfaces are collinear and the flow at a large distance from the gap is a constant shearing motion containing vorticity of any magnitude. A method of solution for the case when the magnitude of the vorticity is sufficiently small for terms of the order of its square and higher powers to be neglected is given in detail. This method may be extended to cover the more general case when there is a step between the flat surfaces on each side of the gap.

N-17751*

Aeronautical Research Council (Gt. Brit.)
INCOMPRESSIBLE TWO-DIMENSIONAL FLOW OF AN INVISCID FLUID ABOUT A SYMMETRICAL AEROFOIL IN A CHANNEL OR FREE STREAM. L. C. Woods. July 7, 1950. 32p. diagrs., 6 tabs. (ARC 13,240; FM 1456)

The paper introduces a new and exact method of calculating the incompressible, inviscid flow about a symmetrical two-dimensional airfoil at zero incidence. The asymmetric case and the effect of circulation will be dealt with a subsequent paper. The method gives velocities throughout the field and is much quicker than the "relaxation" methods that have been applied to this problem. The principle is to replace the airfoil by a series of small arcs on which it is assumed that the product of the radius of curvature and the velocity is constant. It is almost equivalent to replacing the airfoil by a many sided polygon for, at some distance from the airfoil, the field due to a polygon and that due to a profile composed of arcs as defined above, is sensibly the same. Each arc, of course, must cover the same range as the corresponding side of the polygon. The method is termed "The Polygon Method." The idealization takes place in the plane in which the airfoil is represented by a slit, that is, the flow plane. The fields due to each of these arcs are added to give the combined field due to the idealized airfoil. The number of arcs selected to replace the airfoil is governed by the accuracy required in the final results. In the typical example given at the end of the paper, the author found that 12 arcs were sufficient to give accuracies better than 1 percent in the velocity increment due to the airfoil. In a later paper, the method will be extended to obtain an approximate solution of compressible flow, the accuracy of which is a little better than that of the well-known Kármán-Tsien approximation.

N-17759*

Aeronautical Research Council (Gt. Brit.)
AN EXACT FOURIER SERIES METHOD OF CALCULATING THE TWO-DIMENSIONAL INCOMPRESSIBLE FLOW ABOUT AN ASYMMETRICAL AEROFOIL. L. C. Woods. October 12, 1950. 6p. diagrs. (ARC 13,440; FM 1484; Oxford Univ., Engineering Lab. No. 46)

A method of calculating the flow about an asymmetric airfoil at incidence in a free stream is developed. It involves the calculation of a number of Fourier series, the constants of which rapidly converge to zero. The flow about an asymmetric airfoil at incidence in a channel is tackled by an iterative process which the author expects to be rapidly convergent. Separate solutions are obtained in the two regions separated by the stagnation streamlines and are modified step by step until they match along these streamlines.

N-17849*

National Gas Turbine Establishment (Gt. Brit.)
THERMODYNAMIC PROPERTIES OF AIR AND COMBUSTION PRODUCTS OF HYDROCARBON FUELS, PART II. D. Fielding and J. E. C. Topps. July 1952. 72p. diagrs., 7 tabs. (NGTE R. 120)

This report is a continuation of NGTE Report No. R. 74, giving methods whereby the data required for gas turbine performance calculations, using any fuel or supporter of combustion, may be rapidly computed. The principle of the method given is the addition of a calculated quantity to the corresponding value of the property for dry air, so numerical consistency is automatically ensured. The theory from which the corrections are deduced is given fully, and functions have been computed permitting determination of the true specific heat, the total heat and the entropy function of the combustion products of all common fuel-medium mixtures. The thermodynamic aspects of the combustion process are examined and parameters for the calculation of combustion temperature rise are deduced, and calculated functions are given which permit this determination for any fuel and any atmosphere. The data and methods are suitable for the computation of working data sheets, or for the direct determination of gas turbine performance. Examples of the latter are given, also nomographic aids. Special calculations are discussed, and methods are developed whereby data may be prepared for systems involving further elements or compounds, combustible or otherwise, in the fuel or atmosphere.

MISCELLANEOUS

NACA Rept. 1050

Errata No. 1 on "FORMULAS FOR THE SUPERSONIC LOADING, LIFT AND DRAG OF FLAT SWEPT-BACK WINGS WITH LEADING EDGES BEHIND THE MACH LINES". Doris Cohen. 1951.

DECLASSIFIED NACA REPORTS

NACA RM 8I07

RESPONSE OF A ROTATING PROPELLER TO AERODYNAMIC EXCITATION. Walter E. Arnoldi, Hamilton Standard Propellers Division, United Aircraft Corporation. January 21, 1949. 26p. diagrs. (NACA RM 8I07) (Declassified from Restricted, 9/16/52)

This report presents a theoretical analysis of the flexural vibration of an aircraft propeller blade subjected to harmonic aerodynamic exciting forces at a fixed multiple of propeller rotation frequency. The flexural vibration of a rotating propeller blade with clamped shank is analyzed with the object of presenting, in matrix form, equations for the elastic bending moments in forced vibration resulting from aerodynamic forces applied at a fixed multiple of rotational speed. Matrix equations are also derived which define the critical speeds and mode shapes for any excitation order and the relation between critical speed and blade angle.

NACA RM E7H21

PRELIMINARY INVESTIGATION OF HYDRAZINE AS A ROCKET FUEL. Paul M. Ordin, Riley O. Miller and John M. Diehl. May 24, 1948. 35p. diagrs., photos. (NACA RM E7H21) (Declassified from Confidential, 9/16/52)

Several properties of hydrazine were investigated. Theoretical calculations were made of performance of hydrazine with liquid 0_3, liquid 0_2, H_20_2, and $HN0_3$. Hydrazine is poisonous, decomposes some materials, is temperature sensitive, does not propagate detonation waves, reacts violently with H_20_2, $NaMn0_4$, $C(N0_2)_4$, and $HN0_3 \cdot N0_2$, and gives high theoretical performance with several oxidants.

NACA RM L6L11

WIND-TUNNEL INVESTIGATION OF WING INLETS FOR A FOUR-ENGINE AIRPLANE. Walter A. Bartlett, Jr. and Edwin B. Goral. March 11, 1947. 65p. diagrs., photos., 7 tabs. (NACA RM L6L11) (Declassified from Restricted, 9/16/52)

An investigation has been conducted in the Langley propeller-research tunnel to develop wing-leading-edge inlets for location between the inboard and outboard nacelles on each wing of a four-engine airplane for the Army Air Forces. The investigation included aerodynamic tests of the basic wing and the original inlet, and the development by the NACA of wing inlets for two versions of the airplane. The original inlet was found to decrease the maximum lift coefficients and to have critical Mach numbers below those of the wing with the basic nose installed. The total-pressure recovery in the oil-cooler ducts was poor regardless of the inlet installation. As the sharp expanding bend in this duct cannot be avoided, it is recommended that the oil-cooler air be induced through the cowling or from some source other than the subject wing inlet. Two inlets were developed that should be satisfactory for the airplane. The maximum lift coefficients for the model with inlets 5 and 6 installed were about 1.21 and 1.22, respectively, with 0° wing flaps and 1.87 and 2.00, respectively, with 65° wing flaps compared to corresponding values of 1.20 and 2.01 for the model equipped with the faired basic nose. The predicted critical Mach numbers for inlets 5 and 6 for the critical military power high-speed condition for an altitude of 40,000 feet were 0.63 and 0.64, respectively, as compared to 0.64 for the thickest section of the basic wing.

NACA RM L7E20

CORRELATION OF WIND-TUNNEL AND FLIGHT DETERMINATIONS OF THE BUFFET SPEED OF AN AIRPLANE EQUIPPED WITH EXTERNAL STORES. H. Norman Silvers and Kenneth P. Spreemann. March 2, 1948. 54p. diagrs., photos., tab. (NACA RM L7E20) (Declassified from Restricted, 9/16/52)

Presents a comparison of wind-tunnel measurements of incremental lift, drag, and pitching-moment coefficients due to external stores and measurements of pressures in the vicinity of the external stores with flight determinations of buffet Mach numbers. It is indicated that the variation of the incremental drag coefficient with Mach number of the external store may be used to estimate maximum flight buffet Mach number, and the attainment of local critical pressure in the vicinity of the store is indicative of the lower limit of flight buffet due to stores.

NACA RM L7K10

WIND-TUNNEL INVESTIGATION OF THE STABILITY OF JETTISONED NOSE SECTIONS OF THE D-558 AIRPLANE - PHASES I AND II. Stanley H. Scher. January 14, 1948. 33p. photos., diagrs., 6 tabs. (NACA RM L7K10) (Declassified from Confidential, 9/16/52)

An investigation of the stability of models of the jettisonable nose sections of the D-558 airplanes, Phases I and II, has been conducted in the Langley 20-foot free-spinning tunnel. It was found that both model nose sections tumbled end over end about an approximately horizontal axis. The installation of suitable fins, together with sufficient forward location of the center of gravity, prevented the tumbling and caused the models to descend in a stable nose-down attitude.

NACA RM L8E11

PRELIMINARY INVESTIGATION TO DETERMINE PROPELLER SECTION CHARACTERISTICS BY MEASURING THE PRESSURE DISTRIBUTION ON AN NACA 10-(3)(08)-03 PROPELLER UNDER OPERATING CONDITIONS. Albert J. Evans and George Liner. July 14, 1948. 52p. diagrs., tab. (NACA RM L8E11) (Declassified from Confidential, 9/16/52)

Contains preliminary data obtained by measuring the pressure distribution on the airfoil sections at nine

radial stations of an NACA 10-(3)(08)-03 design propeller. The results are presented as normal-force and moment coefficients for a range of nominal angle of attack (simple blade element theory) from 0° to 4° for a section Mach number range of about 0.6 to 1.15 for the outboard stations and about 0.3 to 0.6 for inboard stations.

NACA RM L8H11

AERODYNAMIC CHARACTERISTICS OF FLYING-BOAT HULLS HAVING LENGTH-BEAM RATIOS OF 20 AND 30. John M. Riebe. November 10, 1948. 26p. diagrs., photos., 4 tabs. (NACA RM L8H11) (Declassified from Restricted, 9/16/52)

An investigation of a series of hulls of length-beam ratios 6 to 15 previously reported in NACA TN 1305 has been extended to length-beam ratios 20 and 30. The hulls of the entire series were designed to have approximately the same hydrodynamic performance with respect to spray and resistance characteristics regardless of length-beam ratio. Drag coefficients and longitudinal-stability parameters are presented with and without wing interference. Lateral-stability parameters are presented with wing interference.

NACA RM L9G05

EFFECT OF AN INCREASE IN HULL LENGTH-BEAM RATIO FROM 15 TO 20 ON THE HYDRODYNAMIC CHARACTERISTICS OF FLYING BOATS. Arthur W. Carter and Walter E. Whitaker, Jr. August 24, 1949. 29p. diagrs., photos., 2 tabs. (NACA RM L9G05) (Declassified from Restricted, 9/16/52)

Investigations of the effect of hull lenth-beam ratio on the hydrodynamic qualities of flying boats, made in Langley tank No. 1, have been extended to include a length-beam ratio of 20. The hydrodynamic qualities determined in this investigation were longitudinal stability during take-off and landing, spray characteristics, and take-off performance in smooth water and take-off and landing behavior in waves.

UNPUBLISHED PAPERS

N-9269B*

Massachusetts Inst. of Tech., Research Lab. for Mechanics of Materials.
AN INVESTIGATION OF THE TORSION CREEP-TO-RUPTURE PROPERTIES OF ALLOY N-155. M. E. Shank. (Final rept.) April 4, 1952. 34p. diagrs., photos. (Massachusetts Inst. of Tech., Research Lab. for Mechanics of Materials)

This report describes an investigation of the torsion creep-to-rupture properties of alloy N-155. All tests were in the range of 1200° to 1500° F, with times in the 10-1000 hour range. The effect of stress concentration in the form of transverse circular holes was investigated under similar conditions. The effect of specimen geometry, as affected by slight changes in specimen contours, was found to be great. Preliminary investigation was made into what appeared to be axial extension of the specimen during torsional creep.

N-18354*

APPLICATION OF TRANSONIC SIMILARITY CONSIDERATIONS TO FLOW ALONG A WAVE-SHAPED WALL. Carl Kaplan. 1952. 42p. diagrs., tab. (Presented at Eighth International Congress on Theoretical and Applied Mechanics held in Istanbul, Turkey, August 20-28, 1952).

The Prandtl-Busemann small-perturbation method is utilized to obtain the flow of a compressible fluid past an infinitely long wave-shaped wall. When the essential assumption for transonic flow (that all Mach numbers in the region of flow are nearly unity) is introduced, the expression for the velocity potential takes the form of a power series in the transonic similarity parameter. On the basis of this form of the solution, an attempt is made to solve the nonlinear differential equation for transonic flow past a wavy wall. The analysis utilized exhibits clearly the difficulties inherent in nonlinear-flow problems. Nevertheless, by means of the classical method of integration in series, recursion formulas for certain four-labelled coefficients are obtained. Remarkably enough, these recursion formulas can be solved analytically and lead to a number of conclusions; for example, that the transonic similarity parameter cannot be greater than four-thirds. In addition, a novel numerical test of convergence, applied to the power series (in the transonic similarity parameter) representing the local Mach number distribution at the boundary, indicates that smooth symmetrical potential flow past the wavy wall is no longer possible once the critical value of the undisturbed-stream Mach number has been exceeded.

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CURRENT NACA REPORTS

NACA Rept. 1043

A NUMERICAL METHOD FOR THE STRESS ANALYSIS OF STIFFENED-SHELL STRUCTURES UNDER NONUNIFORM TEMPERATURE DISTRIBUTIONS. Richard R. Heldenfels. 1951. ii, 20p. diagrs., 9 tabs. (NACA Rept. 1043. Formerly TN 2241)

A numerical method is presented for the stress analysis of stiffened-shell structures of arbitrary cross section under nonuniform temperature distributions. The method is based on a previously published procedure that is extended to include temperature effects and multicell construction. The application of the method to practical problems is discussed and an illustrative analysis is presented of a two-cell box beam under the combined action of vertical loads and a nonuniform temperature distribution.

NACA Rept. 1044

THE METHOD OF CHARACTERISTICS FOR THE DETERMINATION OF SUPERSONIC FLOW OVER BODIES OF REVOLUTION AT SMALL ANGLES OF ATTACK. Antonio Ferri. 1951. ii, 16p. diagrs. (NACA Rept. 1044. Formerly TN 1809)

The method of characteristics has been applied to rotational supersonic flow around bodies of revolution at a small angle of attack. The practical numerical calculations are similar to those for zero angle of attack. A method for determining supersonic flow around circular cones at an angle of attack is also given.

NACA Rept. 1045

SUPERSONIC FLOW AROUND CIRCULAR CONES AT ANGLES OF ATTACK. Antonio Ferri. 1951. ii, 11p. diagrs. (NACA Rept. 1045. Formerly TN 2236)

The properties of conical flow without axial symmetry are analyzed. The flow around cones of circular cross section at small angles of attack is determined by correctly considering the effect of the entropy gradients in the flow.

NACA Rept. 1057

ANALYSIS OF THE EFFECTS OF BOUNDARY-LAYER CONTROL ON THE TAKE-OFF AND POWER-OFF LANDING PERFORMANCE CHARACTERISTICS OF A LIAISON TYPE OF AIRPLANE. Elmer A. Horton, Laurence K. Loftin, Jr., Stanley F. Racisz and John H. Quinn, Jr. 1951. ii, 31p. diagrs. (NACA Rept. 1057. Formerly TN 1597; TN 2143)

An investigation has been made to determine whether boundary-layer control by suction might reduce the minimum take-off and landing distance of a four-place or five-place airplane or a liaison type of airplane having a pay load of 1500 pounds and a flight duration of 5 hours. The aspect ratio was varied from 5 to 15, the wing span from 25 to 100 feet, and the brake horsepower from 300 to 1200. The effectiveness of boundary-layer control in reducing the total take-off distance for a given maximum speed improves with increasing aspect ratio and, for wing loadings of 10 pounds per square foot or more and an aspect ratio of 10 or more, the addition of boundary-layer control results in a decrease in the total take-off distance of as much as 14 percent. The use of boundary-layer control causes reduction in total landing distances (25 to 40 percent), ground-run distance, gliding speed, and stalling speed whereas sinking speed is increased only slightly.

NACA TN 2831

SPAN LOAD DISTRIBUTIONS RESULTING FROM CONSTANT ANGLE OF ATTACK, STEADY ROLLING VELOCITY, STEADY PITCHING VELOCITY, AND CONSTANT VERTICAL ACCELERATION FOR TAPERED SWEPTBACK WINGS WITH STREAMWISE TIPS. SUBSONIC LEADING EDGES AND SUPERSONIC TRAILING EDGES. Margery E. Hannah and Kenneth Margolis. December 1952. 221p. diagrs., 4 tabs. (NACA TN 2831)

On the basis of the linearized supersonic-flow theory the theoretical spanwise distributions of circulation (which are proportional to the span load distribution) resulting from constant angle of attack, steady rolling velocity, steady pitching velocity, and constant vertical acceleration were calculated for a series of thin, sweptback, tapered wings with streamwise tips, subsonic leading edges, and supersonic trailing edges. The results of the analysis are presented as a series of design charts. Some illustrative variations of the spanwise distributions of circulation with aspect ratio, taper ratio, Mach number, leading-edge sweepback, and axis-of-pitch location are also included.

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NACA TN 2833

AN ANALYSIS OF NORMAL ACCELERATIONS AND AIRSPEEDS OF ONE TYPE OF TWIN-ENGINE TRANSPORT AIRPLANE IN COMMERCIAL OPERATIONS OVER A NORTHERN TRANSCONTINENTAL ROUTE. Roy Steiner. November 1952. 23p. diagrs., 4 tabs. (NACA TN 2833)

Normal-acceleration and airspeed data obtained for one type of twin-engine transport airplane in commercial operations over a northern transcontinental route are analyzed to determine the gust and gust-load experiences of the airplane. The acceleration increments experienced equaled or exceeded the limit-gust-load factor, on the average, twice (once positive and once negative) in about 7.5×10^6 flight miles, and an effective gust velocity of 30 feet per second was equaled or exceeded twice in about 1×10^6 flight miles. The data indicate that the maximum gusts and gust loads experienced in the winter were roughly 10 percent higher than those experienced in the summer on this route.

NACA TN 2837

CORRECTIONS FOR DRAG, LIFT, AND MOMENT OF AN AXIALLY SYMMETRICAL BODY PLACED IN A SUPERSONIC TUNNEL HAVING A TWO-DIMENSIONAL PRESSURE GRADIENT. I. J. Kolodner, F. Reiche and H. F. Ludloff, New York University. November 1952. 45p. (NACA TN 2837)

Corrections for drag, lift, and moment are derived for an axially symmetrical body placed in a supersonic tunnel having a two-dimensional pressure gradient. Although relatively simple longitudinal and transverse pressure gradients are assumed, the analytical treatment is rather difficult because of the difference in symmetry between the body and the basic flow field. Assuming irrotational conditions, the velocity potential of the flow around the body is expanded in powers of two parameters characterizing the body thickness and the inhomogeneity of the field and as a Fourier series in the azimuth around the body axis. Upon substitution of this potential series, the nonlinear equation of motion and the boundary condition on the body surface are split into a set of linearized boundary-value problems which can be solved analytically.

NACA TN 2840

BUCKLING OF LOW ARCHES OR CURVED BEAMS OF SMALL CURVATURE. Y. C. Fung and A. Kaplan, California Institute of Technology. November 1952. 75p. diagrs., photo., 9 tabs. (NACA TN 2840)

A general solution, based on the classical buckling criterion, is given for the problem of buckling of low arches under a lateral loading acting toward the center of curvature. For a sinusoidal arch under sinusoidal loading, the critical load can be expressed exactly as a simple function of the beam dimension parameters. For other arch shapes and load distributions, approximate values of the critical load can be obtained by summing a few terms of a rapidly converging Fourier series. The effects of initial end thrust and axial and lateral elastic support are discussed. The buckling load based on the energy criterion of Kármán and Tsien is also calculated. Results for both the classical and the energy criteria are compared with experimental results.

NACA TN 2841

INVESTIGATION OF 75-MILLIMETER-BORE DEEP-GROOVE BALL BEARINGS UNDER RADIAL LOAD AT HIGH SPEEDS. I - OIL-FLOW STUDIES. Zolton N. Nemeth, E. Fred Macks and William J. Anderson. December 1952. 30p. diagrs., 2 tabs. (NACA TN 2841)

At an oil inlet temperature of 100° F, two methods of bearing lubrication, single jet and puddling, were investigated. In this investigation, 75-millimeter-bore ball bearings were studied over a range of DN values (bore times speed) from 0.3×10^6 to 1.2×10^6, radial loads from 7 to 1113 pounds, and oil flows from 2 to 8 pounds per minute. The quantity of oil which flows through the bearing is shown to have an important effect on bearing operating temperatures and lubrication-system heat load. The effects of the operating variables on the oil flow through the bearing and upon the bearing outer- and inner-race temperatures are discussed.

NACA TN 2843

AUXILIARY EQUIPMENT AND TECHNIQUES FOR ADAPTING THE CONSTANT-TEMPERATURE HOT-WIRE ANEMOMETER TO SPECIFIC PROBLEMS IN AIR-FLOW MEASUREMENTS. James C. Laurence and L. Gene Landes. December 1952. ii, 77p. diagrs., photos., 3 tabs. (NACA TN 2843)

The constant-temperature hot-wire anemometer amplifier and accessories have been developed to provide an instrument with wide frequency response, good stability, and ease of operation. Auxiliary equipment has been developed to provide heating currents for large wires, to make average-square computations, and to make double-correlation coefficient measurements. Techniques are described for using this equipment to study periodic phenomena such as surge, rotating stall, and wake surveys in centrifugal- and axial-flow compressors. The application of the equipment to the study of nonperiodic phenomena such as intensity, scale, and spectra of isotropic turbulence is also discussed. Heat-loss data for standardized tungsten wire probes show that no wire calibration is necessary if accuracies of ± 5 percent are sufficient.

NACA TN 2844

LAMINAR BOUNDARY LAYER ON CONE IN SUPERSONIC FLOW AT LARGE ANGLE OF ATTACK. Franklin K. Moore. Appendix B: NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS. Lynn Albers. November 1952. 34p. diagrs. (NACA TN 2844)

The laminar boundary-layer flow about a cone at large angles of attack to a supersonic stream has been analyzed in the plane of symmetry. At the bottom of the cone, velocity profiles were obtained showing the expected tendency of the boundary layer to become thinner on the under side of the cone as the angle of attack is increased. At the top of the cone, the analysis failed to yield unique solutions, except for small angle of attack. Beyond a certain critical angle of attack, boundary-layer flow does not exist in the plane of symmetry, thus indicating separation.

NACA RM L52K10a

PRELIMINARY RESULTS OF STABILITY CALCULATIONS FOR THE BENDING OF BOX BEAMS WITH LONGITUDINALLY STIFFENED COVERS CONNECTED BY POSTS. Roger A. Anderson, Thomas W. Wilder, III and Aldie E. Johnson, Jr. December 1952. 17p. diagrs., tab. (NACA RM L52K10a)

The preliminary results of a computational program are presented which give numerical values of the stiffnesses required of posts and longitudinal stiffeners along the row of posts to achieve desired buckling-stress values in the covers of a box beam subjected to bending. The validity of a short-cut solution to the stability equation derived in NACA TN 2760 is also shown.

BRITISH REPORTS

N-17757*

Aeronautical Research Council (Gt. Brit.)
THE PATH OF A LIGHT FLUID WHEN RELEASED IN A HEAVIER FLUID WHICH IS ROTATING. Geoffrey Taylor. August 28, 1950. 10p. diagrs., tab. (ARC 13,327; CF 144; FM 1471)

This report presents a discussion of a previous report, "Thermo-Centrifugal Convection in Combustion Chambers," by J. F. Alcock and W. D. Armstrong, in which an attempt was made to calculate how a fluid would move if released in a fluid of another density while the whole system was rotating at uniform angular velocity.

N-20107*

Marine Aircraft Experimental Establishment (Gt. Brit.) A NOTE ON THE DEVELOPMENT OF SENSITIVE PRESSURE OPERATED WATER CONTACTS FOR USE ON SEAPLANES. R. Parker. July 1952. 10p. diagrs., photos., tab. (MAEE F/Res/224)

A pressure operated water contact has been developed, suitable for indicating the instants of take-off and touchdown for a seaplane hull. Flight tests have shown that the instrument is accurate in operation and sufficiently robust for normal flight test use.

N-20122*

Royal Aircraft Establishment (Gt. Brit.)
NOTES ON THE PERFORMANCE OF CRYSTALLOY AND H. C. R. MAGNETIC MATERIALS IN TRANSDUCTOR CIRCUITS. A. G. Milnes and D. E. Fielder. May 1952. 22p. diagrs. (RAE Tech. Note EL. 35)

Transductor behavior with Crystalloy and H. C. R. as the core materials is examined and the sensitivity is shown to increase with increase in the supply voltage. As a result of this examination, a design flux density of 12,000 to 13,000 gauss (peak) is recommended for H. C. R. and 10,000 to 11,000 gauss (peak) for Crystalloy. The transductor characteristics obtained with H. C. R. cores are superior to those for Crystalloy; but to conserve supplies of nickel-iron materials, the use of Crystalloy or equivalent materials is advised for output stage transductors in applications where the highest standards of performance are not required.

N-20124*

Royal Aircraft Establishment (Gt. Brit.)
THE "NATURAL VIGNETTING" OF PHOTOGRAPHIC LENSES. R. W. Fish. May 1952. 10p. diagrs. (RAE Tech. Note Ph. 466)

The variation of illumination in the focal plane of a photographic lens is commonly represented by the $\cos^4\theta$ law ("natural vignetting") in the absence of true vignetting, reflection and absorption losses, and veiling glare. It is shown that this $\cos^4\theta$ law only holds when the image is free from distortion and there is no aberration of the entrance pupil. The collimator method of measuring the variation of illumination is shown to be correct in theory. The application to wide angle lenses for air survey is briefly discussed.

N-20125*

Royal Aircraft Establishment (Gt. Brit.)
A PHOTO-ELECTRIC CURVE FOLLOWER. R. H. Forrest and K. H. Treweek. With appendices. J. A. Roberts. May 1952. 61p. diagrs., photos. (RAE Tech. Note Arm. 487)

This curve follower reproduces in voltage form the ordinate of a curve recorded photographically as an opaque trace on clear film. A prototype instrument has been constructed and is described in some detail in the present paper. It is capable of following curves, recorded on 35-mm film, which do not exceed 80° in slope nor 20-mm peak to peak in amplitude at 60 cycles per second. The film is drawn past the face of a cathode ray tube in the X-axis direction and is viewed by a photocell which controls the Y-plate voltage to keep the luminous spot locked to the trace. The Y-plate voltage is therefore a measure of the curve ordinate. The follower works as a carrier frequency system and reads substantially the center of the recorded trace. The reading is therefore insensitive to line thickness and density,

and the reading error in the prototype is about 2 percent of full scale. The appendices describe the theory of the generation of the signals by the optical system and the use of a galvanometer in place of a cathode ray tube.

N-20129*

Royal Aircraft Establishment (Gt. Brit.)
THE MEASUREMENT OF HEAT TRANSFER AND SKIN FRICTION AT SUPERSONIC SPEEDS. PART IV - TESTS ON A FLAT PLATE AT M = 2.82.
R. J. Monaghan and J. R. Cooke. June 1952. 43p. diagrs., 3 tabs. (RAE Tech. Note Aero 2171)

This note gives the results of over-all heat transfer and boundary-layer measurements made on a flat plate in a 5-in. square supersonic wind tunnel operating at M = 2.82 under atmospheric stagnation pressure conditions. The tests were made to extend the range of results previously obtained at M = 2.43[1, 2] and used the same experimental equipment. In general, the results confirm those obtained at the lower Mach number and some general conclusions are now drawn concerning the structure and behavior of experimental laminar and turbulent compressible boundary layers on a flat plate. The present series of tests is now complete, but subsonic check tests remain to be made.

MISCELLANEOUS

NACA TN 2598

Errata No. 1 on "A TECHNIQUE APPLICABLE TO THE AERODYNAMIC DESIGN OF INDUCER-TYPE MULTISTAGE AXIAL-FLOW COMPRESSORS".
Melvyn Savage and Loren A. Beatty. March 1952.

UNPUBLISHED PAPERS

N-12952*

ON THE STATICS OF THIN AIRCRAFT WINGS. (Zur Statik von dünnen Flugzeug-Tragflächen). H. Schürch. October 1952. 85p. diagrs., photo., 2 tabs. (Trans. from Eidgenössiche Technische Hochschule Zurich. Institut für Flugzeugstatik und Flugzeugbau. Mitteilungen 2, 1950, 62p.).

This paper deals with the structural analysis of flat structures, similar to those encountered in the wing and tail-plane design of modern aircraft. A sandwich type flat structure is considered. This structure is assumed to be built up of two faces, carrying normal and shearing loads and of a core of pure shearing rigidity normal to its center plane. The faces are assumed to be stiffened by an orthogonal system of stringers. Due to the stringers, the local bending rigidity of the flat structure is variable in different surface directions. An arbitrary variation of these bending rigidities is taken into account. Thus, the considered structure has essentially the properties of an orthotropic plate of variable thickness and differs from the usual aircraft wing design mainly by the assumption of a continuous and rigid system of ribs and webs, represented by the core. The relation between load and elastic deformation of such a flat structure is developed, starting from the theory of solid plates. Analysis yields a partial differential equation of fourth order with variable coefficients as an extension of the biharmonic equation for the deformation of solid plates of uniform thickness. By suppressing the rib bending, the said differential equation is linearized and a numerical computing becomes possible. Hence, a theory of a two dimensional flat structure can be developed, as an extension of the bending and twisting theory of the simple, one-dimensional beam.

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Research Abstracts

NO. 35 JANUARY 5, 1953

CURRENT NACA REPORTS

NACA Rept. 1041

EQUATIONS AND CHARTS FOR THE RAPID ESTIMATION OF HINGE-MOMENT AND EFFECTIVENESS PARAMETERS FOR TRAILING-EDGE CONTROLS HAVING LEADING AND TRAILING EDGES SWEPT AHEAD OF THE MACH LINES. Kennith L. Goin. 1951. ii, 71p. diagrs., 9 tabs. (NACA Rept. 1041. Formerly TN 2221)

Existing conical-flow solutions have been used to calculate the characteristics of deflected trailing-edge controls located either at the wing tip or far enough inboard to prevent the outermost Mach lines from the controls from crossing the wing tip. For either location, the controls have been assumed to be located far enough outboard to prevent the innermost Mach lines from crossing the wing-root chord. The method for determining control hinge moment resulting from wing angle-of-attack loading is restricted to wings having leading edges swept ahead of the Mach lines. Also included is an approximate method by which the theoretical characteristics may be corrected for airfoil-section thickness.

NACA Rept. 1058

INFLUENCE OF CHEMICAL COMPOSITION ON RUPTURE PROPERTIES AT 1200° F OF FORGED CHROMIUM-COBALT-NICKEL-IRON BASE ALLOYS IN SOLUTION-TREATED AND AGED CONDITION. E. E. Reynolds, J. W. Freeman and A. E. White, University of Michigan. 1951. ii, 60p. diagrs., photos., 11 tabs. (NACA Rept. 1058. Formerly TN 2449)

Use of careful control over processing conditions in this investigation has shown that it is possible to correlate stress-rupture properties of forged chromium-cobalt-nickel-iron base alloys at 1200° F with systematic variations in chemical composition and that a wide range in properties can be obtained by such variations. However, no alloy was obtained which had properties which were outstanding compared with those of the basic analysis.

NACA TN 2822

A SPECIAL INVESTIGATION TO DEVELOP A GENERAL METHOD FOR THREE-DIMENSIONAL PHOTOELASTIC STRESS ANALYSIS. M. M. Frocht and R. Guernsey, Jr., Illinois Institute of Technology. December 1952. 59p. diagrs., photos., 3 tabs. (NACA TN 2822)

The method of strain measurement after annealing is reviewed and found to be unsatisfactory for the materials available in this country. A new, general method is described for the photoelastic determination of the principal stresses at any point of a general body subjected to arbitrary loads. The method has been applied to a sphere subjected to diametral compressive loads. The results show possibilities of high accuracy.

NACA TN 2832

THEORETICAL STUDY OF THE TRANSONIC LIFT OF A DOUBLE-WEDGE PROFILE WITH DETACHED BOW WAVE. Walter G. Vincenti and Cleo B. Wagoner. (Portions of this work were reported at the eighth International Congress on Theoretical and Applied Mechanics, Istanbul, Turkey, August 20-28, 1952). December 1952. 63p. diagrs., 2 tabs. (NACA TN 2832)

Numerical calculations are described of the aerodynamic characteristics at small angle of attack of a thin, doubly symmetrical, double-wedge profile in the range of supersonic flight speed in which the bow wave is detached. The analysis is carried out within the framework of the transonic (nonlinear) small-disturbance theory. The following results are provided as functions of the transonic similarity parameter: (1) chordwise lift distribution, (2) lift-curve slope, and (3) position of center of lift.

NACA TN 2836

RADIANT-INTERCHANGE CONFIGURATION FACTORS. D. C. Hamilton and W. R. Morgan, Purdue University. December 1952. 110p. diagrs., photos., 14 tabs. (NACA TN 2836)

A study is presented of the geometric configuration factors required for computing radiant heat transfer between opaque surfaces separated by a nonabsorbing medium and various methods of determining the configuration factors are discussed. Configuration-factor solutions available in the literature have been checked and the more complicated equations are presented as families of curves. Cases for point, line, and finite-area sources are worked out over a wide range of geometric proportions. These cases include several new configuration involving rectangles, triangles, and cylinders of finite length which are integrated and tabulated. An analysis is presented, in which configuration factors are employed, of the radiant heat transfer to the rotor blades of a typical gas turbine under different conditions of temperature and pressure.

NACA TN 2838

CALORIMETRIC DETERMINATION OF CONSTANT-PRESSURE SPECIFIC HEATS OF CARBON DIOXIDE AT ELEVATED PRESSURES AND TEMPERATURES. Virgil E. Schrock, University of California. December 1952. 46p. diagrs., 2 tabs. (NACA TN 2838)

The constant-pressure specific heat of carbon dioxide has been measured over the range of temperatures and pressures from ambient conditions to 1000 pounds per square inch gage and 1000° F using a steady-flow calorimeter operated on an open cycle. It appears that the apparatus as used in this determination will yield values with a probable error of 0.5 percent at the highest temperature level considered. The results of these tests check the widely accepted spectroscopic data within 1 percent. The values at elevated pressure are in reasonable agreement with those derived from the zero-pressure spectroscopic values and the application of the Beattie-Bridgeman equation of state. Only very limited calorimetric data are available in the literature, but substantial agreement exists with those considered reliable.

NACA TN 2842

THE PLANING CHARACTERISTICS OF A SURFACE HAVING A BASIC ANGLE OF DEAD RISE OF 40° AND HORIZONTAL CHINE FLARE. Ulysse J. Blanchard. December 1952. 26p. diagrs., photo., tab. (NACA TN 2842)

The principal planing characteristics of a surface having an angle of dead rise of 40° and horizontal chine flare are presented. The data indicate that at a given trim the important planing characteristics depend mainly on lift coefficient. The effects of increasing the basic angle of dead rise from 20° (NACA TN 2804) to 40° are to decrease the ratio of the center-of-pressure location to the mean wetted length, to decrease the extent of pile-up of water at the keel, and to increase the friction drag.

NACA TN 2846

EFFECTIVE LUBRICATION RANGE FOR STEEL SURFACES BOUNDARY LUBRICATED AT HIGH SLIDING VELOCITIES BY VARIOUS CLASSES OF SYNTHETIC FLUIDS. Robert L. Johnson, Max A. Swikert and Edmond E. Bisson. December 1952. 23p. diagrs., photos., tab. (NACA TN 2846)

Synthetic lubricants are necessary in order to satisfy the physical-property requirements for future lubricants of aircraft turbine engines. Since boundary-lubrication data on synthetic fluids are limited, the effects of a wide range of sliding velocities on boundary lubrication were studied. Friction data and surface-failure properties showed that a silicone diester blend, an alkyl silicate ester, and a compounded diester (containing lubrication additives) were more effective lubricants at high sliding velocities than the comparable diesters from which the most widely accepted synthetic lubricants are made. The diesters as well as polyethers, silicate ester, and phosphonate esters are more effective boundary lubricants at high sliding velocities than petroleum oils of comparable viscosity. In a preliminary study of the mechanism of lubrication by diesters, it was found that a diester failed to lubricate nonreactive surfaces, possibly indicating that the mechanism may involve chemical reaction of the diesters with the lubricated surfaces.

NACA TN 2847

SECTION CHARACTERISTICS OF A 10.5-PERCENT-THICK AIRFOIL WITH AREA SUCTION AS AFFECTED BY CHORDWISE DISTRIBUTION OF PERMEABILITY. Robert E. Dannenberg and James A. Weiberg. December 1952. 52p. diagrs., photos., 3 tabs. (NACA TN 2847)

Results are presented of an investigation of a two-dimensional, 10.51-percent-thick symmetrical airfoil with area suction near the leading edge. Area suction delayed leading-edge stall. Maximum lift appeared to be limited by turbulent separation from the trailing edge. The suction flow and power coefficients required to maintain a given lift are shown to be dependent on the chordwise extent and the porosity and permeability arrangement of the surface material. The flow-resistance characteristics of several porous materials are presented.

NACA TN 2848

INVESTIGATION OF SPONTANEOUS IGNITION TEMPERATURES OF ORGANIC COMPOUNDS WITH PARTICULAR EMPHASIS ON LUBRICANTS. Charles E. Frank, Angus U. Blackham and Donald E. Swarts, University of Cincinnati. December 1952. 40p. diagrs., 6 tabs. (NACA TN 2848)

The study of spontaneous ignition characteristics of organic compounds has been extended to include various types of lubricants by using a spray-injection as well as a dropwise-addition procedure. It has been shown that certain nonvolatile compounds previously considered to have relatively high spontaneous ignition temperatures exhibit basically the same ease of ignition as the lower-molecular-weight, more-volatile compounds. Of the lubricants studies, the polyisobutylenes were the only ones which gave consistently high spontaneous ignition temperatures (about 400° C) in all molecular-weight ranges. The influence of additives and metal surfaces on spontaneous ignition temperatures and on the ignition behavior of selected two-component mixtures was also determined.

NACA TN 2849

CORRECTIONS FOR LIFT, DRAG, AND MOMENT OF AN AIRFOIL IN A SUPERSONIC TUNNEL HAVING A GIVEN STATIC PRESSURE GRADIENT. H. F. Ludloff and M. B. Friedman, New York University. December 1952. 69p. diagrs. (NACA TN 2849)

Corrections for lift, drag and moment of a two-dimensional airfoil are analyzed assuming that the airfoil is tested in a supersonic tunnel in which the pressure field, instead of being uniform, is characterized by gradients in the axial and transverse directions. The tunnel gradients as well as the airfoil effect are regarded as perturbations of the original rectilinear flow field of given Mach number. Therefore the velocity potential of the flow, the nonlinear differential equation of motion, and the boundary conditions are expanded into double series in powers of two parameters characterizing the airfoil thickness and the inhomogeneity of the field. The nonlinear problem is thus split into a system of linear boundary-value problems which can be solved analytically. The resulting expressions have been derived for arbitrary given pressure gradients and general profile form.

NACA TN 2851

THE AERODYNAMIC DESIGN OF SUPERSONIC PROPELLERS FROM STRUCTURAL CONSIDERATION. Jerome B. Hammack. December 1952. 21p. diagrs. (NACA TN 2851)

A solution for radial distribution of cross-sectional area of supersonic propellers so that blade sections operate at maximum allowable centrifugal stress is given. The aerodynamic characteristics of some propellers designed by this method for Mach numbers from 0.9 to 2.4 for advance ratios of 2.0 and 3.0 are discussed.

NACA TN 2852

AN INVESTIGATION UTILIZING AN ELECTRICAL ANALOGUE OF CYCLIC DE-ICING OF A HOLLOW STEEL PROPELLER WITH AN EXTERNAL BLADE SHOE. Carr B. Neel, Jr. December 1952. 54p. diagrs., photos., 3 tabs. (NACA TN 2852)

A study of the heat requirements for cyclic de-icing of hollow steel propellers fitted with external blade shoes, utilizing an electrical analogue, showed how energy requirements could be decreased by changes in the method of operation of existing shoes and through proper blade-shoe design. Savings in total energy in the order of 60 percent would be possible in each case. Energy requirements were shown to increase with decreasing liquid-water content and air temperature.

NACA TN 2855

GENERAL CORRELATION OF TEMPERATURE PROFILES DOWNSTREAM OF A HEATED AIR JET DIRECTED AT VARIOUS ANGLES TO AIR STREAM. Robert S. Ruggeri. December 1952. 59p. diagrs., tab. (NACA TN 2855)

An experimental investigation was conducted to determine the temperature profile downstream of a heated-air jet directed at various angles to an air stream. The profiles were determined at two positions downstream of the jet as a function of jet diameter, jet density, free-stream density, jet velocity, free-stream velocity, jet total temperature, orifice flow coefficient, and jet discharge angles. A method is presented which yields a good approximation of the temperature profile in terms of dimensionless parameters of the flow and geometric conditions.

NACA TN 2857

A THEORETICAL METHOD OF ANALYZING THE EFFECTS OF YAW-DAMPER DYNAMICS ON THE STABILITY OF AN AIRCRAFT EQUIPPED WITH A SECOND-ORDER YAW DAMPER. Albert A. Schy and Ordway B. Gates, Jr. December 1952. 72p. diagrs., 2 tabs. (NACA TN 2857)

A method is presented for analyzing the effects of autopilot gain, natural frequency, and damping ratio on the damping of an aircraft equipped with a second-order autopilot. The method is illustrated by analyzing the effects of a second-order yaw damper on the lateral motion of an airplane. Constant-damping curves which show the effect of varying autopilot parameters on system damping are plotted and discussed. Greater damping is shown to be obtainable from a second-order yaw damper than from a no-lag yaw damper with the same gain. A method of designing yaw dampers is discussed.

NACA TN 2858

SUPERSONIC WAVE DRAG OF NONLIFTING DELTA WINGS WITH LINEARLY VARYING THICKNESS RATIO. Arthur Henderson, Jr. December 1952. 51p. diagrs. (NACA TN 2858)

The supersonic wave drag of a nonlifting, symmetrical, double-wedge-profile, delta wing the thickness ratio of which varies linearly in the spanwise direction is calculated by means of linear theory. In general it is found that a delta wing with linearly varying thickness ratio can have less wave drag than a constant thickness-ratio delta wing of the same plan form when both wings have either the same projected frontal area or the same internal volume. The thickness distributions for minimum drag and the corresponding values of the ratio of the drag of a linearly varying thickness-ratio wing to a constant-thickness-ratio wing are found.

NACA TN 2859

THE LANGLEY 2,000-HORSEPOWER PROPELLER DYNAMOMETER AND TESTS AT HIGH SPEED OF AN NACA 10-(3)(08)-03 TWO-BLADE PROPELLER. Blake W. Corson, Jr. and Julian D. Maynard. December 1952. 75p. diagrs., photos., 3 tabs. (NACA TN 2859. Formerly RM L7L29)

This paper contains a detailed description of a 2,000-horsepower propeller dynamometer used to make wind-tunnel tests of a two-blade NACA 10-(3)(08)-03 propeller for a range of blade angles from 20° to 55° at airspeeds up to 500 miles per hour. The results of these tests and comparisons with results obtained from a theoretical analysis and from previous tests made in other wind tunnels are presented.

NACA TN 2860

INTERACTION BETWEEN A SUPERSONIC STREAM AND A PARALLEL SUBSONIC STREAM BOUNDED BY FLUID AT REST. Herbert S. Ribner and E. Leonard Arnoff. December 1952. 45p. diagrs., 2 tabs. (NACA TN 2860)

Tsien and Finston's simplified model of shock boundary-layer interaction is modified to introduce effects of the separated "dead-air" bubble, where one exists. The boundary layer is simulated by an inviscid uniform subsonic stream bounded below by fluid at rest and impinged on above by a weak oblique shock in an infinite supersonic stream. Linearized analysis indicates that the simulated boundary layer approximates the expansive corner turn that would occur if the shock were incident directly on the dead-air region; there are localized distortions top and bottom.

NACA TN 2862

INFLUENCE OF NONMARTENSITIC TRANSFORMATION PRODUCTS ON MECHANICAL PROPERTIES OF TEMPERED MARTENSITE. J. M. Hodge and W. T. Lankford, United States Steel Company. December 1952. 13p. diagrs., 4 tabs. (NACA TN 2862)

The influence of nonmartensitic transformation products on the mechanical properties of tempered martensite is presented for samples of an SAE 4340 steel, partially isothermally transformed to specific high-temperature transformation products and quenched and tempered to hardness values of from 25 to 40 Rockwell C. The effects of upper bainite in amounts of 1, 5, 10, 20, and 50 percent, of 5 percent ferrite, and of 5 percent pearlite on the tensile, impact, and fatigue properties are evaluated.

NACA TN 2863

LAMINAR NATURAL-CONVECTION FLOW AND HEAT TRANSFER OF FLUIDS WITH AND WITHOUT HEAT SOURCES IN CHANNELS WITH CONSTANT WALL TEMPERATURES. Simon Ostrach. December 1952. 55p. diagrs. (NACA TN 2863)

An analysis of the natural-convection phenomenon shows that the flow and heat transfer, in general, not only are functions of the Prandtl and Grashof numbers but also depend on a new dimensionless parameter. If this parameter is not negligibly small, the compression work and frictional heating may appreciably affect this mode of heat transfer. Particular consideration is given to the fully developed natural-convection flow of fluids with and without heat sources between two long parallel plane surfaces whose temperatures are maintained constant but not necessarily equal. Detailed velocity and temperature distributions are obtained from which the effects of heat sources in the fluids and frictional heating on the process can be seen. Frictional heating and heat sources increase the velocities and temperatures. Increasing the ratio of the two wall-temperature differences (wall minus outside ambient) also leads to similar results.

NACA RM E52I22

VARIATION IN SMOKING TENDENCY AMONG LOW MOLECULAR WEIGHT HYDROCARBONS. Rose L. Schalla and Glen E. McDonald. December 1952. 16p. diagrs., 3 tabs. (NACA RM E52I22)

An investigation was made of the variations in smoking tendency among 38 gaseous and liquid pure hydrocarbon compounds when burned as diffusion flames in still air. The maximum rates at which the fuels could be burned smoke-free varied as follows: n-paraffins > isoparaffins > monoolefins > alkynes > aromatics. Cyclic paraffins and olefins as well as diolefins were also studied. Their position overlapped the trends of several of the series presented. Variations in smoking tendencies within the given homologous series were rather complex, but a tentative explanation is that the greater the strength of the carbon bonds or skeleton of the hydrocarbon molecule, the greater will be its tendency to form smoke during combustion. From this suggested explanation a possible mechanism based on dehydrogenation and subsequent polymerization of the carbon nuclei was proposed as the initial step involved in the formation of smoke.

NACA RM E52J06

PRELIMINARY SURVEY OF ICING CONDITIONS MEASURED DURING ROUTINE TRANSCONTINENTAL AIRLINE OPERATION. Porter J. Perkins. December 1952. 27p. diagrs., photos., 3 tabs. (NACA RM E52J06)

Icing data collected on routine operations by four DC-4-type transport aircraft equipped with NACA pressure-type icing-rate meters and flying over a transcontinental route from January through May 1951 are presented. The four aircraft were in icing conditions approximately 1-1/2 percent of the total flying time. Nearly one-half of the icing conditions were encountered over the Great Lakes area. Average liquid-water-content measurements did not exceed 1.0 gram per cubic meter and 80 percent of the measurements did not exceed 0.4 gram per cubic meter. The data are considered only preliminary and the program is continuing to provide additional data from world-wide air routes.

MISCELLANEOUS

NACA RM E52B12

Errata No. 1 on "IMPINGEMENT OF WATER DROPLETS ON AN NACA 65_1-212 AIRFOIL AT AN ANGLE OF ATTACK OF 4°". Rinaldo J. Brun, John S. Serafini and George J. Moshos. September 10, 1952.

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Research Abstracts

NO.36 JANUARY 16, 1953

CURRENT NACA REPORTS

NACA Rept. 1082

METHOD OF ANALYSIS FOR COMPRESSIBLE FLOW THROUGH MIXED-FLOW CENTRIFUGAL IMPELLERS OF ARBITRARY DESIGN. Joseph T. Hamrick, Ambrose Ginsburg and Walter M. Osborn. 1952. ii, 10p. diagrs. (NACA Rept. 1082. Formerly NACA TN 2165)

A method is presented for the analysis of compressible flow between the hub and the shroud of mixed-flow impellers of arbitrary design. Axial symmetry was assumed, but the forces in the meridional (hub-shroud) plane, which are derived from tangential pressure gradients, were taken into account. The method was applied to an experimental mixed-flow impeller. The analysis of the flow in the meridional plane of the impeller showed that the rotational forces, the blade curvature, and the hub-shroud profile can introduce severe velocity gradients along the hub and shroud surfaces. Choked flow at the impeller inlet as determined by the analysis was verified by experimental results.

NACA TN 2845

X-RAY INSTRUMENTATION FOR DENSITY MEASUREMENTS IN A SUPERSONIC FLOW FIELD. John Dimeff, Ralph K. Hallett, Jr. and C. Frederick Hansen. December 1952. 39p. diagrs., photos., 2 tabs. (NACA TN 2845)

An instrument has been constructed to measure the density of an air stream by utilizing the reduction in intensity of an undeviated beam of X rays. This equipment has been designed for density ranges from 2×10^{-5} to 3×10^{-4} grams per cubic centimeter. Path-length-density products were measured within 5×10^{-5} g/cm^2 for X-ray-beam areas of 5×10^{-4} cm^2 and averaging times of 30 seconds, and within 1×10^{-5} g/cm^2 for beam areas of 8×10^{-3} cm^2 and averaging times of 5 minutes.

NACA TN 2850

STUDY OF PRESSURE EFFECTS ON VAPORIZATION RATE OF DROPS IN GAS STREAMS. Robert D. Ingebo. January 1953. 36p. diagrs., 5 tabs. (NACA TN 2850)

Vaporization-rate and surface-temperature data were obtained for four pure liquids evaporating from the surface of a porous sphere in air streams having a static pressure range of 450 to 1500 millimeters of mercury. Data were also obtained for methanol evaporating in streams of helium, argon, and carbon dioxide. Experimental heat-transfer coefficients were found to correlate a semiempirical equation which shows the Nusselt number to be a function of the group ReSc, the thermal-conductivity ratio, and the molecular-scale momentum-transfer ratio of gravitational to inertial forces. These data show the heat-transfer coefficient to be independent of the static pressure of the gas stream, and the effect of pressure on the vaporization rate to be determined directly by the effect of pressure on the surface temperature of the drop. An equation is also presented for calculating the driving potential Δt value for water at a static pressure of 450 to 1500 millimeters of mercury by using the Δt^* value for 1 atmosphere pressure and a calculated correction term $\Delta t'$.

NACA TN 2853

A STUDY OF THE APPLICATION OF POWER-SPECTRAL METHODS OF GENERALIZED HARMONIC ANALYSIS TO GUST LOADS ON AIRPLANES. Harry Press and Bernard Mazelsky. January 1953. 48p. diagrs., 2 tabs. (NACA TN 2853)

The applicability of some results from the theory of generalized harmonic analysis to the analysis of gust loads on airplanes in continuous rough air is examined. The input and output relations in terms of power spectrums are used to relate the standard deviation (root mean square) of loads in continuous rough air to the gust response characteristics of the airplane and the spectral characteristics of atmospheric turbulence. For the case of a normally distributed output, which appears from experimental evidence to apply to a homogeneous turbulence condition, the probability distribution of loads is shown to be a simple function of the output power spectrum. In order to illustrate the application of power-spectral analysis to gust loads and to obtain an insight into the relation between loads in continuous rough air and the gust response characteristics of the airplane, two selected series of calculations are presented. The results of these applications are compared with those obtained from calculations for single gusts and their implications are discussed.

NACA TN 2854

AVERAGE SKIN-FRICTION DRAG COEFFICIENTS FROM TANK TESTS OF A PARABOLIC BODY OF REVOLUTION (NACA RM-10). Elmo J. Mottard and J. Dan Loposer. January 1953. 18p. diagrs., photos. (NACA TN 2854)

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Average skin-friction drag coefficients were obtained from boundary-layer total-pressure measurements on a parabolic body of revolution (NACA RM-10) basic fineness ratio 15) in water at Reynolds numbers from 4.4×10^6 to 70×10^6. The tests were made in the Langley tank no. 1 with the body sting-mounted at a depth of two maximum body diameters. The arithmetic mean of three drag measurements taken around the body was in good agreement with flat-plate results, but, apparently because of the slight surface wave caused by the body, the distribution of the boundary layer around the body was not uniform over part of the Reynolds number range.

NACA TN 2861

ANALYTICAL INVESTIGATION OF ICING LIMIT FOR DIAMOND-SHAPED AIRFOIL IN TRANSONIC AND SUPERSONIC FLOW. Edmund E. Callaghan and John S. Serafini. January 1953. 18p. diagrs. (NACA TN 2861)

Calculations have been made for the icing limit of a diamond airfoil at zero angle of attack in terms of the stream Mach number, stream temperature, and pressure altitude. The icing limit is defined as a wetted-surface temperature of 32° F and is related to the stream conditions by the method of Hardy. The results show that the point most likely to ice on the airfoil lies immediately behind the shoulder and is subject to possible icing at Mach numbers as high as 1.4.

NACA TN 2866

ICING PROTECTION FOR A TURBOJET TRANSPORT AIRPLANE: HEATING REQUIREMENTS, METHODS OF PROTECTION, AND PERFORMANCE PENALTIES. Thomas F. Gelder, James P. Lewis and Stanley L. Koutz. January 1953. i, 57p. diagrs., tab. (NACA TN 2866)

The heating requirements for several methods of icing protection for a typical turbojet transport airplane operating over a probable range of icing conditions are evaluated, and the airplane performance penalties associated with providing this protection from various energy sources are assessed. Continuous heating requirements and airplane penalties for the turbojet transport are considerably increased over those for lower-speed aircraft. Heating requirements can be substantially reduced by use of a cyclic de-icing system and choice of the proper energy source.

NACA RM E52J13

PREDICTION OF FLAME VELOCITIES OF HYDROCARBON FLAMES. Gordon L. Dugger and Dorothy M. Simon. January 1953. 23p. diagrs., 3 tabs. (NACA RM E52J13)

The effects of four combustible-mixture variables on the laminar flame velocities of hydrocarbon-oxygen-nitrogen mixtures are predicted by semitheoretical methods based on (1) Semenov equation (thermal mechanism), (2) Tanford-Pease equation (active-particle-diffusion mechanism), and (3) Manson equation (momentum-pressure-drop equation using active-particle concentrations). A semiempirical factor, calculated from flame velocity data, is required by each of these equations. When these factors are calculated for each variable separately, mean deviations between calculated and measured flame velocities are 2 to 15 percent for the variables studied, namely, hydrocarbon structure, equivalence ratio, oxygen-nitrogen ratio, and initial temperature. When the semiempirical factor for one variable is used to predict the effect of another variable, the mean deviations are approximately doubled. Empirical equations are summarized which give better predictions, but require more constants.

NACA RM E52J24

FLAME VELOCITIES OF PROPANE- AND ETHYLENE-OXYGEN-NITROGEN MIXTURES. Gordon L. Dugger and Dorothy D. Graab. January 1953. 23p. diagrs., 3 tabs. (NACA RM E52J24)

Laminar flame velocities of propane and ethylene with oxygen-nitrogen mixtures containing 0.166 to 0.496 mole fraction of oxygen were determined as a function of mixture composition at 311° and 422° K by a Bunsen-burner method. For each case flame velocity increased linearly with oxygen concentration. Empirical equations including the effects of initial temperature and oxygen concentration were obtained. Thermal and diffusion theories were used to predict the relative effect of oxygen concentration on maximum flame velocity within 5 to 15 percent. No linear correlations between maximum flame velocity and calculated active particle concentrations were obtained.

NACA RM E52J28

SPARK IGNITION OF FLOWING GASES. III - EFFECT OF TURBULENCE PROMOTER ON ENERGY REQUIRED TO IGNITE A PROPANE-AIR MIXTURE. Clyde C. Swett, Jr. and Richard H. Donlon. January 1953. 7p. diagrs. (NACA RM E52J28)

An investigation was conducted to determine the effect of turbulence generated by different sizes of wire grid on the minimum spark-ignition energy of a flowing propane-air mixture. Test conditions were: pressure, 5 inches of mercury absolute; temperature, 80° F; fuel-air ratio, 0.0835 (by weight); velocity, 50 to 250 feet per second; spark duration, 500 microseconds; and electrode spacing, 0.37 inch. The wire sizes of the turbulence promoters ranged from 0.006 to 0.105 inch in diameter and the promoters were located either 4-3/8 or 6-3/8 inches upstream of the spark electrodes. The investigation was conducted with turbulence having superimposed flow pulsations and duct resonance. The required ignition energy increased with wire size of the turbulence promoter and with gas velocity and decreased with distance from the promoter to the spark electrodes. The required ignition energy therefore in-

creased with those factors that are reported to generate increased intensity of turbulence. At a velocity of 250 feet per second, three times more energy was required with the 0.105-inch wire-diameter promoter than with no promoter.

NACA TM 1324

STEADY VIBRATIONS OF WING OF CIRCULAR PLAN FORM. (Ob ustanovivshikhsya kolebaniyakh kryla krugovoi formy v plane). THEORY OF WING OF CIRCULAR PLAN FORM. (Teoriya kryla konechnogo razmakha krugovoi formy v plane). N. E. Kochin. January 1953. 93p. diagrs. (NACA TM 1324. Trans. from: Prikladnaya Matematika i Mekhanika, v. 6, no. 4, 1942, p. 287-316; Prikladnaya Matematika i Mekhanika, v. 4, no. 1, 1940, p. 3-32).

This paper treats the problem of determining the lift, moment, and induced drag of a thin wing of circular plan form in uniform incompressible flow on the basis of linearized theory. As contrasted to a similar paper by Kinner, in which the acceleration potential method was used, the present paper utilizes the concept of the velocity potential. Calculations of the lift and moment are presented for several deformed shapes. It is shown that considerable deviations exist between the strip theory analysis and the more exact theory. The lift, moment, and induced drag are also determined for a harmonically oscillatory circular plan form wing. As constrasted to a similar paper by Schade, in which the acceleration potential method was used, the present paper utilizes the concept of the velocity potential. Expressions for lift, moment, and induced drag are given and finally specialized to the case of a slowly oscillating circular wing.

BRITISH

N-17876*

National Gas Turbine Establishment (Gt. Brit.)
A DIRECT, EASILY COMPUTABLE METHOD FOR THE EVALUATION OF CENTRIFUGAL AND THERMAL STRESSES IN DISCS, AND STRESS CHANGES DUE TO PLASTIC FLOW AND CREEP. R. L. Brooking, J. Brown and B. R. Atkins. July 1952. 68p. diagrs., 7 tabs. (NGTE R. 122)

A method is presented below by the use of which stressing of turbine disks may be performed. It permits the evaluation of stresses due both to rotation, and to existence of a thermal gradient radially across the disk. The method is extended to cover the calculation of the stress changes which occur at any point under conditions where stresses exceed the elastic limit of the disk material (plastic flow), or where the disk is rotating for long periods of time under given conditions (creep). The method is a direct one in that it involves neither initial stress assumptions nor successive approximations. It may be described as a small-difference, step-by-step method, and can be set out in an easily computable form, the operation of which requires little mathematical knowledge. Two examples of the application of the method are given. One treats an aeroengine turbine disk in which the stress changes due to plastic flow are included, and the results obtained by this are compared with those obtained using a somewhat more mathematical method due to Prof. Hartree. Good agreement is exhibited. The second example shows the evaluation of the stress distribution in a rotor after 10,000 hours under steady running conditions, the latter example showing also the application to this problem of a current theory on creep data.

N-20200*

National Gas Turbine Establishment (Gt. Brit.)
THE RELATIONSHIP BETWEEN THE CREEP AND TENSILE PROPERTIES AT ELEVATED TEMPERATURE OF NIMONIC 80. A. Graham and K. F. A. Walles. August 1952. 45p. diagrs., 9 tabs. (NGTE R. 100)

A variety of empirical formulas is available to represent the effect of stress, time, rate, and temperature, on deformation, and the report describes the experimental side of an attempt to combine the more promising of them into a comprehensive theory which may be usefully applied to a commercial material.

N-20231*

Forest Products Research Lab. (Gt. Brit.)
INVESTIGATIONS INTO GLUES AND GLUING. PROGRESS REPORT SIXTY-NINE - AUGUST 1952. THE COMPARATIVE DURABILITY OF PLYWOOD GLUES IN ENGLAND AND IN NIGERIA (SERIES IV). SECOND YEAR'S ANALYSIS. J. F. S. Carruthers, P. Burgess and A. M. Thomas. (Superseding Progress Rept. 62, May, 1951). 11p. 2 tabs. (Forest Products Research Lab.)

Since 1940 this Laboratory has been conducting tests on the durability of plywood adhesives in various environments in the United Kingdom. This report is concerned with an extension of these experiments to include exposures in the tropics.

N-20232*

Forest Products Research Lab. (Gt. Brit.)
INVESTIGATIONS INTO GLUES AND GLUING. PROGRESS REPORT SIXTY-FOUR - JANUARY, 1952. THE DURABILITY OF ASSEMBLY GLUES - SERIES A. FIFTH-YEAR REPORT ON THE PLY-CLAD FRAME TESTS. R. A. G. Knight, L. S. Doman and G. E. Soane. 14p. photos., 6 tabs. (Forest Products Research Lab.)

This report records the observations made of the durability of assembly glues tested by a ply-clad frame unit, one side of which has been fully exposed to weather and the other protected by a hutch through which unheated outside air can circulate.

N-20233*

Forest Products Research Lab. (Gt. Brit.) INVESTIGATIONS INTO GLUES AND GLUING. PROGRESS REPORT SIXTY-SEVEN - SEPTEMBER, 1952. DURABILITY OF ASSEMBLY GLUES - SERIES B. FIFTH-YEAR REPORT ON LAMINATED BEAMS. R. J. Newall and J. E. Grosert. (Superseding Progress Rept. 54, May, 1950). 9p. diagrs. (Forest Products Research Lab.)

This report describes one of the series of investigations being made by the Laboratory of the durability of adhesives in various kinds of joints under different exposure conditions. The test units in this case are laminated beams of different widths made with assembly glues representative of the main types, namely animal, casein, urea- and phenol-formaldehyde resins.

N-20257*

Aeronautical Research Council (Gt. Brit.) OBSERVATIONS ON A THIN CAMBERED AEROFOIL BEYOND THE CRITICAL MACH NUMBER. E. W. E. Rogers. July 7, 1950. 23p. diagrs., photos. (ARC 13,238; Perf. 685; FM 1455)

In the course of surface pressure measurements and wake traverses on an airfoil section of 10-percent thickness-chord ratio, tested at high subsonic speeds in the 20 in. x 8 in. (50.8 cm x 20.3 cm) high speed tunnel of the National Physical Laboratory, it was discovered that at a particular incidence (3.7°) an extensive region of supersonic velocity ($M = 1.15$) existed without the formation of a well-defined shock wave or a rise of drag. The drag coefficient in fact decreased markedly as the Mach number was raised from a low value, and this was accompanied by a rearward movement on the upper surface of the position of boundary layer transition corresponding to a favorable change of the surface pressure gradient. In an attempt to explain this phenomenon, some analysis is made of the observed pressure distribution curves, and the measured transition positions are compared with those estimated from the observed drag coefficients. Direct shadow photographs illustrate the development of the shockwave pattern.

N-20260*

Aeronautical Research Council (Gt. Brit.) A NOTE ON THE BOUNDARY LAYER AND STALLING CHARACTERISTICS OF AEROFOILS. D. D. Carrow. October 5, 1950. 21p. diagrs. (ARC 13,424; Perf. 697; S & C 2435)

A qualitative explanation is suggested for the changes which occur in the stalling characteristics of airfoils as the Reynolds number is increased. This explanation is based on the variation, with Reynolds number, in the state of the boundary layer along the upper surface at just below the stalling incidence.

MISCELLANEOUS

NACA Rept. 1041

Errata No. 1 on "EQUATIONS AND CHARTS FOR THE RAPID ESTIMATION OF HINGE-MOMENT AND EFFECTIVENESS PARAMETERS FOR TRAILING-EDGE CONTROLS HAVING LEADING AND TRAILING EDGES SWEPT AHEAD OF THE MACH LINES". Kennith L. Goin. 1951.

UNPUBLISHED PAPERS

N-12887*

TURBULENT HETEROGENEOUS COMBUSTION. (Turbulentnoe geterogennoe gorenie). S. A. Goldenberg. 16p. diagrs. (Trans. from Izvestia Akademii Nauk SSSR, no. 8, August 1950, p. 1154-1164).

An experimental investigation was made of the process of combustion of carbon in the form of a cylindrical tube for turbulent flow of the gases with velocities from 22 to 145 meters per second. On the basis of the hydrodynamic characteristics determining the transport of the masses in the turbulent flow (the coefficient of turbulent diffusion), an approximate analytical method is given for the computation of the combustion process. The temperature dependence was obtained for the coefficient of gas exchange within the temperature range 500° to 1050°, which is expressed by the formula $\alpha \approx 8.5 \times 10^{5} \exp(-18,000/RT)$.

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NO.37 FEBRUARY 6, 1953

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CURRENT NACA REPORTS

NACA Rept. 1070

MATRIX METHOD OF DETERMINING THE LONGITUDINAL-STABILITY COEFFICIENTS AND FREQUENCY RESPONSE OF AN AIRCRAFT FROM TRANSIENT FLIGHT DATA. James J. Donegan and Henry A. Pearson. 1952. ii, 11p. diagrs., 3 tabs. (NACA Rept. 1070. Formerly TN 2370)

A method is presented for obtaining the over-all longitudinal-stability coefficients and frequency response of an aircraft from an analysis of arbitrary maneuvers in which simple instrumentation is used. Although the method presented deals entirely with the aircraft, it is equally applicable to other problems which can be expressed by second-order differential equations.

NACA TN 2839

DEVELOPMENT OF TURBULENCE-MEASURING EQUIPMENT. Leslie S. G. Kovásznay. National Bureau of Standards. January 1953. 86p. diagrs., photos. (NACA TN 2839)

Hot-wire turbulence-measuring equipment has been developed to meet the more-stringent requirments involved in the measurement of fluctuations in flow parameters at supersonic velocities. The higher mean speed necessitates the resolution of higher frequency components than at low speed, and the relatively low turbulence level present at supersonic speed makes necessary an improved noise level for the equipment. The equipment covers the frequency range from 2 to 70,000 cycles per second. The equipment is adaptable to all-purpose turbulence work with improved utility and accuracy over that of older types of equipment. Sample measurements are given to demonstrate the performance.

NACA TN 2856

ESTIMATED POWER REDUCTION BY WATER INJECTION IN A NONRETURN SUPERSONIC WIND TUNNEL. Morton Cooper and John R. Sevier, Jr. January 1953. 19p. diagrs., tab. (NACA TN 2856)

A simplified analysis has been made to estimate the extent to which the pressure ratio and power of a nonreturn supersonic wind tunnel operating in the low supersonic Mach number range can be reduced by the evaporation of water injected into the diffuser. It appears to be theoretically possible to reduce the power by as much as 20 percent for a typical example of a tunnel operating at a Mach number of 1.4 and at the following stagnation conditions: pressure, 15 pounds per square inch; temperature, 200° F; and dew point, 0° F or less. For a tunnel having a test section of 50 square feet, the amount of water injected would be about 300 gallons per minute and the power saved, about 7,000 horsepower. The power required to provide the necessary water and the possible increases in diffuser losses associated with water injection must, of course, be weighted against the theoretical power saving.

NACA TN 2864

CONVECTION OF A PATTERN OF VORTICITY THROUGH A SHOCK WAVE. H. S. Ribner. January 1953. ii, 48p. diagrs. (NACA TN 2864)

An arbitrary weak spatial distribution of vorticity can be represented in terms of plane sinusoidal shear waves of all orientations and wave lengths (Fourier integral). The analysis treats the passage of a single representative weak shear wave through a plane shock and shows refraction and modification of the shear wave with simultaneous generation of an acoustically intense sound wave. Applications to turbulence and to noise in supersonic wind tunnels are indicated.

NACA TN 2865

INVESTIGATION OF GASES EVOLVED DURING FIRING OF VITREOUS COATINGS ON STEEL.

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Dwight G. Moore and Mary A. Mason, National Bureau of Standards. January 1953. 34p. diagrs., photos., 7 tabs. (NACA TN 2865)

A study was made of the nature and source of gases evolved when a ground-coat enamel is applied to low-carbon steel. The principal gases evolved were found to be carbon monoxide, carbon dioxide, and hydrogen. The cause of primary boil was determined as the evolution of carbon gases from the oxidation of carbon in the steel. Further results indicate that hydrogen, formed from the reaction between dissolved water in the coating and the hot iron base, diffuses into the coating as firing continues. On fast cooling the hydrogen is expelled causing bubbles to form at the interface of the coating. Practically all of the bubble structure in a normally fired enamel was found to be due to some impurity in the clay addition which may be organic matter adsorbed on the clay particles.

NACA TN 2868

REFLECTION OF A WEAK SHOCK WAVE FROM A BOUNDARY LAYER ALONG A FLAT PLATE. I - INTERACTION OF WEAK SHOCK WAVES WITH LAMINAR AND TURBULENT BOUNDARY LAYERS ANALYZED BY MOMENTUM-INTEGRAL METHOD. Alfred Ritter and Yung-Huai Kuo, Cornell University. January 1953. 66p. diagrs., tab. (NACA TN 2868)

The present paper is concerned with the phenomena encountered when a plane oblique shock wave is incident upon the boundary layer of a flat plate. The problem has been simplified by dividing the flow field into a viscous layer near the wall and a supersonic potential outer flow. Ordinary linearized theory has been applied to the outer flow inasmuch as the study has been restricted to infinitesimal compression waves and only small perturbations are encountered. The paper deals primarily with the case of laminar flow and the boundary-layer treatment is based upon the momentum-integral equation previously derived by Howarth.

NACA TN 2869

REFLECTION OF WEAK SHOCK WAVE FROM A BOUNDARY LAYER ALONG A FLAT PLATE. II - INTERACTION OF OBLIQUE SHOCK WAVE WITH A LAMINAR BOUNDARY LAYER ANALYZED BY DIFFERENTIAL-EQUATION METHOD. Yung-Huai Kuo, Cornell University. January 1953. 60p. diagrs. (NACA TN 2869)

By analogy with the boundary-layer concept, the flow produced by the interaction between a shock wave and a laminar boundary layer is subdivided into a viscous layer and a potential field. The assumptions that the compressibility effect in the inner layer is negligible and that the original flow in the outer layer is uniform lead to simple analytical solutions using a differential-equation method to determine the perturbed flow. The joining conditions at the interface between the layers determine an eigenvalue which gives the rate of decay and the character of the disturbances both upstream and downstream of the point of incidence.

NACA TN 2870

POWER-OFF FLARE-UP TESTS OF A MODEL HELICOPTER ROTOR IN VERTICAL AUTOROTATION. S. E. Slaymaker and Robin B. Gray, Princeton University. January 1953. 36p. diagrs., photos. (NACA TN 2870)

The problem of reducing the descending velocity of a helicopter model in steady vertical autorotation by expending the kinetic energy of the rotor in a collective-pitch flare was investigated experimentally. Test data were obtained over a wide range of operating conditions from a freely falling model rotor restrained laterally by a guide wire. The results indicate the influence of disk loading and rotor inertia on a given rotor configuration under various flare conditions. A semiempirical method was developed for predicting the flare performance of the model. The accuracy of the method was checked experimentally for all model configurations and sample calculations were made for two full-scale helicopters. The method yields results which compare favorably with experimental data.

NACA TN 2871

EXPERIMENTAL INVESTIGATION OF LOSS IN AN ANNULAR CASCADE OF TURBINE-NOZZLE BLADES OF FREE VORTEX DESIGN. Hubert W. Allen, Milton G. Kofskey and Richard E. Chamness. January 1953. 33p. diagrs., photos., tab. (NACA TN 2871)

Losses originating in a cascade of turbine-nozzle blades of free-vortex design were investigated quantitatively at two Mach numbers, and visual studies were also made of the boundary-layer flow on blade and shroud surfaces. High loss regions were found near the corners between the suction side of the wake and the shrouds. These losses were accompanied by high discharge-angle gradients. Visual traces of shroud boundary-layer flow showed a cross-channel component of velocity and indicated one source fo the accumulation of low-momentum fluid comprising the loss region. Results of a shift of the loss region and visual indications of the boundary-layer flow along the blade surfaces at the higher Mach number showed that the low-momentum fluid originating on the outer shroud and blade surfaces flows radially inward through a thickened portion of the boundary layer on the blade suction surface and along the trailing edge in the wake of the blades.

NACA TN 2872

THE EFFECT OF INITIAL CURVATURE ON THE STRENGTH OF AN INELASTIC COLUMN. Thomas W. Wilder, III, William A. Brooks, Jr., and Eldon E. Mathauser. January 1953. 17p. diagrs. (NACA TN 2872)

The reduction in column strength due to initial curvature is determined theoretically for a pin-ended idealized inelastic H-section column. Equations

relating load and lateral deflection are obtained which permit a systematic variation in the parameters representing the stress-strain properties, column proportions, and initial curvature of the column. The results, presented graphically, show the effect on column strength for various combinations of these parameters.

NACA TN 2873

THE EFFECT OF LONGITUDINAL STIFFENERS LOCATED ON ONE SIDE OF A PLATE ON THE COMPRESSIVE BUCKLING STRESS OF THE PLATE-STIFFENER COMBINATION. Paul Seide. January 1953. 66p. diagrs., 2 tabs. (NACA TN 2873)

The problem of buckling under uniform compression of flat, simply supported, rectangular plates with equally spaced longitudinal stiffeners on one side of the plate is investigated. For the case of a plate with one, two, or infinitely many stiffeners, the analysis yields expressions for the effective moment of inertia of the stiffeners that can be used in conjunction with the buckling charts previously presented in NACA TN 1825.

NACA TN 2874

ON TRAVELING WAVES IN BEAMS. Robert W. Leonard and Bernard Budiansky. January 1953. 76p. diagrs., tab. (NACA TN 2874)

The basic equations of Timoshenko for the motion of vibrating nonuniform beams, which allow for effects of transverse shear deformation and rotary inertia, are presented in several forms; the propagation of sharp disturbances is discussed. Numerical traveling-wave solutions are obtained for some elementary problems of finite uniform beams for which the propagation velocities of shear and bending discontinuities are equal. Comparisons are made with modal solutions and, in some cases, with exact closed solutions.

NACA TN 2875

BEHAVIOR IN PURE BENDING OF A LONG MONOCOQUE BEAM OF CIRCULAR-ARC CROSS SECTION. Robert W. Fralich, J. Mayers and Eric Reissner. January 1953. 33p. diagrs. (NACA TN 2875)

An analysis is made of the behavior under a loading of pure bending moment of a thin, infinitely long, pure-monocoque beam having a constant, doubly symmetric, circular-arc cross section. Bending moments, deflections, and stresses are obtained. The analysis shows a nonlinear behavior in bending which leads ultimately to a maximum moment and instability.

NACA TN 2876

THE PLANING CHARACTERISTICS OF TWO V-SHAPED PRISMATIC SURFACES HAVING ANGLES OF DEAD RISE OF 20° and 40°. Derrill B. Chambliss and George M. Boyd, Jr. January 1953. 38p. diagrs., photos., 2 tabs. (NACA TN 2876)

An investigation was conducted to determine the principal planing characteristics of two V-shaped surfaces having angles of dead rise of 20° and 40°. The data indicate that, for a given condition of load, speed, and trim, the wetted length, distance of center of pressure from trailing edge, and drag increase with an increase in the angle of dead rise.

NACA TN 2877

ON THE USE OF A DAMPED SINE-WAVE ELEVATOR MOTION FOR COMPUTING THE DESIGN MANEUVERING HORIZONTAL-TAIL LOAD. Melvin Sadoff. January 1953. 32p. diagrs., 3 tabs. (NACA TN 2877)

An analysis was made to evaluate the assumption of a damped sine-wave elevator motion for computing the design maneuvering load on the horizontal tail. Also investigated was the effect of control frequency on the tail load. The results indicated that the tail loads computed by the method of the present report agreed closely with the loads computed by a method currently specified for use in the U.S. Air Force structural loading requirements. For a given design normal acceleration factor, it was found that an increase in control frequency resulted in a marked increase in both the negative and positive peak tail loads attained during the assumed maneuvers.

NACA TN 2878

COMBINED EFFECT OF DAMPING SCREENS AND STREAM CONVERGENCE ON TURBULENCE. Maurice Tucker. January 1953. i, 62p. diagrs., tab. (NACA TN 2878)

The analysis treats, in the absence of turbulent decay processes, the combined effect of a series of identical damping screens followed by a stream convergence upon the mean-square fluctuation velocities, scales, correlation coefficients, and one-dimensional spectra of a convected field of turbulence described by a triple Fourier integral superposition of plane transverse waves. Numerical results are tabulated for the case of upstream isotropic turbulence. An approximate method for taking into account the effects of turbulent decay upon the mean-square fluctuation velocities is also presented.

NACA TN 2879

UNSTEADY OBLIQUE INTERACTION OF A SHOCK WAVE WITH A PLANE DISTURBANCE. Franklin K. Moore. January 1953. 66p. diagrs. (NACA TN 2879)

Analysis is made of the flow field produced by oblique impingement of weak plane disturbances of arbitrary profile on a plane normal shock. Three types of distrubance are considered: (a) Sound wave propagating in the gas at rest into which the shock moves. The sound wave refracts either as a simple isentropic sound wave or an attenuating isentropic pressure wave, depending on the angle between the shock and the incident sound wave. A stationary vorticity wave of constant pressure appears behind the shock. (b) Sound wave overtaking the shock from behind. The sound wave reflects as a sound wave, and a stationary vorticity wave is produced. (c) An incompressible vorticity wave stationary in the gas ahead of the shock. The incident wave refracts as a stationary vorticity wave, and either a sound wave or attenuating pressure wave is also produced. Computations are presented for the first two types of incident wave, over the range of incidence angles, for shock Mach numbers of 1, 1.5, and ∞.

NACA TN 2880

A DIGITAL AUTOMATIC MULTIPLE PRESSURE RECORDER. Bert A. Coss, D. R. Daykin, Leonard Jaffe and Elmer M. Sharp. January 1953. 24p. diagrs., photo. (NACA TN 2880)

A machine is described which will automatically measure and record 100 pressures in a range from 5 to 65 inches of mercury, in approximately 2-1/2 minutes, to an accuracy of 0.1 inch of mercury. The method used is to compare the unknown pressures with a scanning pressure whose value at any instant is known in digitalized form. Sensitive diaphragms indicate balance between the unknown and the scanning pressures. All unknown pressures are compared with the scanning pressure simultaneously and the information is stored temporarily within the machine. During read out, the information is properly sequenced, identified, coded, and punched into paper tape, which is the actual permanent record of the output of the machine, although typewritten tabulated data may also be produced. The punched paper tape may be used subsequently either to tabulate data or to punch cards automatically for use in punched-card calculators.

NACA TN 2882

THEORETICAL INVESTIGATION OF THE LONGITUDINAL RESPONSE CHARACTERISTICS OF A SWEPT-WING FIGHTER AIRPLANE HAVING A PITCH-ATTITUDE CONTROL SYSTEM. Fred H. Stokes and J. T. Matthews. January 1953. 41p. diagrs., tab. (NACA TN 2882)

An analysis is made of a pitch-attitude control system, both with and without rate feedback, as applied to a swept-wing fighter airplane. The results show the response characteristics of the airplane-autopilot combination. The effects that changes in altitude and Mach number have on these response characteristics are investigated, as are the effects of changes in the rate and error gain settings of the system.

NACA TN 2883

BEARING STRENGTHS OF SOME 75S-T6 AND 14S-T6 ALUMINUM-ALLOY HAND FORGINGS. E. M. Finley, Aluminum Company of America. January 1953. 24p. diagrs., photos., 4 tabs. (NACA TN 2883)

Results are given from an investigation of bearing properties of some 75S-T6 and 14S-T6 aluminum-alloy hand forgings in the longitudinal and long transverse directions and in surface and center locations. The tensile properties of the forgings were above those specified for such material and showed the expected directional or locational characteristics. The bearing properties showed less directional or locational variations than did the tensile properties. Ratios of bearing to longitudinal tensile strengths are summarized and nominal values are recommended for use in selecting design bearing strengths.

NACA TN 2887

ON THE STABILITY OF THE LAMINAR MIXING REGION BETWEEN TWO PARALLEL STREAMS IN A GAS. C. C. Lin, Massachusetts Institute of Technology. January 1953. 50p. diagrs., 5 tabs. (NACA TN 2887)

A study was made of the stability of the mixing of two parallel streams in a gas. It is shown that, when the relative speed of the two parallel streams exceeds the sum of their velocities of sound, subsonic oscillations cannot occur and the mixing region may be expected to be stable with respect to small disturbances. It is further shown that, when viscosity and heat conductivity are neglected, if the flow can execute a small neutral subsonic disturbance it can also execute self-excited oscillations of longer wave lengths and damped oscillations of shorter wave lengths. Additional developments of the mathematical theory of asymptotic solutions showed that, at high Reynolds numbers, the damped oscillations in a strictly parallel main flow have a structure similar to that of the vorticity field in fully developed flow.

NACA TM 1342

SPIRAL MOTIONS OF VISCOUS FLUIDS. (Spiralförmige Bewegungen zäher Flüssigkeiten). Georg Hamel. January 1953. 44p. (NACA TM 1342. Trans. from Deutsche Mathematiker-vereinigung, Jahresbericht, v. 25, 1917, p. 34-60).

Exact solutions of the steady incompressible viscous flow equations are obtained. The streamlines corresponding to such solutions are in general logarithmic spirals. The more specific cases of purely concentric and purely radial flows are fully investigated. Corresponding to the radial flows are the physically important cases of flow in radially convergent channels and in divergent channels. A second method is used to investigate exact steady and unsteady two-dimensional motions in free spirals. Neighborhood solutions to the radial flow are also discussed.

BRITISH REPORTS

N-20292*

Royal Aircraft Establishment (Gt. Brit.)
THE CURRENT AND VOLTAGE RELATIONSHIPS OF A STABLE D.C. ARC BETWEEN COPPER ELECTRODES IN AIR AT 4-760 MM. HG. I. A. Mossop and F. D. Gill. May 1952. 53p. diagrs., photos., 14 tabs. (RAE EL. 1477)

This report describes a method that has been developed for measuring the current and voltage characteristics of a stable d-c arc. The arc is formed between stationary electrodes by first breaking down the gap using a high voltage capacitor discharge. This discharge is allowed to develop into a power arc which is then maintained by a 120 volts accumulator supply. The arc current and voltage are measured on peak voltmeters which are switched into the circuit only after the arc has become stable. Switching is done automatically by a "sequence controller" which also opens the main circuit breaker as soon as the measurements have been made. In this way electrode wear is reduced to a minimum. The methods of previous workers using oscillographic-film techniques are reviewed critically; the advantages of the new method of measurement are great saving in time and labor, increased accuracy due to the measurement of true stable arc characteristics, and freedom from the complications of moving electrodes such as the measurement of instantaneous gap length. An appendix describes a statistical method of analyzing the experimental results which, apart from minimizing the troublesome effects of random scatter on the analysis, ends by giving the results in the form of a single expression which has been presented as a nomograph. This research is part of a general program of investigation of the effects of reduced gas pressure on the behavior of an arc. This report gives the results that have been obtained for copper electrodes in air in the pressure range 4-760 mm Hg at currents between 1 and 17 amps and for gaps up to 2 mm in length.

N-20295*

Royal Aircraft Establishment (Gt. Brit.)
SOME EFFECTS OF PITOT SIZE ON THE MEASUREMENTS OF BOUNDARY LAYERS IN SUPERSONIC FLOW. F. V. Davies. August 1952. 40p. diagrs. (RAE Tech. Note Aero 2179)

This note describes some effects of pitot size on measurements of laminar boundary layers on a flat plate and cones in a 5- by 5-inch supersonic wind tunnel at $M_\infty = 2.43$, Reynolds

number/inch = 0.25×10^6 and compares them with results obtained by other investigators.

N-20500*

Ministry of Supply (Gt. Brit.)
AIRCRAFT PRIMARY STRUCTURES IN WELDED MAGNESIUM ALLOY. 1951. i, 28p. diagrs., photos., 3 tabs. (MOS S & TM 5/52; Bristol Aeroplane Co., Ltd.)

The use of magnesium-zirconium alloys in sheet and plate form, joined by arc welding, for the primary structure of aircraft is studied. A detailed description is given of the welding equipment and technique used in the magnesium-zinc-zirconium sample found to be more promising from the standpoint of weldability, strength, and resistance to stress corrosion.

N-20501*

Royal Aircraft Establishment (Gt. Brit.)
NOTES ON TRANSDUCTOR DESIGN AND CORE MATERIALS. A. G. Milnes and A. R. George. August 1952. 31p. diagrs., 4 tabs. (RAE Tech.Note EL.40)

Transductor performance with Mumetal or silicon-iron cores is examined for a series circuit with complete self-excitation, and design data are obtained for 50, 400 and 1600 c/s operation. The influence of supply voltage or core flux density on the sensitivity and linearity is examined. The results are compared with experiments reported earlier with crystalloy and H.C.R. cores. Three design methods are described: one is based on idealized theoretical equations, another on load line techniques, and the third is based on the similarity in shape of the transductor characteristic to the B-H curve of the core. A specimen design calculation is given to illustrate the use of the design data. The methods described are applicable to both separately excited and auto-self-excited types of connections.

N-20509 *

Marine Aircraft Experimental Establishment (Gt. Brit.) THE M.A.E.E. RECORDING ACCELEROMETER. D. M. Ridland and R. Parker. September 1952. 15p. diagrs., photos. (MAEE F/Res/226)

The M.A.E.E. recording accelerometer is basically the accelerometer unit of a desynn accelerometer, adapted to make a continuous and immediate presentation of accurate, calibrated accelerations on a half second time base. The recording medium is metallized paper, having a speed of half an inch per second, and the instrument can be operated continuously for twenty minutes on one loading. It can record with full scale deflections, from 1g to 10g, when the natural frequencies will be about 7 and 22 c.p.s. respectively. The instrument is simple, it has been proved reliable and accurate and it is most convenient in use.

N-20515*

Royal Aircraft Establishment (Gt. Brit.)
A REVIEW AND ASSESSMENT OF VARIOUS FORMULAE FOR TURBULENT SKIN FRICTION IN COMPRESSIBLE FLOW. R. J. Monaghan. August 1952. 49p. diagrs. (RAE Tech. Note Aero 2182)

Despite a lack of experimental evidence, numerous formulas have been developed for the variation of turbulent skin friction on a flat plate in compressible flow, with and without heat transfer. The present note makes an extended comparison of available formulas and examines the assumptions made in their development, checking against experimental evidence where possible.

N-20549*

Aeronautical Research Council (Gt. Brit.)
THE TWO-DIMENSIONAL FLOW OF AN INCOMPRESSIBLE FLUID ABOUT AN AEROFOIL BY THE "INFLUENCE FACTORS" METHOD. L. C. Woods. October 19, 1950. 18p., 3 tabs. (ARC 13,460; FM 1489; Oxford Univ., Engineering Lab. No. 38)

This report describes an exact method of calculating the two-dimensional flow of an incompressible fluid about either a symmetrical or an asymmetric airfoil. The method enables the flow to be calculated at any point in the field. It was originated by Thom, and termed by him "the influence factor method." In this paper, his work on symmetrical airfoils is extended to asymmetric airfoils, and his approximate equations for the bounded stream are replaced by the exact forms.

N-20607*

National Gas Turbine Establishment (Gt. Brit.)
STUDIES ON THE SPONTANEOUS IGNITION OF FUELS INJECTED INTO A HOT AIR STREAM. PART VI. IGNITION DELAY MEASUREMENTS ON ORGANIC COMPOUNDS CONTAINING NITROGEN OR HALOGEN. B. P. Mullins. July 1952. 58p. diagrs., 36 tabs. (NGTE R.106)

Ignition delay measurements have been made upon a number of organic compounds containing nitrogen or halogen using the continuous flow method of test and the nitrogen pressurized fuel system previously described. The present report is mainly a catalogue of the experimental results. The fuels tested may be grouped in the following classes: miscellaneous nitrogen compounds, nitro compounds, nitrite esters, nitrate esters, aliphatic amines, aromatic amines, aliphatic halogen compounds, and aromatic halogen compounds. Acetonitrile is the least ignitable and n-butyl nitrite is the most ignitable of the fuels examined in the test rig. Flame observations were made and activation energies of reaction were computed for each fuel.

N-20608*

National Gas Turbine Establishment (Gt. Brit.)
STUDIES ON THE SPONTANEOUS IGNITION OF FUELS INJECTED INTO A HOT AIR STREAM. PART VII. IGNITION DELAY MEASUREMENTS ON ALCOHOLS AND ETHERS. B. P. Mullins. July 1952. 55p. diagrs., 32 tabs. (NGTE R. 107)

Ignition delay measurements have been made upon a number of alcohols and ethers using the continuous flow method of test and nitrogen-pressurized fuel system previously described, and the present report is mainly a catalogue of the experimental results. The fuels tested may be grouped in the following classes: saturated aliphatic alcohols, miscellaneous alcohols, aliphatic ethers, glycol ethers, and miscellaneous ethers. Furfuryl alcohol is the most ignitable and m-cresol is the least ignitable of the alcohols examined. The ignitability of the n-paraffin alcohols increases as the homologous series is ascended. Propylene oxide is the most ignitable and and di-isopropyl ether is the least ignitable of the ethers examined. Flame observations were made and activation energies of reaction were computed for each fuel.

N-20609*

National Gas Turbine Establishment (Gt. Brit.)
STUDIES ON THE SPONTANEOUS IGNITION OF FUELS INJECTED INTO A HOT AIR STREAM. PART VIII. IGNITION DELAY MEASUREMENTS ON ALDEHYDES, KETONES, ESTERS, CYCLO-COMPOUNDS, HETEROCYCLIC COMPOUNDS AND CARBON DISULPHIDE. B. P. Mullins. July 1952. 79p. diagrs., 28 tabs. (NGTE R. 108)

Ignition delay measurements have been made upon a number of miscellaneous organic compounds using the continuous flow method of test and nitrogen pressurized fuel system previously described and the present report is mainly a catalogue of the experimental results. The fuels tested may be grouped in the following classes: aldehydes, ketones, acetates, miscellaneous esters, cyclo-compounds, furan and its derivatives, miscellaneous heterocyclic compounds, and carbon disulphide. Acrolein is the most ignitable and acetaldehyde is the least ignitable of the aldehydes examined. Diacetyl is the most ignitable and acetone is the least ignitable of the ketones examined. The ignitability of the aliphatic acetates increases as the homologous series is ascended. Carbon disulphide is more ignitable than any of the aldehydes, ketones or acetates tested; at 650° C it has an ignition delay of 11 milliseconds in vitiated air. Flame observations were made and activation energies of reaction were computed for each fuel.

N-20631*

Aeronautical Research Council (Gt. Brit.)
NOTES ON THE DERIVATION OF TRUE AIR TEMPERATURE FROM AIRCRAFT OBSERVATIONS. D. D. Clark. 1952. 8p. diagr., 2 tabs. (ARC CP 90)

This report presents methods of obtaining the true air temperature from aircraft instrument readings.

N-20632*

Aeronautical Research Council (Gt. Brit.)
AN ASSESSMENT OF THE PROBABLE CAUSES OF VARIATION OF THE SPEED CORRECTION COEFFICIENT OF AIRCRAFT THERMOMETERS. D. D. Clark. 1952. 17p. diagrs., 2 tabs. (ARC CP 91)

In M. R. P. 527 Shellard has summarized the evidence indicating that a variation takes place in the speed correction coefficient of aircraft thermometers both with altitude and, in one particular case, with airspeed. He also mentions some possible reasons for the variations. In this report, an attempt has been made to list all factors which could possibly affect the speed correction coefficient and to examine each thoroughly in turn.

N-20633*

Aeronautical Research Council (Gt. Brit.)
THE INFLUENCE OF THE METHOD OF STRINGER ATTACHMENT ON THE BUCKLING AND FAILURE OF SKIN PANELS WITH SQUARE TOP-HAT STRINGERS. Abstract from thesis of E. E. Labram, prepared by K. H. Griffin. 1952. 8p. diagrs., tab. (ARC CP 93)

The results of experiments to find the buckling and failing loads of panels with riveted and glued stringers are given, and a comparison between the two methods of attachment is made. In the case of buckling stresses, a comparison is made with theoretical results.

N-20634*

Aeronautical Research Council (Gt. Brit.)
TESTS IN THE COMPRESSED AIR TUNNEL ON TWO AEROFOIL SECTIONS HAVING A LARGE SCALE EFFECT ON $C_{L_{MAX}}$ AT A CRITICAL REYNOLDS NUMBER. C. Salter, H. M. Lee and R. C. Owen. 1952. 21p. diagrs., 4 tabs. (ARC CP 92)

This report gives results of tests on two "constant velocity" airfoil sections, 9 percent and 11 percent thick, respectively, and of aspect ratio 6, over a range of R of 0.3×10^6 to 7.5×10^6.

N-20635*

Aeronautical Research Council (Gt. Brit.)
IMPROPER INTEGRALS IN THEORETICAL AERODYNAMICS. K. W. Mangler. 1952. 35p. diagr. (ARC CP 94)

This paper deals with an integral, involving a "principal value of the order n." It was first introduced by Hadamard and is a generalization of Cauchy's principal value. It occurs, if one determines the derivatives of an integral, involving Cauchy's principal value.

N-20636*

Aeronautical Research Council (Gt. Brit.)
COMPARISON OF HELICOPTER ROTOR MODEL TESTS OF AERODYNAMIC DAMPING WITH THEORETICAL ESTIMATES. G. J. Sissingh. 1952. 16p. diagrs. (ARC CP 98)

The present report deals with the aerodynamic damping of a rotor oscillating in pitch (or roll) and is mainly concerned with the comparison between theory and experiment. Both the free and forced oscillations of a rotor system pivoted below the rotor center are investigated.

N-20637*

Aeronautical Research Council (Gt. Brit.)
HELICOPTER BEHAVIOUR IN THE VORTEX RING CONDITIONS. W. Stewart. 1952. 16p. diagrs., tab. (ARC CP 99)

This report describes flight experience in the vortex ring conditions with the Sikorsky R-4B, R-6 and S-51, Bell 47 and Bristol 171 helicopters.

N-20638*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF INDUCED VELOCITY VARIATION ON HELICOPTER ROTOR DAMPING IN PITCH OR ROLL. G. J. Sissingh. 1952. 16p. diagrs. (ARC CP 101)

The present investigation is a continuation of a recent report by K. B. Amer on the aerodynamic damping of a rotor with centrally arranged flapping hinges in a steady pitching or rolling motion. It considers the effect of variation in the induced velocity due to the changes in the distribution of the thrust around the rotor disk. The results are compared with the flight measurements given in Amer's report and the agreement is good.

N-20675*

Forest Products Research Lab. (Gt. Brit.)
THE RISBOROUGH PLATEN-OVEN; A MACHINE FOR RAPID MOISTURE CONTENT DETERMINATIONS UPON VENEERS. J. F. S. Carruthers and P. M. C. Lacey. (Forest Products Research Lab.; Reprint from Wood, v. 17, Nov., 1952, p. 420-423)

This article describes the machine developed by the Forest Products Research Laboratory and compares some results obtained with it and by other means.

N-20762*

Royal Aircraft Establishment (Gt. Brit.)
GRAVINER STRIP-TYPE CONTACT SWITCHES FOR OPERATION OF AIRCRAFT FIRE EXTINGUISHING

SYSTEMS IN CRASHES. NOTE ON A SIMULATED CRASH-LANDING TEST. E. Bade and I. S. H. Brown. September 1952. 10p. diagrs., photos. (RAE Tech. Note Mech. Eng. 134)

The development of aircraft fire extinguishing systems has included a simulated crash test using a Seafire aircraft to check the performance of a strip-type contact switch developed by the Graviner Manufacturing Co. The contact switch is intended for use in addition to, or as a replacement of, the conventional inertia-types of crash switch which, because of their necessarily high "g" setting, frequently fail to function in crashes of moderate severity. The trial was arranged so that a comparison could be made of the behavior of the strip-type contact switches against the pendulum- and piston-type switches. The results have shown that the contact switch will operate instantly and effectively in a crash landing in which impact is made on the switch. Installation of the contact switch on the surfaces of high-speed aircraft would incur no significant aerodynamic penalty and it appears that both for practical and psychological reasons its adoption for service aircraft would be advantageous. To this end a specification of service requirements is being prepared to enable acceptance tests to be carried out.

MISCELLANEOUS

NACA TN 2552

Errata No. 1 on "CONSIDERATIONS ON THE EFFECT OF WIND-TUNNEL WALLS ON OSCILLATING AIR FORCES FOR TWO-DIMENSIONAL SUBSONIC COMPRESSIBLE FLOW". Harry L. Runyan and Charles E. Watkins. December 1951.

NACA TN 2861

Errata No. 1 on "ANALYTICAL INVESTIGATION OF ICING LIMIT FOR DIAMOND-SHAPED AIRFOIL IN TRANSONIC AND SUPERSONIC FLOW." Edmund E. Callaghan and John S. Serafini. January 1953.

NACA TN 2866

Errata No. 1 on "ICING PROTECTION FOR A TURBOJET TRANSPORT AIRPLANE: HEATING REQUIREMENTS, METHODS OF PROTECTION, AND PERFORMANCE PENALTIES." Thomas F. Gelder, James P. Lewis and Stanley L. Koutz. January 1953.

UNPUBLISHED PAPERS

N-19412*

Experimental Towing Tank, Stevens Inst. of Tech. TURBULENCE STIMULATION IN THE BOUNDARY LAYER OF PLANING SURFACES. PART I. REVIEW OF ANALYTICAL AND EXPERIMENTAL ASPECTS OF THE SUBJECT. B. V. Korvin-Kroukovsky, Edward W. Ross and Daniel Savitsky. Appendix I: CALCULATIONS ON LAMINAR AND TURBULENT BOUNDARY LAYER. Edward W. Ross. August 1952. i, 116p. diagrs., photos. (Experimental Towing Tank, Stevens Inst. of Tech. Rept. 443)

This is the first report in a series by the Stevens Institute of Technology on the subject of investigating means of stimulating and detecting boundary layer turbulence in tests of planing surface and seaplane hull models. This report presents the results of an analytical survey of the existing literature on the subject.

N-19413*

Experimental Towing Tank, Stevens Inst. of Tech. TURBULENCE STIMULATION IN THE BOUNDARY LAYER OF PLANING SURFACES. PART II. PRELIMINARY EXPERIMENTAL INVESTIGATION. Daniel Savitsky and Edward W. Ross. August 1952. i, 57p. diagrs., photos., tab. (Experimental Towing Tank, Stevens Inst. of Tech. Rept. 444)

This is the second report in a series by the Stevens Institute of Technology on the subject of investigating means of stimulating and detecting boundary layer turbulence in tests of planing surface and seaplane hull models. This report describes tests using a turbulence inducing strut and the Royal Aircraft Establishment chemical paint turbulence detection technique.

N-19616*

Virginia U.
EXPLORATORY INVESTIGATIONS OF THE RESISTANCE OF SOME METALS UNDER STRESS. L. G. Hoxton. July 1952. i, 51p. diagrs., photo., tab. (Virginia U.)

The purpose of these investigations was to try to find new facts about metals that might ultimately contribute to the art of making measurements with electrical resistance strain gages. This report is a study of the conducting properties of metals under longitudinal stresses, particularly within their elastic ranges.

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CURRENT NACA REPORTS

NACA Rept. 1069

ON A SOLUTION OF THE NONLINEAR DIFFERENTIAL EQUATION FOR TRANSONIC FLOW PAST A WAVE-SHAPED WALL. Carl Kaplan. 1952. ii, 11p. diagrs., tab. (NACA Rept. 1069. Formerly TN 2383)

The simplified nonlinear differential equation for transonic flow past a wavy wall is solved by the method of integration in series. The solution has been carried to the point where the question of the existence or nonexistence of a mixed potential flow can be answered by the behavior of a single power series in the transonic similarity parameter. The calculation of the coefficients of this dominant power series has been reduced to a routine computing problem by means of recursion formulas resulting from the solution of the differential equation and the boundary condition at the surface of the wavy wall.

NACA Rept. 1071

THEORETICAL SYMMETRIC SPAN LOADING DUE TO FLAP DEFLECTION FOR WINGS OF ARBITRARY PLAN FORM AT SUBSONIC SPEEDS. John DeYoung. 1952. ii, 41p. diagrs., tabs. (NACA Rept. 1071. Formerly NACA TN 2278)

A procedure based upon a simplified lifting-surface theory that includes effects of compressibility and spanwise variation of section lift-curve slope is presented in such a manner that the spanwise loading due to flap deflection can be simply found for wings having symmetric plan forms with constant spanwise sweep angle of the quarter-chord line. Aerodynamic characteristics due to flap deflection are considered and for straight-tapered wings, values of certain of these characteristics are presented in charts for a range of swept plan forms. Further use of the method gives downwash in the vertical center of the wake of the wing.

NACA Rept. 1083

AXISYMMETRIC SUPERSONIC FLOW IN ROTATING IMPELLERS. Arthur W. Goldstein. 1952. ii, 14p. diagrs. (NACA Rept. 1083. Formerly TN 2388)

General equations are developed for isentropic, frictionless, axisymmetric compressible flow in rotating impellers with blade forces eliminated in favor of the blade-surface function. The characteristic equations for supersonic flow are developed and a computing technique is utilized to find the effect of variations of design parameters on internal flow and work-input distribution.

NACA TN 2881

AERODYNAMIC CHARACTERISTICS OF A TWO-BLADE NACA 10-(3)(062)-045 PROPELLER AND OF A TWO-BLADE NACA 10-(3)(08)-045 PROPELLER. William Solomon. January 1953. 53p. diagrs., photo., tab. (NACA TN 2881. Formerly RM L8E26)

Characteristics are given for the two-blade NACA 10-(3)(062)-045 propeller and for the two-blade NACA 10-(3)(08)-045 propeller over a range of advance ratio from 0.5 to 3.8, through a blade-angle range from 20° to 55° measured at the 0.75 radius. Maximum efficiencies of the order of 91.5 to 92 percent were obtained for the propellers. The propeller with the thinner airfoil sections over the outboard portion of the blades, the NACA 10-(3)(062)-045 propeller, had lower losses at high tip speeds, the difference amounting to about 5 percent at a helical tip Mach number of 1.10.

NACA TN 2884

CALCULATION AND MEASUREMENT OF NORMAL MODES OF VIBRATION OF AN ALUMINUM-ALLOY BOX BEAM WITH AND WITHOUT LARGE DISCONTINUITIES. Frank C. Smith and Darnley M. Howard, National Bureau of Standards. January 1953. 40p. diagrs., photo., 8 tabs. (NACA TN 2884)

The lowest normal modes of vibration of three aluminum alloy box beams were calculated using a matrix iteration method. For the calculations the actual structures were idealized to a system of mass points interconnected by massless springs. The lowest normal modes of these beams were measured experimentally and compared with those calculated. This comparison indicates that the mode shapes and natural frequencies for structures of this type may be adequately calculated using this method. The experimental measurements were limited at the higher frequencies by local vibrations of small elements of the beams.

NACA TN 2885

SOME EXACT SOLUTIONS OF TWO-DIMENSIONAL FLOWS OF COMPRESSIBLE FLUID WITH HODOGRAPH METHOD. Chieh-Chien Chang and Vivian O'Brien, Johns Hopkins University. February 1953. 63p. diagrs., 4 tabs. (NACA TN 2885)

*AVAILABLE ON LOAN ONLY.
ADDRESS REQUESTS FOR DOCUMENTS TO NACA, 1724 F ST., NW., WASHINGTON 25, D. C., CITING CODE NUMBER ABOVE EACH TITLE, THE REPORT TITLE AND AUTHOR.

A suggestion is given for classifying compressible potential flows according to location and number of singularities in the subsonic region of the hodograph plane, which seems to offer a convenient criterion for systematic investigation of these flows with Chaplygin's original method. The object of the paper is to present and analyze a few useful solutions of compressible potential flow with the exact gas law. These solutions include flows about convex corners and belong to the same class as that of Ringleb. Also, the exact solution of compressible flow through a particular contracting channel is given.

NACA TN 2886

AN ANALYSIS OF STATICALLY INDETERMINATE TRUSSES HAVING MEMBERS STRESSED BEYOND THE PROPORTIONAL LIMIT. Thomas W. Wilder, III. February 1953. 13p. diagrs., 4 tabs. (NACA TN 2886)

A procedure for analyzing statically indeterminate trusses in the plastic stress range is presented which is applicable to trusses having any number of redundant members. By using the Ramberg-Osgood analytical representation of the stress-strain curve, the analysis of the truss is reduced to the solution of a set of simultaneous equations. A numerical example is presented to illustrate the procedure.

NACA TN 2888

PERFORMANCE CHARACTERISTICS OF PLANE-WALL TWO-DIMENSIONAL DIFFUSERS. Elliott G. Reid, Stanford University. February 1953. i, 80p. diagrs., photos., 3 tabs. (NACA TN 2888)

Performance characteristics were determined for plane-wall, two-dimensional diffusers which were so proportioned as to insure reasonable approximation of two-dimensional flow. The diffusers had identical entrance cross sections and discharged directly into a large plenum chamber; the test program included wide variations of divergence angle and length. A dynamic pressure of 60 pounds per square foot was maintained at the diffuser entrance and the boundary layer there was thin and fully turbulent. A few tests were made with asymmetric diffusers. Others showed the effects of addition of a short exit duct of uniform section and of installation of a thin, central, longitudinal partition.

NACA TN 2891

FACTORS AFFECTING LAMINAR BOUNDARY LAYER MEASUREMENTS IN A SUPERSONIC STREAM. Robert E. Blue and George M. Low. Appendix B: REDUCTION OF DATA. Jack M. Lande. February 1953. 49p. diagrs. (NACA TN 2891)

The observed discrepancy at supersonic speeds between theoretical and apparent experimental average flat plate friction-drag coefficients calculated from boundary layer total-pressure surveys was investigated. Effects of the total-pressure probe, heat transfer through the leading-edge region, leading-edge geometry and strength of the leading-edge wave, possible early transition to turbulent flow or "bursts of turbulence," and the slight streamwise pressure gradient inherent in flat-plate flow were included in the investigation. Only one of these factors, the effect of the total-pressure probe, was found to be significant. Total-pressure probes of different tip heights, when placed in laminar boundary layers developing under identical conditions, measure different values of friction-drag coefficient. Extrapolation of these measurements indicates that a probe of vanishing tip height would measure the theoretically predicated values of average flat plate friction-drag coefficients.

NACA TN 2894

CALCULATIONS OF UPWASH IN THE REGION ABOVE OR BELOW THE WING-CHORD PLANES OF SWEPT-BACK WING-FUSELAGE-NACELLE COMBINATIONS. Vernon L. Rogallo and John L. McCloud, III. February 1953. 15p. diagrs., photo. (NACA TN 2894)

A procedure has been developed for predicting the upwash components of the upflow angles in the region above or below the wing-chord planes of swept-back wing-fuselage-nacelle combinations. Comparisons are made of the predicted and measured upflow angles for six semispan models with 40° swept-back wings.

NACA TN 2896

SURVEY OF PORTIONS OF THE IRON-NICKEL-MOLYBDENUM AND COBALT-IRON-MOLYBDENUM TERNARY SYSTEMS AT 1200° C. Dilip K. Das and Paul A. Beck, University of Notre Dame. February 1953. 56p. diagrs., photos., 15 tabs. (NACA TN 2896)

The 1200° C isothermal sections of the iron-nickel-molybdenum and the cobalt-iron-molybdenum ternary systems were surveyed. The phases occurring in these systems were identified by means of X-ray diffraction and by etching methods, and the phase boundaries at 1200° C were determined microscopically, using the disappearing phase method with quenched specimens. Both systems contain long solid-solution fields of the mu phase. Other intermediate phases occurring in the iron-nickel-molybdenum system are the P phase and the delta phase. Both phase diagrams have extensive face-centered cubic solid-solution fields and some body-centered cubic solid solutions.

NACA RM E52L09

FORCED-CONVECTION HEAT-TRANSFER CHARACTERISTICS OF MOLTEN SODIUM HYDROXIDE. Milton D. Grele and Louis Gedeon. February 1953. 27p. diagrs., photo., 2 tabs. (NACA RM E52L09)

The forced-convection heat-transfer characteristics of sodium hydroxide were experimentally investigated. The heat-transfer data for heating fall slight-

ly above the McAdams correlation line, and the heat-transfer data for cooling are fairly well represented by the McAdams correlation line.

NACA TM 1344

ON THE THEORY OF THE TURBULENT BOUNDARY LAYER. (Über die Theorie der turbulenten Grenzschichten). J. Rotta. February 1953. 50p. diagrs. (NACA TM 1344. Trans. from Max-Planck-Institut für Strömungsforschung, Göttingen. Mitteilungen 1, 1950)

Turbulent energy, dissipation, and momentum relations are discussed. A procedure is given for computation of turbulent skin friction in boundary-layer flow with pressure gradients. The boundary layer is divided into a region near the wall where viscosity and surface roughness are important, an outer region which is dependent on friction coefficient and pressure gradient, and an intermediate zone between these two which is unaffected by wall roughness, viscosity, and the outer flow. Analytical confirmation is obtained for the empirical fact that turbulent boundary layers are able to overcome a greater pressure rise than laminar ones.

NACA TM 1349

ON A CLASS OF EXACT SOLUTIONS OF THE EQUATIONS OF MOTION OF A VISCOUS FLUID. (Ob odnom klasse tochnykh reshenii uravnenii dvizheniya vyazkoi zhidkosti). V. I. Yatseyev. February 1953. 7p. (NACA TM 1349. Trans. from Zhurnal Eksperimental 'noi i Teoretisheskoi Fiziki, v. 20, no. 11, 1950, p. 1031-1034).

The general solution is obtained of the equations of motion of a viscous fluid in which the velocity field is inversely proportional to the distance from a certain point. Some particular cases of such motion are investigated.

NACA TM 1358

CALCULATION OF THE SHAPE OF A TWO-DIMENSIONAL SUPERSONIC NOZZLE IN CLOSED FORM. (Sul Calcolo in Termini Finiti dell'Effusore di una Galleria Bidimensionale Supersonica). Dante Cunsolo. January 1953. 29p. diagrs. (NACA TM 1358. Trans. from Aerotecnica, v. 31, no. 4, August 15, 1951, p. 225-230).

The idea is advanced of making a supersonic nozzle by producing one, two, or three successive turns of the whole flow; with the result that the wall contour can be calculated exactly by means of the Prandtl-Meyer "Lost Solution."

BRITISH REPORTS

N-20661*

Aeronautical Research Council (Gt. Brit.)
NOTE ON PROFILE DRAG CALCULATIONS FOR LOW-DRAG WINGS WITH CUSPED TRAILING EDGES. R. C. Lock. 1952. 10p. diagrs., tab. (ARC R & M 2419; ARC 9772. Formerly RAE Aero 2130)

In R. & M. 1833 calculations of profile drag were made based on wing sections of conventional design, and were later extended in an Addendum to "low-drag" wing sections with convex trailing edges. Further calculations were required for low-drag sections of more recent design with cusped trailing edges. This report presents calculations made on sections of the NACA 65-family of thickness 0.12c and 0.23c with maximum thickness at 0.4c from the leading edge, over a range of Reynolds number and position of the transition points.

N-20662*

Aeronautical Research Council (Gt. Brit.)
MODEL TESTS WITH FLOW ON THE GLOSTER F.9/40 WITH H.1 NACELLES (METEOR II). J. S. Thompson, C. M. Fougere and E. G. Barnes. 1952. 17p. diagrs., 14 tabs. (ARC R & M 2517; ARC 6901. Formerly RAE Aero 1821)

For an earlier estimate by Thompson and Barnes of the longitudinal stability of the F.9/40 in flight, it was necessary to extrapolate for the higher values of C_L, because the maximum jet flow from model tests then available was that appropriate to a C_L of only 0.2, ground level. The purpose of the tests described in this note was to extend the previous model tests, using a considerably larger flow, to enable more precise estimates to be made. Measurements were made of lift, drag, pitching and yawing moments for jet flows up to an exit v/V of 4.5 and at various tunnel speeds.

N-20664*

Aeronautical Research Council (Gt. Brit.)
THE DESIGN AND INSTALLATION OF SMALL COMPRESSED AIR TURBINES FOR TESTING POWERED DYNAMIC MODELS IN THE ROYAL AIRCRAFT ESTABLISHMENT SEAPLANE TANK. D. I. T. P. Llewelyn-Davies, W. D. Tye and D. C. MacPhail. 1952. 19p. diagrs., photos., tab. (ARC R & M 2620; ARC 10,812. Formerly RAE Aero 2192)

This report describes the development of small lightweight air turbines for powering dynamic models in the R.A.E. seaplane tank. The units have proved to be rugged and reliable and power/weight ratios of 0.4 lb/bhp have been achieved. The installation of the turbines in dynamic models and the provision of their air supply are also discussed.

N-20665*

Aeronautical Research Council (Gt. Brit.)
ON THE SOLUTION OF LINEAR SIMULTANEOUS DIFFERENTIAL EQUATIONS WITH CONSTANT COEFFICIENTS BY A PROCESS OF ISOLATION. J. Morris. 1952. 7p. (ARC R & M 2623; ARC 11,420. Formerly RAE SME 4036)

In this report, a process is given for the solution of linear differential equations with constant coefficients. The operative artifice is closely akin to Routh's method of isolation by means of which the constants of integration are found separately for each root of the characteristic equations.

N-20666*

Aeronautical Research Council (Gt. Brit.)
THE DYNAMIC LANDING LOADS OF FLYING BOATS WITH SPECIAL REFERENCE TO MEASUREMENTS MADE ON SUNDERLAND TX. 293. Anne Burns and A. J. Fairclough. 1952. 38p. diagrs., photos., 2 tabs. (ARC R & M 2629; ARC 11,344. Formerly RAE Structures 17)

An account is given of a full-scale investigation into the stresses occurring in the wing members of a Sunderland flying boat during landing impacts. It is found that the main dynamic effect is caused by the wing oscillating in its fundamental mode. These dynamic loads have a spanwise distribution similar to the normal lift load and, if the level flight lift load is taken as unity, a magnitude (in the most severe impact recorded) of 1.4 upwards and 1.5 downwards. Generalizing this result, one concludes that whereas down loads in landing may be a deciding factor in design the up loads are amply covered by existing requirements. Comparison of calculated and experimental loads found in these tests indicates that satisfactory agreement can be attained by using recently introduced modifications of standard dynamical methods. Although the investigation is primarily a structural one some interesting results on general water load phenomena are obtained.

N-20667*

Aeronautical Research Council (Gt. Brit.)
LOAD DIFFUSION AT AN INTERSPAR OPENING: THEORETICAL METHODS OF ANALYSIS COMPARED WITH STRAIN MEASUREMENTS ON A LARGE WING. D. C. Allen. 1952. 26p. diagrs., 6 tabs. (ARC R & M 2664; ARC 11,731. Formerly RAE Structures 30)

The diffusion of load from spar flanges into skin and stringers near an opening was investigated experimentally in a large wing structure undergoing strength tests. A comparison of measured strains with those given by theoretical methods shows that in general the flange loads are represented with reasonable accuracy. Any theory, however, in which the chordwise rib at the edge of the opening is ignored gives shear stresses much greater than those measured. Allowance for the bending stiffness of this rib produces values of shear stress comparable with those obtained experimentally.

N-20668*

Aeronautical Research Council (Gt. Brit.)
LANDING GEAR WITH TWIN TANDEM WHEEL UNITS: CORNERING CHARACTERISTICS AS DETERMINED BY MODEL TESTS. J. W. Blinkhorn. 1952. 7p. diagrs., photos., tab. (ARC R & M 2668; ARC 11,850. Formerly RAE Tech. Note Mech. Eng. 18)

For twin tandem units, the wheel loading conditions which arise when aircraft are turned on the ground may be critical for the landing gear. To estimate the magnitude of these loads, cornering tests were made on a small-scale model of the main undercarriage unit proposed for the Brabazon I, MK. II. These tests showed that for zero turning radius, that is, turning about the central vertical axis of the model undercarriage, the wheel side loads were almost equal to the vertical load multiplied by the coefficient of sliding friction between the tires and the ground. The side loads rapidly decreased as the turning radius increased, and with the turning radius equal to three times the wheel base, the wheel side loads were only about half of those at zero turning radius. The severity of the design loads for turning on the ground will therefore be considerably reduced if it can be ensured that the center of the minimum turning circle of the aircraft is a short distance outboard of either main undercarriage unit.

N-20669*

Aeronautical Research Council (Gt. Brit.)
CONICAL FLOW AS A RESULT OF SHOCK AND BOUNDARY-LAYER INTERACTION ON A PROBE. J. Lukasiewicz. 1952. 16p. diagrs., photos. (ARC R & M 2669; ARC 12,023. Formerly RAE Tech. Note Aero 1968; SD 85)

The formation of a conical shock and a conical region of flow separation originating from the tip of a thin traversing tube was observed in a supersonic tunnel as a result of interaction of a strong shock with the boundary layer on the tube surface. The angles of the conical shock and separation surfaces and the static pressure in the separation region are in good agreement with the theoretical conical flow solutions. The extent of the conical flow illustrated should act as a warning against the use of static pressure tubes for measuring pressures in the regions of strong shocks.

N-20670*

Aeronautical Research Council (Gt. Brit.)
AN ELECTRIC TANK FOR THE DETERMINATION OF THEORETICAL VELOCITY DISTRIBUTIONS. T. J. Hargest. 1952. 9p. diagrs., photos. (ARC R & M 2699; ARC 12,448. Formerly NGTE Memo. M. 48)

An analogy due to Relf has been applied to the design of apparatus for quickly determining the theoretical velocity distributions around an airfoil in cascade. The accuracy of the apparatus was tested by determining the velocity distribution around a cylinder.

An accuracy of within 1 percent of the approach velocity was obtained for this case. The apparatus has since been applied to determine the theoretical velocity distribution around various airfoils in cascades; an example is given of the pressure distribution around an airfoil at zero incidence. An application to determine the theoretical velocity distribution around the central airfoil of a nozzle cascade where the effect of the ducting side walls is included is also given.

N-20671*

Aeronautical Research Council (Gt. Brit.)
VELOCITY DISTRIBUTION ON STRAIGHT AND SWEPT-BACK WINGS OF SMALL THICKNESS AND INFINITE ASPECT RATIO AT ZERO INCIDENCE. S. Newmark. 1952. 40p. diagrs. (ARC R & M 2713; ARC 10,907. Formerly RAE Aero 2200)

A solution by H. Ludwieg, giving the velocity distribution in the central section of a thin sweptback wing of infinite aspect ratio with a biconvex profile at zero incidence, has been found erroneous. In connection with this problem, the approximate method of sources and sinks for determining velocity distribution on straight and sweptback wings is critically examined, its limitations established, and proper ways of its application to three-dimensional problems indicated. A correct solution of Ludwieg's problem is found, and generalized to give the velocity distribution over the entire wing. The method is further extended to cover a wide class of thin symmetrical wing profiles, those with rounded leading edge being, however, often intractable by this particular method. The ultimate purpose of the investigation is to provide a reliable basis for determining the critical Mach number for sweptback wings. Further work is needed to embrace wings of finite aspect ratio and tapered wings, in particular, delta wings. The method seems adequate to deal with these more complex cases.

N-20672*

Aeronautical Research Council (Gt. Brit.)
THE NUMERICAL SOLUTION OF TWO-DIMENSIONAL FLUID MOTION IN THE NEIGHBOURHOOD OF STAGNATION POINTS AND SHARP CORNERS. L. C. Woods. 1952. 15p. diagrs. (ARC R & M 2726. Formerly ARC 12,887; FM 1407)

Methods are given in this paper of dealing with singularities of functions satisfying certain two-dimensional partial differential equations. For a numerical solution, the differential equations are replaced by difference equations on a square mesh. Log (1/q) where q is the velocity, becomes infinite at stagnation points, sharp corners, sinks, etc., while the conjugate function θ (flow direction) becomes multivalued. The method consists in finding a series expansion for the function (log 1/q or θ) in the neighborhood of the singularity. This expansion is then used to find relationships between the function values at points of the mesh adjacent to the singularity. A method of working directly in the transformed flow plane (in which the airfoil is a slit), and thus avoiding irregular squares on the boundary, is also given. The method is developed for incompressible flow, but an approximation suitable for compressible flow is given.

DECLASSIFIED NACA REPORTS

NACA RM A8E17

THE ASYMMETRIC ADJUSTABLE SUPERSONIC NOZZLE FOR WIND-TUNNEL APPLICATION. H. Julian Allen. July 23, 1948. 42p. diagrs., photos., 2 tabs. (NACA RM A8E17) (Declassified from Restricted, 10/30/52)

An asymmetric adjustable nozzle for supersonic wind tunnel application which permits continuous adjustment of the test-section Mach number is described. The characteristics of this nozzle are compared with the more conventional supersonic tunnel nozzles.

NACA RM L8E06

AERODYNAMIC CHARACTERISTICS AT HIGH SPEEDS OF RELATED FULL-SCALE PROPELLERS HAVING DIFFERENT BLADE-SECTION CAMBERS. Julian D. Maynard and Leland B. Salters, Jr. August 31, 1948. 54p. diagrs., tab., photo. (NACA RM L8E06) (Declassified from Restricted, 11/26/52)

Comparisons are made of results obtained in wind-tunnel tests of related full-scale propellers over a range of blade angles from 20° to 55° at airspeeds up to 500 miles per hour to evaluate the combined effects of blade-section camber and compressibility on propeller aerodynamic characteristics.

NACA RM L8E07

AERODYNAMIC CHARACTERISTICS AT HIGH SPEEDS OF FULL-SCALE PROPELLERS HAVING CLARK Y BLADE SECTIONS. Peter J. Johnson. October 26, 1948. 60p. diagrs., photos., tab. (NACA RM L8E07) (Declassified from Restricted, 11/26/52)

Results obtained in wind-tunnel tests of two full-scale propellers over a range of blade angles from 20° to 55° and at airspeeds varying from 60 to 485 miles per hour are presented.

NACA RM L8E24

AERODYNAMIC CHARACTERISTICS OF A TWO-BLADE NACA 10-(3)(08)-03R PROPELLER. Albert J. Evans and Leland B. Salters, Jr. September 2, 1948. 29p. diagrs., tab. (NACA RM L8E24) (Declassified from Restricted, 11/26/52)

Contains results of wind-tunnel tests on a full-scale NACA 10-(3)(08)-03R two-blade propeller. The

tests were part of a program to determine the effects of blade-shank design on propeller aerodynamic characteristics. A maximum efficiency of 91.5 percent was attained at a rotational speed of 1600 revolutions per minute at a 30° blade angle. Peak efficiency at a blade angle of 45° was decreased 32 percent by increasing the helical-tip Mach number from 0.80 to 1.20.

NACA RM L8H16

AERODYNAMIC CHARACTERISTICS OF A THREE-BLADE PROPELLER HAVING NACA 10-(3)(08)-03 BLADES. Robert E. Davidson. October 29, 1948. 29p. diagrs., tab. (NACA RM L8H16) (Declassified from Confidential, 11/26/52)

Contains results of wind-tunnel tests of a 10-foot-diameter, three-blade propeller at stream Mach numbers from 0.12 to 0.64. The tests were part of a program to determine the effects of blade number on propeller aerodynamic characteristics. The propeller blades are of designation NACA 10-(3)(08)-03. A maximum efficiency of 92 percent was attained at a rotational speed of 1350 rpm at a 40° blade angle. Peak efficiency at the design blade angle of 45° was decreased 4 percent by increasing the helical tip Mach number from 0.80 to 0.96.

NACA RM L9G20

TWO-DIMENSIONAL WIND-TUNNEL INVESTIGATION OF A 6-PERCENT-THICK SYMMETRICAL CIRCULAR-ARC AIRFOIL SECTION WITH LEADING-EDGE AND TRAILING-EDGE HIGH-LIFT DEVICES DEFLECTED IN COMBINATION. Robert J. Nuber and Gail A. Cheesman. September 6, 1949. 29p. diagrs., photo., 3 tabs. (NACA RM L9G20) (Declassified from Restricted, 10/7/52)

An investigation of a 6-percent-thick symmetrical circular-arc airfoil with leading-edge and trailing-edge high-lift devices was made to determine the effectiveness of these devices in increasing the maximum section lift coefficient of the airfoil when deflected in combination. The results indicated that, with the plain trailing-edge flap deflected 60°, maximum section lift coefficients of 2.02 and 1.95 can be obtained by deflecting a 15-percent-chord leading-edge slat or a 15-percent-chord drooped-nose flap, respectively. Variations in Reynolds number for either the slat or drooped-nose-flap configurations or moving the drooped-nose-flap hinge from the lower surface to the upper surface had essentially no effect on the lift characteristics.

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CURRENT NACA REPORTS

NACA Rept. 1072

INELASTIC COLUMN BEHAVIOR. John E. Duberg and Thomas W. Wilder, III. 1952. iii, 16p. (NACA Rept. 1072. Formerly TN 2267)

This paper presents the significant findings of a theoretical study of column behavior in the plastic stress range that shows the tangent-modulus load to be the load at which bending can start for a straight column. Load-deflection analyses are made for two column models - one model having a concentrated flexibility and the other having its flexibility distributed along its length. Results are presented which relate the maximum load to the stress-strain curve of the material.

NACA Rept. 1079

SOUND FROM A TWO-BLADE PROPELLER AT SUPERSONIC TIP SPEEDS. Harvey H. Hubbard and Leslie W. Lassiter. 1952. ii, 9p. diagrs., photos. (NACA Rept. 1079. Formerly RM L51C27)

Propeller sound measurements at static conditions have been extended to a tip Mach number of 1.30. Spectrums have been obtained at both subsonic and supersonic tip speeds for comparison, and the measured data are compared with calculations by the Gutin theory. At supersonic tip speeds, the maximum intensities were measured in the plane of rotation and the spectrums are noted to contain a large high-frequency content. At supersonic tip speeds the over-all sound pressures, at a given power to the propeller, were noted to be independent of tip speed. The Gutin theory was found to be adequate for predicting the intensities of the lower-order harmonics but overestimates the intensities of the higher-order ones at supersonic tip speeds.

NACA Rept. 1084

COMPARISON OF HIGH-SPEED OPERATING CHARACTERISTICS OF SIZE 215 CYLINDRICAL-ROLLER BEARINGS AS DETERMINED IN TURBOJET ENGINE AND IN LABORATORY TEST RIG. E. Fred Macks and Zolton N. Nemeth. 1952. ii, 12p. diagrs., photos., tab. (NACA Rept. 1084. Formerly RM E51I05)

Inner- and outer-race cooling-correlation curves were obtained for the turbojet-engine turbine-roller bearing with the same inner- and outer-race cooling-correlation parameters and exponents as those determined for the test-rig bearing. The inner- and outer-race turbine roller-bearing temperatures may be predicted from a single curve regardless of variations in speed, load, oil flow, oil inlet temperatures, oil inlet viscosity, oil-jet diameter, or any combination of these parameters.

NACA TN 2892

A RAPID METHOD FOR ESTIMATING THE SEPARATION POINT OF A COMPRESSIBLE LAMINAR BOUNDARY LAYER. Laurence K. Loftin, Jr. and Homer B. Wilson, Jr. February 1953. 19p. diagrs. (NACA TN 2892)

A method which permits the rapid estimation of the separation point of a compressible laminar boundary layer has been developed. The method is generally applicable to any two-dimensional flow which satisfies the classical boundary-layer assumptions. Calculations made with the use of the method indicate that the amount of velocity recovery possible before laminar separation occurs decreases as the Mach number increases.

NACA TN 2893

THEORETICAL AND MEASURED ATTENUATION OF MUFFLERS AT ROOM TEMPERATURE WITHOUT FLOW, WITH COMMENTS ON ENGINE-EXHAUST MUFFLER DESIGN. Don D. Davis, Jr., George L. Stevens, Jr., Dewey Moore and George M. Stokes. February 1953. iii, 111p. diagrs., photos., 4 tabs. (NACA TN 2893)

Equations are presented for the attenuation characteristics of several types of mufflers. Experimental curves of attenuation plotted against frequency are presented for 77 different mufflers and the results are compared with theory. The experiments were made at room temperature without flow and the sound source was a loud-speaker. A method is given for including the tail pipe in the calculations. The application of the theory to the design of engine-exhaust mufflers is discussed, and charts have been included for the assistance of the designer.

NACA TN 2895

EFFECT OF VARIABLE VISCOSITY AND THERMAL CONDUCTIVITY ON HIGH-SPEED SLIP FLOW BETWEEN CONCENTRIC CYLINDERS. T. C. Lin and R. E. Street, University of Washington. February 1953. 122p. diagrs. (NACA TN 2895)

*AVAILABLE ON LOAN ONLY.

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The differential equations of slip flow, including the Burnett terms, were first solved by Schamberg assuming that the coefficients of viscosity and heat conduction of the gas were constants. The problem is solved herein for variable coefficients of viscosity and thermal conductivity by applying a transformation leading to an iteration method. The method, starting with the solution for constant coefficients, enables one to approximate the solution for variable coefficients very closely after one or two steps. Satisfactory results are shown to follow from Schamberg's solution by using his values of the constant coefficients multiplied by a constant factor η, leading to what are denoted as the effective coefficients of viscosity and thermal conductivity.

NACA TN 2897

EVALUATION OF GUST RESPONSE CHARACTERISTICS OF SOME EXISTING AIRCRAFT WITH WING BENDING FLEXIBILITY INCLUDED. Eldon E. Kordes and John C. Houbolt. February 1953. 31p. diagrs., 2 tabs. (NACA TN 2897)

Calculation studies made by means of the analysis presented in NACA TN 2763 to evaluate the influence that wing bending flexibility has on the structural response due to gust are reported for three twin-engine transports and one four-engine bomber. The manner in which dynamic response factors for acceleration and bending moment vary with various assumed operational factors is shown. Factors investigated include gust-gradient distance, gust shape, spanwise mass distribution, forward velocity, altitude, and compressibility and aspect-ratio corrections. A limited correlation of some of the calculated results with flight data is also presented.

NACA TN 2898

THEORETICAL CALCULATION OF THE PRESSURE DISTRIBUTION, SPAN LOADING, AND ROLLING MOMENT DUE TO SIDESLIP AT SUPERSONIC SPEEDS FOR THIN SWEPTBACK TAPERED WINGS WITH SUPERSONIC TRAILING EDGES AND WING TIPS PARALLEL TO THE AXIS OF WING SYMMETRY. Kenneth Margolis, Windsor L. Sherman and Margery E. Hannah. February 1953. 70p. diagrs., tab. (NACA TN 2898)

On the basis of linearized supersonic-flow theory, equations for the pressure distribution have been derived for thin, sweptback, tapered wings sideslipping at a constant angle of attack. The analysis is applicable to plan forms for which the wing tips are parallel to the axis of wing symmetry and at supersonic speeds for which the wing trailing edge is supersonic. A minor restriction is that the Mach cones emanating from the opposite side edges may not intersect on the wing. The plan form with both leading edges subsonic has been analyzed in detail. Equations for the span loading, rolling moment, and the corresponding stability derivative C_{l_β} have been obtained. Illustrative span loadings and variations of the derivative C_{l_β} with Mach number are presented for a number of wings.

NACA TN 2899

MEASUREMENTS OF FLYING QUALITIES OF AN F-47D-30 AIRPLANE TO DETERMINE LONGITUDINAL STABILITY AND CONTROL AND STALLING CHARACTERISTICS. Christopher C. Kraft, Jr., R. Fabian Goranson and John P. Reeder. February 1953. 75p. photos., diagrs., 2 tabs. (NACA TN 2899)

Flight tests were made of the flying qualities of an F-47D-30 airplane to determine the longitudinal stability and control and stalling characteristics.

NACA TN 2900

THE CALCULATION OF PRESSURE ON SLENDER AIRPLANES IN SUBSONIC AND SUPERSONIC FLO Max. A. Heaslet and Harvard Lomax. March 1953 25p. diagrs. (NACA TN 2900)

Under the assumption that a wing, body, or wing-body combination is slender or flying at near sonic velocity, expressions are given which permit the calculation of pressure in the immediate vicinity of the configuration. The disturbance field, in both subsonic and supersonic flight, is shown to consist of two-dimensional disturbance fields extending laterally and a longitudinal field that depends on the streamwise growth of cross-sectional area. A discussion is also given of couplings, between lifting and thickness effects, that necessarily arise as a result of the quadratic dependence of pressure on th induced velocity components.

NACA TN 2901

AN ANALYSIS OF THE FACTORS AFFECTING TH LOSS IN LIFT AND SHIFT IN AERODYNAMIC CENTER PRODUCED BY THE DISTORTION OF A SWEPT WING UNDER AERODYNAMIC LOAD. Charles W. Mathews and Max C. Kurbjun. March 1953. 65p. diagrs. (NACA TN 2901)

Results of a simplified analysis of the factors affec ing the loss in lift and shift in aerodynamic center o a swept wing due to its bending under aerodynamic load are presented as charts which relate the stres and aeroelastic effects considered to the wing struc tural weight, external geometry, material, and flight condition. Illustrative examples of the mag tudes of the aeroelastic effects to be expected are presented for typical swept wings. The manner in which these aeroelastic effects influence the longitu dinal stability of an airplane is also considered.

NACA TN 2906

AN AIRBORNE INDICATOR FOR MEASURING VERTICAL VELOCITY OF AIRPLANES AT WHEEL CONTACT. Robert C. Dreher. February 1953. 19p. diagrs., photos. (NACA TN 2906)

An investigation has been made with an airborne vertical-velocity indicator in order to determine the accuracy and practicability of such an indicator. A prototype installation was tested under controlled conditions in the Langley impact basin and by means of flight tests with a small trainer-type airplane. A second more compact installation which is retractable was developed for use on a high-speed jet bomber. A description of the operation of the indicator is given. The data obtained and an evaluation of the indicator are presented and show that this type of vertical-velocity indicator is accurate and practical for obtaining vertical velocities at the instant of airplane wheel contact.

NACA TN 2907

EFFECT OF HORIZONTAL-TAIL SPAN AND VERTICAL LOCATION ON THE AERODYNAMIC CHARACTERISTICS OF AN UNSWEPT TAIL ASSEMBLY IN SIDESLIP. Donald R. Riley. February 1953. 39p. diagrs., photos., tab. (NACA TN 2907)

Wind-tunnel results on the effect of horizontal-tail span and vertical location of the horizontal tail relative to the vertical tail on the aerodynamic characteristics of an unswept vertical-tail assembly in sideslip are presented. By applying the well-known discrete-horseshoe-vortex method used for wings to the problem of intersecting surfaces, theoretical span loadings were obtained for each of the configurations tested. Calculated values obtained from the span loadings are compared with experimental results.

NACA TN 2909

STUDY OF SECONDARY-FLOW PATTERNS IN AN ANNULAR CASCADE OF TURBINE NOZZLE BLADES WITH VORTEX DESIGN. Harold E. Rohlik, Hubert W. Allen and Howard Z. Herzig. March 1953. 29p. diagrs., photos. (NACA TN 2909)

In order to increase understanding of the origin of losses in a turbine, the secondary-flow components in the boundary layers and the blade wakes of an annular cascade of turbine nozzle blades (vortex design) were investigated. A detailed study was made of the total-pressure contours and, particularly, of the inner-wall loss cores downstream of the blades. The inner-wall loss core associated with a blade of the turbine-nozzle cascade is largely the accumulation of low-momentum fluids originating elsewhere in the cascade. This accumulation is effected by the secondary-flow mechanism which acts to transport the low-momentum fluids across the channels on the walls and radially in the blade wakes and boundary layers. The patterns of secondary flow were determined by use of hydrogen sulfide traces, paint, flow fences, and total-pressure surveys. At one flow condition investigated, the radial transport of low-momentum fluid in the blade wake and on the suction surface near the trailing edge accounted for 65 percent of the loss core; 30 percent resulted from flow in the thickened boundary layer on the suction surface and 35 percent from flow in the blade wake.

NACA RM E52L05

PRELIMINARY COMPARISON OF 17- AND 75-MILLIMETER-BORE CAGELESS CYLINDRICAL ROLLER BEARINGS WITH CONVENTIONAL CYLINDRICAL ROLLER BEARINGS AT HIGH SPEEDS. E. Fred Macks, W. J. Anderson and Zolton N. Nemeth. March 1953. 39p. diagrs., photos., tab. (NACA RM E52L05)

Preliminary results at high speeds indicate lower bearing temperatures, less internal bearing wear, and greater reliability of the conventional, cage-type cylindrical roller bearings than of either full-complement or special cageless roller bearings of the types investigated, although the latter bearing types have been operated successfully to DN values of 1.0×10^6.

NACA RM E52L24a

SMOKE STUDIES OF SECONDARY FLOWS IN BENDS, TANDEM CASCADES, AND HIGH-TURNING CONFIGURATIONS. Arthur G. Hansen, Howard Z. Herzig and George R. Costello. March 1953. 33p. photos., diagr. (NACA RM E52L24a)

Flow-visualization studies, using smoke, were made of the secondary flows in rectangular bends, tandem cascades, and high-turning configurations. The roll-up of the wall boundary layer of a rectangular bend forms a passage vortex near the suction surface similar to that previously observed for cascades. The vortex so formed then shifts out into the main stream. Because of leading-edge effects, the boundary-layer flows in bends were found to be sufficiently different from the flows in blade rows to make direct application of bend results to blade rows inadvisable. Passage vortices are shown, in the tandem-cascade study, to resist turning with the main stream through which they pass and to disturb the flow in subsequent blade rows. This disturbance may explain in part the appreciable size of the losses sometimes attributed to secondary flows in turbomachines despite the fact that the energy involvement in vortex formation is slight. Tip-flow studies of high-turning blades with relative motion between blades and end wall indicated that if the relative sizes of the passage vortex forces, the tip clearance forces, and the blade-scraping effects are properly controlled, it may be possible to improve the blade-tip loading characteristics in turbomachine.

NACA RM E53A22

AN ANALYTICAL STUDY OF HEAT REQUIREMENTS FOR ICING PROTECTION OF RANDOMES. James P. Lewis. March 1953. 20p. diagrs. (NACA RM E53A22)

The heat requirements for the icing protection of two radome configurations have been studied over a range of design icing conditions. Both the protection limits of a typical thermal protection system and the relative effects of the various icing variables have been determined. For full evaporation of all impinging water, an effective heat density of 14 watts per square inch was required. When a combination of the full evaporation and running wet surface systems

square inch provided protection at severe icing and operating conditions.

BRITISH REPORTS

N-13437*

Aeronautical Research Council (Gt. Brit.)
THE BOUNDARY LAYER WITH DISTRIBUTED SUCTION. M. R. Head. April 2, 1951. 118p. diagrs., photos., 4 tabs. (ARC 13,897; FM 1547; Perf. 771)

Experiments performed in flight at Reynolds numbers in the region of 3×10^6 have clearly demonstrated the stabilizing effect of small amounts of distributed suction on the laminar boundary layer. In the absence of a pressure gradient and in adverse gradients similar to those occurring on a normal airfoil, transition of the boundary layer to the turbulent form has been prevented by the use of such suction quantities as may be expected to lead to very considerable reductions in effective drag. It appears, however, that for extensive laminar flow to be achieved in this way, the surface must be free from such excrescences as would cause transition in the absence of suction. Laminar boundary-layer velocity profiles obtained with suction in the absence of a pressure gradient are found to be in good agreement with those calculated for the flat plate, and the suction quantities required to maintain laminar flow are similar to those suggested by stability theory.

N-16313*

Royal Aircraft Establishment (Gt. Brit.)
CHARTS OF THE WAVE DRAG OF WINGS AT ZERO LIFT. T. Lawrence. November 1952. 22p. diagrs. (RAE Tech. Note Aero 2139, rev.)

Theoretical calculations of the wave drag at supersonic speeds of nonlifting wings of double wedge and biconvex section are reviewed, and the best method of presenting the results considered. Using this method, a representative selection of the available numerical evaluations of the theory is presented. These should be of value for wing drag estimation purposes.

N-20663 *

Aeronautical Research Council (Gt. Brit.)
SOME PRELIMINARY RESULTS FROM V-G RECORDERS INSTALLED IN MILITARY AND CIVIL AIRCRAFT. R. Hain Taylor. 1952. 43p. diagrs., 5 tabs. (ARC R & M 2610; ARC 10,433. Formerly RAE SME 3393; RAE Tech. Note SME 188; ARC 7266; RAE Tech. Note SME 204; ARC 7475; RAE Tech. Note SME 232; ARC 7887; RAE Tech. Note SME 303; ARC 8621; RAE Tech. Note SME 368; ARC 9940)

During the latter half of the 1939-45 war, V-g recorder slides were collected from a number of operational and training aircraft types, and about April

mercial transport aircraft. A number of the results has been given limited circulation as Aeronautical Research Council papers, from heavy bombers in October 1943, from fighters in January 1944, and from twin-engined aircraft in April 1944, and a summary of readings from commercial aircraft in 1946; this report collects these scattered results into one body. Part I outlines the method of collection of the slides, describes the nature of the readings obtained, and their method of presentation, and discusses the results. These are grouped roughly into classes, as heavy bombers, fighters, twin-engined aircraft, training aircraft and commercial transport aircraft, and the possibilities of comparison between different types performing the same role, and between different roles performed by the same basic type, are indicated. Part II is a theoretical consideration of possible methods of analysis and extrapolation; it is pointed out that as the work has developed, first ideas have been enlarged or superseded, and finality is still far off. The advantages and disadvantages of several methods used up to 1946 are discussed, and suggestions are made for subsequent work.

N-20917 *

Aeronautical Research Council (Gt. Brit.)
INVESTIGATIONS ON SWEPT AND UNSWEPT WINGS AT HIGH SUBSONIC SPEEDS. J. Ackeret, M. Degen and N. Rott. February 16, 1951. 12p. diagrs. (ARC 13,788; FM 1525; Perf. 894)

In the high-speed wind tunnel of the Institue of Aerodynamics, E.T.H., Zürich, straight and sweptback wings have been tested at high subsonic speeds. Drag measurements at zero incidence were made on a series of geometrically similar models at the same Reynolds number, which was maintained constant by varying the air density. In this way the theoretical tunnel correction formulas could be checked and an extrapolation made to vanishing tunnel influence; straight and sweptback wings were compared after the corrections had been applied. Two different profile thicknesses (9 percent and 12 percent) were used. The transonic drag - Mach number relation for different thicknesses was found to be in very satisfactory agreement with von Kármán's similarity law.

N-20919*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE EFFECT OF SWEEP AND INTERFERENCE ON THE OVERALL DRAG COEFFICIENT OF AN AIRCRAFT AT SUBCRITICAL MACH NUMBERS. J. H. Preston. March 22, 1951. 6p. (ARC 13,875; Perf. 769)

The influence of sweep and interference on the overall drag coefficient of an aircraft is discussed. It is concluded that the induced drag need only slightly exceed the ideal minimum for practical sweptback plan forms. The part of the profile drag coefficient independent of C_L may be slightly reduced by sweep, and the part proportional to C_L^2 may be considerably increased and may be sensitive to the spanwise variation of C_L from the mean value. The drag increments due to interference at junctions can be split into two parts - a profile loss such as would be obtained from a pitot traverse, and an induced loss arising from the secondary flows set up in the junction. This latter does not seem to have been studied in connection with aircraft. Both parts of the interference drag may rise steeply with increase of C_L. Correct design of the fairing and the use of boundary-layer suction would assist in reducing the interference drag.

N-20954 *

Royal Aircraft Establishment (Gt. Brit.)
DYNAMICALLY EQUIVALENT CIRCUITS OF TRANSDUCTORS FEEDING INDUCTIVE RESISTANCE LOADS. D. O. Burns. August, 1952. 26p. diagrs. (RAE Tech. Note EL. 41)

The dynamic relationship between the input voltage and the input current of series self-excited transductors has been reported on by various authorities, notably Milnes. However, amplifier designers in general, and servomechanics in particular, are more concerned with the dynamic relationship between input voltage and output current, especially when feeding inductive loads such as relays, motor windings, etc. In the case of the electronic amplifier, equivalent circuits, involving the parameters of the vacuum tube and the load resistance and inductance, which enable the dynamic response of the amplifier to be calculated, are now well known. As an extension of this field, this report gives the dynamically equivalent circuits for transductors, which may be used for calculating the dynamic responses of magnetic amplifiers feeding inductive resistance loads.

N-20960 *

Marine Aircraft Experimental Establishment (Gt. Brit.) THE FULL SCALE HYDRODYNAMIC PERFORMANCE OF A LARGE FOUR-ENGINED FLYING BOAT AT OVERLOAD IN CALM WATER AND SWELL. J. A. Hamilton and R. V. Gigg. August 1952. 63p. diagrs., photos., 2 tabs. (MAEE F/Res/225)

Tests have been made on a large four-engined flying boat (Solent Mk. 3) to determine the hydrodynamic performance in sheltered water and in open sea swells. The results of general research interest are considered in this report. The sheltered water characteristics were investigated over a range of weights between 72,000 and 84,000 lb. The performance in swell covered weights up to 82,000 lb, and swell heights up to 5 feet.

N-20964*

Forest Products Research Lab. (Gt. Brit.)
INVESTIGATIONS INTO GLUES AND GLUING, PROGRESS REPORT SEVENTY-TWO - NOVEMBER 1952. THE BONDING OF PRESERVATIVE TREATED VENEERS WITH PHENOLIC RESIN. R. A. G. Knight, L. S. Doman and G. E. Soane. 6p. 2 tabs. (Forest Products Research Lab.)

This report describes tests made on phenolic-bonded plywood with preservatives applied to the individual veneers prior to their being bonded together. These tests were conducted in order to determine if these preservatives interfered with the phenolic resin either in its setting action or subsequently.

N-21005 *

Royal Aircraft Establishment (Gt. Brit.)
PHYSICAL ENTROPY AND THE ENTROPY OF INFORMATION THEORY. G. F. Cawsey. February, 1952. 36p. (RAE Tech. Note GW 169)

This note briefly outlines some of the definitions of entropy in physics, and considers the interrelations of entropy and information in physical and communication systems as discussed by Szilard, Brillouin, and Shannon. In conclusion, some suggestions are offered as to the associations to be made in observational and communication systems with the words "entropy" and "information."

N-21029*

Royal Aircraft Establishment (Gt. Brit.)
THE PRODUCTION OF TRANSDUCER, ACCELERATION (TELEMETRY) TYPE IT 1-16. October 1951. 4p. (RAE Specif. IT. 163)

This report presents the RAE specifications for the construction, adjustment, testing, marking and packing of an acceleration transducer.

N-21034*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF STOVE-ENAMELLING TEMPERATURES ON ALUMINIUM ALLOYS. G. Meikle and J. Thompson. August, 1952. 9p. diagrs. (RAE Tech. Note Met. 166)

The effect of heating the D.T.D. 603 type of alloy at 120°, 165° and 185° C was investigated as these temperatures are liable to be used either for stove-enamelling or for "curing" synthetic resin adhesives. Tests were also made at 120° C on D.T.D. 687 aluminum alloy. Stoving at 120° C is liable to cause a drop of 2 tons/sq in. in proof stress and ultimate tensile stress in D.T.D. 603 and this is not regained except by prolonged heating at 120° C. At 165° C, the improvement due to artificial aging is apparent after 2 hours heating. A temperature of 185° C for an hour is not likely to have much deleterious effect on fully aged D.T.D. 603 (D.T.D. 646) or D.T.D. 610 (D.T.D. 546). Heating D.T.D. 687 at 120° C for a few hours has only a slight deleterious effect.

N-21035*

Marine Aircraft Experimental Establishment (Gt. Brit.) 50 FT. REFUELLER MARK 2 NO. 2133 PERFORMANCE. November 1952. 14p. diagrs. (MAEE F/181, pt. 2)

Full performance measurements were made on 50-ft Refueller Mark 2, No. 2133, fitted with two Perkins S.6M. engines. The top speed of the craft fully laden is 10 knots, at a fuel consumption of 0.65 nautical m.p.g. The turning circle is about 2-1/4 boat lengths under most conditions, and the emergency stopping distance from full throttle also about 2-1/4 boat lengths. Fuel pumping rates are about the same as for the Mark 1 craft, that is, 20 gallons per minute per 1-1/2 in. hose. The fuel meter is, however, liable to give false indications of the quantity pumped, due to air entering the system. The fuel delivery rates of the craft are much lower than the rating of the pump. The compressed air starting system is barely adequate. Higher pressure cylinders and a larger compressor are desirable.

N-21036*

Marine Aircraft Experimental Establishment (Gt. Brit.) PRELIMINARY PRESSURE MEASUREMENTS DURING THE LANDING OF A SUNDERLAND MARK 5 FLYING BOAT IN ROUGH WATER CONDITIONS INCLUDING ONE ON WHICH THE FOREBODY WAS SEVERELY DAMAGED. R. Parker. Appendix I by W. McClymont. Appendix II by R. Parker. September 1952. 40p. diagrs., photos., 5 tabs. (MAEE F/Res/227)

A series of 11 exploratory landings were carried out on a Sunderland Mark 5 flying boat in rough water conditions, during which pressures at various positions on the planing bottom and the c.g. acceleration were measured. Detailed investigations were to be carried out, based on these tests, but the aircraft was severely damaged and this report presents these first results. Analysis of these results shows that pressures occurring in the bow region are of the same order of magnitude as those in the main step region which, in turn, are similar in magnitude to those encountered in high rate of descent landings in calm water conditions. Pressures recorded on the afterbody are invariably much lower than those on the forebody. The greatest risk of damaging the aircraft occurs when, a short time after touchdown, the aircraft still has considerable forward speed and the pilot little or no control.

N-21044*

Royal Aircraft Establishment (Gt. Brit.) GERMAN WIND TUNNEL TESTS ON TRAILING EDGE SPOILERS AT SUBSONIC AND SUPERSONIC SPEEDS. H. Voepel. November, 1952. 21p. diagrs., 3 tabs. (RAE Tech. Note Aero 2214)

During the war, Herbert Wagner introduced a new aerodynamic controlling device in the form of trailing edge
for guided missiles. Considerable tunnel development of the control was done, but the work has not previously been reported in an accessible form, nor has any analysis of the results been attempted. Such presentation and analysis is given here.

N-21055*

Royal Aircraft Establishment (Gt. Brit.) THE PRODUCTION OF TRANSDUCER, ACCELERATION TYPE IT.1-22. October 1951. 6p. (RAE Specif. IT. 164)

This report presents a description and RAE specifications for the adjustment, testing, marking, and packing of acceleration transducers.

N-21056*

Royal Aircraft Establishment (Gt. Brit.) THE PRODUCTION OF GYRO, ANGULAR VELOCITY TRANSMITTING TYPE IT.3-1. January 1952. 5p. (RAE Specif. IT. 114)

This report presents the RAE specifications for an angular velocity transmitting gyroscope to be used in conjunction with telemetering equipment, for measuring the rate of angular movement of falling bodies.

N-21057*

Royal Aircraft Establishment (Gt. Brit.) THE PRODUCTION OF PICK-UP, PRESSURE DIFFERENTIAL (VARIABLE INDUCTANCE) TYPE IT.1-2. April 1949. 5p. diagr. (RAE Specif. IT. 99)

This report contains the RAE specifications for pressure units to be used for the measurement of steady and fluctuating air pressures.

N-21058*

Royal Aircraft Establishment (Gt. Brit.) GYRO, RATE, REMOTE INDICATING TYPE IT.2-1. April 1947. 5p. (RAE Specif. IT. 80)

This report presents the RAE specifications for a remote indicating gyroscope to be used in aircraft in conjunction with a desynn indicator to measure rates of rotation of the aircraft.

N-21074*

Royal Aircraft Establishment (Gt. Brit.)
THE BASIC NOTIONS OF INFORMATION THEORY. D. J. Richardson. October, 1952. 27p. (RAE Tech. Note GW 214)

A study of available literature on the theory of information has been made. The various notions and terms employed in the theory are gathered together and explained or defined in the text. A list of references is appended.

MISCELLANEOUS

NACA Rept. 1054

Errata No. 1 on "INTEGRALS AND INTEGRAL EQUATIONS IN LINEARIZED WING THEORY." Harvard Lomas, Max. A. Heaslet and Franklyn B. Fuller. 1951.

NACA Rept. 1062

Errata No. 1 on "INVESTIGATION OF WEAR AND FRICTION PROPERTIES UNDER SLIDING CONDITIONS OF SOME MATERIALS SUITABLE FOR CAGES OF ROLLING-CONTACT BEARINGS." Robert L. Johnson, Max. A. Swikert and Edmond E. Bisson. 1952.

NACA Rept. 1083

Errata No. 1 on "AXISYMMETRIC SUPERSONIC FLOW IN ROTATING IMPELLERS." Arthur W. Goldstein. 1952.

NACA RM L8H23

Errata No. 1 on "EXPERIMENTAL DETERMINATION OF THE LATERAL STABILITY OF A GLIDER TOWED BY A SINGLE TOWLINE AND CORRELATION WITH AN APPROXIMATE THEORY." Bernard Maggin and Robert E. Shanks. November 12, 1948.

UNPUBLISHED PAPERS

N-15503*

Armour Research Foundation.
STRESS CORROSION IN AIRCRAFT ALLOYS. Joseph B. McAndrew and Howard T. Francis. (Final rept.) May 29, 1952. i, 24p. photos. (Armour Research Foundation)

An attempt has been made to verify the existing theory for the stress corrosion cracking of aluminum 4-percent copper alloy. The approach used has employed a scanning device, called a "corroscope," which permits a two-dimensional picture to be observed on an oscilloscope, in which is shown the potential distribution in the electrolyte immediately adjacent to the corroding metal surface. Since this potential field is directly related to the current lines flowing from point to point on the specimen, the picture allows direct observation of the location of anodic and cathodic regions on the surface.

N-19882*

Battelle Memorial Inst.
THE PLASTIC DEFORMATION OF SINGLE CRYSTALS OF ALUMINUM. R. D. Johnson, A. P. Young, W. B. Wilson and A. D. Schwope. (Summary rept.) October 10, 1952. i, 59p. photos., diagrs., tab. (Battelle Memorial Inst.)

This report describes a portion of the work performed in a fundamental investigation of creep in metals. The creep of single crystals of high-purity aluminum has been studied in the temperature range from 700° F to 1100° F. Experiments were carried out to investigate the possible effect of small amounts of prestraining by various methods on the creep properties of these aluminum single crystals. An experimental survey was conducted with various high-resolution X-ray diffraction techniques to determine the feasibility of studying the nature of plastic deformation in this manner.

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Billy Watson

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA TN 2867

HEAT AND MOMENTUM TRANSFER BETWEEN A SPHERICAL PARTICLE AND AIR STREAMS. Y. S. Tang, J. M. Duncan and H. E. Schweyer, University of Florida. March 1953. 48p. diagrs., photo., tab. (NACA TN 2867)

Heat-transfer coefficients for a spherical particle heated by an induction coil in a moving air stream were experimentally determined for the Reynolds number range from 50 to 1000 using spheres of 1/8- to 5/8-inch diameter and air velocities from 1 to 13 feet per second. A correlation of the heat-transfer factor or Stanton number with the Reynolds number was obtained and expressed by an empirical equation. This correlation is in agreement with the values calculated from theory for the lower range of Reynolds numbers studied. The skin-friction factor representing the momentum transfer calculated from the boundary-layer theory shows good agreement with the experimental heat-transfer factor except in the lower range of Reynolds numbers studied. The relationship $St = C_f/2$ where St is the Stanton number and C_f is the skin-friction factor is suggested for the case of an air stream flowing around a sphere. An empirical equation relating the heat-transfer factor to the total-drag coefficient is also suggested.

NACA TN 2890

A LINEAR TIME-TEMPERATURE RELATION FOR EXTRAPOLATION OF CREEP AND STRESS-RUPTURE DATA. S. S. Manson and A. M. Haferd. March 1953. 49p. diagrs. (NACA TN 2890)

A time-temperature parameter based on examination of the published stress-rupture data for a variety of materials is proposed in the form $(T - T_a)/(\log t - \log t_a)$, where T is temperature in degrees Fahrenheit, t is rupture time or the time to obtain a given total creep elongation, and T_a and $\log t_a$ are material constants which appear to be determinable from suitable rupture data in the time range between 30 and 300 hours. For the 40 materials investigated, use of this parameter in conjunction with experimental data involving rupture times below 300 hours resulted in very good extrapolations to longer rupture times (up to 10,000 hr where data were available) compared with corresponding predictions obtainable from a recently proposed parameter $(T + 460)(20 + \log t)$. For correlation of minimum creep-rate data, the parameter used is in the form $(T - T_a)/(\log r + \log r_a)$, where r is the creep rate and r_a is a material constant.

NACA TN 2902

MATRIX METHODS FOR DETERMINING THE LONGITUDINAL-STABILITY DERIVATIVES OF AN AIRPLANE FROM TRANSIENT FLIGHT DATA. James J. Donegan. March 1953. 65p. diagrs., 6 tabs. (NACA TN 2902)

Three methods are presented for calculating the longitudinal stability derivatives from transient flight data. Several examples using flight data are given to illustrate the method. The results indicate the scatter which is typical of this type of analysis.

NACA TN 2903

IMPINGEMENT OF CLOUD DROPLETS ON AERODYNAMIC BODIES AS AFFECTED BY COMPRESSIBILITY OF AIR FLOW AROUND THE BODY. Rinaldo J. Brun, John S. Serafini and Helen M. Gallagher. March 1953. 20p. diagrs. (NACA TN 2903)

The trajectories of water droplets in a compressible-air flow field around a cylinder were computed with a mechanical analog. The results of the calculations at the flight critical Mach number were compared with calculations of trajectories in an incompressible flow field. For a cylinder, the effect of compressibility of the air on the droplet trajectories was negligible up to the flight critical Mach number. The results obtained with the cylinder were extended to airfoils. This extension is possible because the incompressible flow fields of both cylinders and airfoils are similarly altered by compressibility.

NACA TN 2904

IMPINGEMENT OF WATER DROPLETS ON A CYLINDER IN AN INCOMPRESSIBLE FLOW FIELD AND EVALUATION OF ROTATING MULTICYLINDER METHOD FOR MEASUREMENT OF DROPLET-SIZE DISTRIBUTION, VOLUME-MEDIAN DROPLET SIZE, AND LIQUID-WATER CONTENT IN CLOUDS. Rinaldo J. Brun and Harry W. Mergler. March 1953. 71p. diagrs., photo., 4 tabs. (NACA TN 2904)

The trajectories of water droplets in an incompressible flow field around a cylinder were calculated with a mechanical analog. The collection efficiency, the area of droplet impingement on the cylinder, and the rate of droplet impingement were determined from the trajectories. An evaluation of the rotating multicylinder method for the measurement of droplet-size distribution, volume-median droplet size, and liquid-water content was made based on the results of the trajectory calculations.

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NACA TN 2910

AN APPLICATION OF THE METHOD OF CHARACTERISTICS TO TWO-DIMENSIONAL TRANSONIC FLOWS WITH DETACHED SHOCK WAVES. Keith C. Harder and E. B. Klunker. March 1953. 16p. diagrs. (NACA TN 2910)

An application of the method of characteristics is presented which affords a means for determining the surface pressures for a class of two-dimensional airfoils of given nose shape and arbitrary rear part in a sonic or supersonic stream if surface pressure data are given for one member of the class. For engineering purposes, the method of characteristics may be replaced by a simple application of Prandtl-Meyer flow concepts. An explanation of the nonlinear force characteristics of two-dimensional airfoils at transonic speeds is presented on the basis of sensitivity of these flows to changes in geometry and angle of attack.

NACA TN 2911

A LOW-SPEED EXPERIMENTAL STUDY OF THE DIRECTIONAL CHARACTERISTICS OF A SHARP-NOSED FUSELAGE THROUGH A LARGE ANGLE-OF-ATTACK RANGE AT ZERO ANGLE OF SIDESLIP. William Letko. March 1953. 27p. diagrs., photo. (NACA TN 2911. Formerly RM L52J14)

Static yawing moments and some instantaneous yawing moments are presented through a range of angle of attack at zero sideslip angle for a plain fuselage model having a sharp conical nose and for the fuselage with several nose modifications, one of which consisted of a ring located at different stations along the nose. Some circumferential pressure measurements at one station on the body at several angles of attack are also presented.

NACA TN 2912

THE NORMAL COMPONENT OF THE INDUCED VELOCITY IN THE VICINITY OF A LIFTING ROTOR AND SOME EXAMPLES OF ITS APPLICATION. Walter Castles, Jr. and Jacob Henri De Leeuw, Georgia Institute of Technology. March 1953. 38p. diagrs., 3 tabs. (NACA TN 2912)

A method is presented for computing the approximate values of the normal component of the induced velocity at points in the flow field of a lifting rotor. Tables and graphs of the relative magnitudes of the normal component of the induced velocity are given for selected points in the longitudinal plane of symmetry of the rotor and on the lateral rotor axis. A method is also presented for using the tables and graphs to determine the interference induced velocities arising from the second rotor of a tandem- or side-by-side-rotor helicopter and the induced flow angle at a horizontal tail plane.

NACA TN 2913

ON THE DEVELOPMENT OF TURBULENT WAKES FROM VORTEX STREETS. Anatol Roshko, California Institute of Technology. March 1953. 77p. diagrs., photos., 3 tabs. (NACA TN 2913)

Wake development behind circular cylinders at Reynolds numbers from 40 to 10,000 was investigated by hot-wire techniques in a low-speed wind tunnel. The Reynolds number range of periodic vortex shedding is divided into two distinct subranges. In the stable range, R = 40 to 150, regular vortex streets are formed and no turbulent motion develops, the vortices decaying by viscous diffusion. The range R = 150 to 300 is a transition region to the irregular range in which turbulent velocity fluctuations accompany the periodic formation of vortices. The diffusion is turbulent and the wake becomes fully turbulent in 40 to 50 diameters. The turbulence is initiated by laminar-turbulent transition in the free layers which spring from the separation points on the cylinder. An annular vortex street was observed in the wake of a ring.

NACA TN 2914

A METHOD FOR RAPID DETERMINATION OF THE ICING LIMIT OF A BODY IN TERMS OF THE STREAM CONDITIONS. Edmund E. Callaghan and John S. Serafini. March 1953. 33p. diagrs. (NACA TN 2914)

The effects of existing frictional heating were analyzed to determine the conditions under which ice formations on aircraft surfaces can be prevented. A method is presented for rapidly determining by means of charts the combination of Mach number, altitude, and stream temperature which will maintain an ice-free surface in an icing cloud. The method can be applied to both subsonic and supersonic flow. The charts presented are for Mach numbers up to 1.8 and pressure altitudes from sea level to 45,000 feet.

NACA TN 2915

EFFECT OF PROCESSING VARIABLES ON THE TRANSITION TEMPERATURE, STRENGTH, AND DUCTILITY OF HIGH-PURITY, SINTERED, WROUGHT MOLYBDENUM METAL. Kenneth C. Dike and Roger A. Long. March 1953. 26p. diagrs., photos., 3 tabs. (NACA TN 2915)

High-purity, sintered, wrought molybdenum metal has a transition temperature range near room temperature which varies according to the amount of swaging reduction; increasing swaging reduction decreases the transition temperature range. Recrystallized metal possesses a higher transition temperature range than as-swaged metal, regardless of the amount of prior working. Ultimate tensile strengths of as-swaged, stress-relieved, or recrystallized metal are affected by varying amounts of working from 35 to 99 percent swaging reduction, but the differential is not large. Ductility of as-swaged metal at room temperature increases with increased working; however, when stress-relieved, the ductility does not vary with working. Recrystallized metal has good ductility above the transition range

provided that the prior working is greater than about 50 percent. Other data are presented as to grain size, type of fracture, and chemical analysis.

NACA TN 2917

A MODIFIED REYNOLDS ANALOGY FOR THE COMPRESSIBLE TURBULENT BOUNDARY LAYER ON A FLAT PLATE. Morris W. Rubesin. March 1953. 23p. diagrs., tab. (NACA TN 2917)

A modified Reynolds analogy is developed for the compressible turbulent boundary layer on a flat plate. When mixing-length theories are used to evaluate terms of the final expressions, it is found for air that the ratio of Stanton number to half the local skin-friction coefficient is greater than unity. At Mach number equals zero, this ratio is of the order of 1.18 to 1.21 for Reynolds numbers based on momentum thickness of 10^3 to 10^6. Up to a Mach number of 5 and under extreme conditions of surface temperature, it is found that the ratio of Stanton number to half the skin-friction coefficient differs from its values for the incompressible case (M = 0) by amounts so small as to be of the magnitude of the uncertainties in the theory.

NACA TN 2918

EFFECTS OF PARALLEL-JET MIXING ON DOWNSTREAM MACH NUMBER AND STAGNATION PRESSURE WITH APPLICATION TO ENGINE TESTING IN SUPERSONIC TUNNELS. Harry Bernstein. March 1953. 26p. diagrs., photos. (NACA TN 2918)

A one-dimensional analysis of the results of the parallel-jet mixing encountered in the testing of engines in supersonic wind tunnels is reported. This type of analysis presents a reasonable approach to obtaining approximate figures for the tunnel operating conditions while the tunnel is still in the design stage. These figures would be based upon the known tunnel geometry and inlet conditions and estimations of the model geometry and values of the engine performance parameters. Additional equations are presented for evaluation of changes due to the burning of excess fuel downstream of the engine-exhaust station.

NACA TM 1355

STUDY OF THE SUPERSONIC PROPELLER. (Étude de L'Hélice Supersonique). Jean Fabri and Raymond Siestrunck. March 1953. 23p. diagrs. (NACA TM 1355. Trans. from Ministère de l'Air. Publications Scientifiques et Techniques 248, 1951, p. 113-130; International Conference on Mechanics, Proceedings, v. 1, 1950).

In this paper a propeller having all sections operating at supersonic speeds is designated a supersonic propeller regardless of flight speed. Analyses assume subsonic flight speeds but very high rotational speeds. A very elementary analysis of the efficiency of a jet-propeller system is presented. A propeller analysis based on conventional vortex blade element theory is presented and reduced to a single point method which leads to an expression for optimum advance ratio in terms of hub-tip diameter ratio and airfoil fineness ratio. An expression for propeller efficiency in terms of advance ratio, hub-tip diameter ratio, and airfoil thickness ratio is also presented. Use is made of theoretical airfoil characteristics at supersonic speeds. A study of blade section interference, blade shock and expansion fields, at supersonic section speeds is presented. An example taken indicates that an efficiency of seventy percent can be obtained with a propeller having a tip Mach number of 2.3.

BRITISH REPORTS

N-21075*

Royal Aircraft Establishment (Gt. Brit.)
COMMUNICATION IN THE PRESENCE OF NOISE. D. J. Richardson. October, 1952. 29p. (RAE Tech. Note GW 215)

This report is divided into three main parts. The first part considers discrete information, and a number of theorems on discrete information are developed. The second discusses continuous information, and shows how the various theorems on discrete information may be generalized to apply to the continuous case. An information potential measure is introduced. The third is concerned with the transfer of continuous information in the presence of noise.

N-21206*

Aeronautical Research Council (Gt. Brit.)
THE CALCULATION OF AERODYNAMIC DERIVATIVE COEFFICIENTS FOR WINGS OF ANY PLAN FORM IN NON-UNIFORM MOTION. W. P. Jones. 1952. 12p. diagrs., tab. (ARC R & M 2470. Formerly ARC 10, 142; 0. 623; FM 1030; S & C 2074)

In the present paper, a method is outlined for the calculation of aerodynamic forces on wings of any plan form in steady or unsteady motion. It is based on vortex sheet theory for thin wings as developed by the writer in previous reports, but makes use of Falkner's scheme for the approximate calculation of downwash distributions. In the earlier work, satisfactory agreement with the experimental evidence available was obtained, but as the downwash distributions were calculated exactly the numerical work was rather complicated and involved the use of incomplete elliptic integrals and the treatment of singularities. The method now proposed avoids these computational difficulties and is perhaps more suitable for routine calculations of flutter derivatives. Satisfactory solutions of many problems in steady motion have already been obtained by Falkner using approximate downwash distributions as determined by his vortex lattice, and it is thought that the similar scheme suggested in this paper might also prove to be sufficiently accurate for problems in unsteady motion. The computational procedure is briefly summarized

in appendix II. Certain modifications of the main scheme which would further reduce the amount of computation are indicated in the main text.

N-21207 *

Aeronautical Research Council (Gt. Brit.)
PART I. TABULATED THERMAL DATA FOR HYDROCARBON OXIDATION PRODUCTS AT HIGH TEMPERATURES. PART II. THE EFFECT OF DISSOCIATION ON ROCKET PERFORMANCE CALCULATIONS. A. B. P. Beeton. 1952. 14p. diagrs., 3 tabs. (ARC R & M 2542. Formerly RAE Tech. Note Aero 1835; SD 40; RAE Tech. Note Aero 1838; SD 42)

Tables are given of the total heat and entropy of H_2O, CO_2, O_2, CO, H_2, OH, O, and H for the range of temperature 1500°-4000° K. Values are also given for the corresponding equilibrium constants over the same temperature range. The tables have been compiled with a view to their use in calculating the performance of liquid-fuel rockets.

N-21208 *

Aeronautical Research Council (Gt. Brit.)
FLIGHT TESTS ON HURRICANE II, Z.3687 FITTED WITH SPECIAL WINGS OF 'LOW-DRAG' DESIGN. R. H. Plascott, D. J. Higton, F. Smith and A. R. Bramwell. 1952. 13p. diagrs. (ARC R & M 2546; ARC 9172; ARC 10,106. Formerly RAE Aero 2090; Aero 2153)

This report describes flight tests to investigate the profile-drag characteristics of a "low-drag" section wing built by Armstrong Whitworth, Ltd., using a new type of construction of their own design. During the first series of tests, a section of the wing was pressure-plotted and the results showed that it should be possible to obtain laminar flow over a range of lift coefficient from 0.12 to 0.50. A few preliminary profile-drag measurements were also made and a fairly low profile-drag coefficient (C_D = 0.0046 to 0.0050) was recorded over a lift coefficient range of 0.20 to 0.40; there was, however, a rapid rise in the profile drag coefficient at lift coefficients less than 0.20, and investigation of the surface waviness showed that the failure to maintain laminar flow at higher speeds was probably due to the excessive waviness present, which amounted to a variation of about ±2-1/2 thousandths of an inch from the mean deflection curve on a two-inch gage length. A further series of profile-drag measurements was made when the surface waviness had been reduced to ±1 thousandth of an inch variation from the mean deflection curve on a 2-inch gage length. It was found that, provided no flies or other insects were picked up during the flight, the drag coefficient had been reduced to 0.0044 over a range of lift coefficient from 0.12 to 0.50. This corresponds to transition from 50 to 60 percent chord. With the reduced surface waviness, it was possible to maintain laminar flow up to Reynolds numbers of nearly 20 millions.

N-21209*

Aeronautical Research Council (Gt. Brit.)
TESTS IN THE COMPRESSED AIR TUNNEL ON THE AEROFOILS NACA 0015 AND NACA 0030 WITH AND WITHOUT SPLIT FLAP AND ON OTHER AEROFOILS OF VARIOUS THICKNESSES WITH A SPLIT FLAP. R. Jones. 1952. 32p. diagrs., 16 tabs. (ARC R & M 2584. Formerly ARC 4191; ARC 4511; ARC 4607)

This report contains the results of experiments to determine the effect of thickness on the aerodynamic characteristics of a group of rectangular wings with and without a split flap. Wings with the following airfoil sections were tested: NACA 0015 and NACA 0030 with and without a split flap; NACA 0012, NACA 23012, RAF 28 and RAF 48 with the flap. The effect of rounding the edge of the flap was considered on the wing with NACA 0015 section. The effect of rounding the ends of the NACA 0030 section was examined. C_L, C_D, and C_m were obtained over a range of Reynolds numbers with additional C_D measurements at closer intervals of R on the two wings without flap.

N-21210*

Aeronautical Research Council (Gt. Brit.)
THE EFFICIENCY OF A PITOT INTAKE INCLINED TO THE AIR STREAM. E. L. Place and R. Lecavalier. 1952. 8p. diagrs. (ARC R & M 2621; ARC 11,162. Formerly NGTE Memo. M. 21)

In an earlier report on intake ducting for supersonic flight, the efficiency of a "pitot" type intake was discussed and shown to have a marked effect on the performance of gas-turbine engines. The present report is supplementary in that it describes the effect of inclining the pitot intake to the main airstream direction in the transonic Mach number range 0.7 to 1.5, an effect which is at present incalculable. Curves are presented showing the influence of inclination on intake adiabatic efficiency and air mass flow into the intake. These experimental results are then illustrated by application to the performance of a typical turbine engine and a propulsive duct in sonic and supersonic flight. At a flight Mach number of 1.5, it is found that, for both turbine engine and propulsive duct, an inclination of 5° reduces the net thrust by roughly 2 percent compared with the normal flight thrust. For inclinations greater than 5°, however, thrust falls off more rapidly, and at 10° inclination, it is reduced by roughly 6.5 percent for the turbine engine and 7.5 for the propulsive duct.

N-21211*

Aeronautical Research Council (Gt. Brit.)
REGENERATOR HEAT EXCHANGERS FOR GAS-TURBINES. J. E. Johnson. 1952. 72p. diagrs., 13 tabs. (ARC R & M 2630; ARC 11,770. Formerly RAE Aero 2266; SD 27)

Information was required from which the performance of regenerators suitable for heat exchangers for gas turbines could readily be estimated. A series of

tables and curves have been prepared from which the efficiency of a regenerator can be calculated if the operating conditions and heat-transfer coefficients are known. The tables and curves cover a range of lengths and blow times appropriate to gas-turbine conditions. Measurements of heat transfer and pressure drop coefficients have been made on several examples of matrix of both the gauze and flame trap type in conditions similar to those in a gas turbine. A number of examples have been worked out from the experimental results to show the relative importance of the different variables on the performance of typical regenerators. A gauze matrix of fine wire and open mesh has a much lower weight and only slightly higher pressure drop than a flame-trap matrix for the same efficiency. The recommended size of gauze is a wire diameter of 0.002 in. to 0.004 in. and a mesh of 20 to 40 wires per inch; the material should be stainless steel. Further design study is necessary to determine whether this advantage can be maintained in a complete regenerator.

N-21212*

Aeronautical Research Council (Gt. Brit.)
COMPARATIVE FLUTTER TESTS ON TWO, THREE, FOUR AND FIVE-BLADE PROPELLERS. H. G. Ewing, J. Kettlewell and D. R. Gaukroger. 1952. 8p. diagrs. (ARC R & M 2634; ARC 11,438. Formerly RAE Structures 18)

This report describes comparative flutter tests on two-, three-, four-, and five-blade Duralumin propellers with the same blade design. The tests were made on the No. 3 spinning tower, Royal Aircraft Establishment. Strain gages were used for determining the vibratory stresses and the phase relations between the blades. A wide range of blade angles above and below the stalling region was explored. Stalling flutter was the only form encountered. The phase relation of the blades was found to be dependent on number of blades and speed of rotation, and to influence the amplitude of the vibratory stresses. It is shown that no direct comparison of the flutter characteristics of the two-, three-, four-, and five-blade propellers can be made.

N-21213*

Aeronautical Research Council (Gt. Brit.)
CONCERNING THE ANNULAR AIR INTAKE IN SUPERSONIC FLIGHT. I. M. Davidson and L. E. Umney. 1952. 22p. diagrs., photos. (ARC R & M 2651; ARC 11,645. Formerly NGTE R. 16)

The stability of an annular air intake at a Mach number of 1.4 and with Reynolds numbers of about 1.5×10^6 is considered in detail and a method is described whereby the experimental results might be extrapolated for preliminary full-scale design purposes. This extrapolation has yet to be checked experimentally, but suggests that a typical aircraft intake would have an over-all isentropic efficiency of about 85 percent. The results also indicate that both the stability and the efficiency of an intake could be improved by controlling the boundary layer on its nacelle, and as an alternative to boundary-layer suction a device which is described as a segregation ring is suggested. This, it appears, might raise the efficiency by some 2 or 3 percent.

N-21214*

Aeronautical Research Council (Gt. Brit.)
THE PHYSICAL CHARACTERISTICS OF WIRE RESISTANCE STRAIN GAUGES. Eric Jones and K. R. Maslen. 1952. 44p. diagrs., photos., 4 tabs. (ARC R & M 2661; ARC 12,357. Formerly RAE Instn. 2)

This report deals with the fundamental principles of the wire resistance strain gage. Types of strain gage in common use and their methods of construction are described, and the mechanism whereby strain effects change of resistance is discussed. A subsection is devoted to the behavior of fine wires, in general, under strain. Possible causes of error, including the effects of humidity and temperature, are discussed, and as far as possible methods are given of overcoming these difficulties. The effect of the passage of current on the strain gages is described, and methods of increasing the output are suggested. The final section is devoted to miscellaneous properties of the wire resistance strain gage, on several of which very little information is at present available.

N-21215*

Aeronautical Research Council (Gt. Brit.)
THEORETICAL INVESTIGATIONS OF TERNARY LIFTING SURFACE - CONTROL SURFACE - TRIMMING TAB FLUTTER AND DERIVATION OF A FLUTTER CRITERION. H. Wittmeyer. 1952. 42p. diagrs., 3 tabs. (ARC R &M 2671; ARC 12,043. Formerly RAE Structures 19)

Theoretical investigations have been made of the flutter of an idealized trimming tab system having three degrees of freedom - normal translation of the main lifting surface, rotation of the control surface, and rotation of the tab. All the structural parameters of the system have been varied except the out-of-balance moment of the control surface. The cases in which the system is free from flutter have been particularly investigated. From these investigations, criteria for the avoidance of flutter have been derived. If the structural parameters of the system satisfy these criteria, flutter of the system with these three degrees of freedom should be impossible. The results are applicable to trimming tabs, servotabs with zero follow-up ratio, and generally to all systems in which the tab can be regarded as connected elastically only to the control surface.

N-21217*

Aeronautical Research Council (Gt. Brit.)
FLOW THROUGH A HELICOPTER ROTOR IN VERTICAL DESCENT. P. Brotherhood. 1952. 14p. diagrs., photos. (ARC R & M 2735; ARC 11,837. Formerly RAE Aero 2272)

Flight tests have been made on a Hoverfly I helicopter to investigate the types of flow associated with various rates of vertical descent. At the same time, measurements of the performance were made. The results are analyzed by two different methods to produce characteristic curves for the rotor and are compared with data obtained from wind-tunnel tests on model propellers at negative rates of advance. The information was obtained from the Hoverfly I helicopter but it is thought that the results can be applied to any other helicopter of similar size.

N-21218*

Aeronautical Research Council (Gt. Brit.)
LOW-SPEED WIND-TUNNEL TESTS OF FOWLER FLAPS, SLATS AND NOSE FLAPS ON A MODEL OF A JET AIRCRAFT WITH A 40 DEG SWEPT-BACK WING. A. Spence. 1952. 18p. diagrs., 6 tabs. (ARC R & M 2752; ARC 12, 131. Formerly RAE Aero 2302)

This report presents the results of tests with Fowler flaps on a model of a single-jet aircraft with a 40° sweptback 10-percent-thick wing. Slats and nose flaps were also tested as means of delaying the tip stall. The maximum trimmed lift coefficient without flaps or slats was 1.055 ($R = 2.7 \times 10^{6}$). With half-span Fowler flaps (leaving a gap across the fuselage) and slats over the outer half of the span, this value was increased to 1.64, and there was adequate stability. Tests in which the spanwise extent of the nose flap was varied, indicated that about 50 percent wing semispan per side was the optimum length of slat or nose flap for avoiding instability at the stall.

N-21219*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE INFLUENCE OF ASPECT RATIO ON THE VARIATION WITH MACH NUMBER OF THE LIFT AND HINGE-MOMENT CHARACTERISTICS OF A WING AND FULL-SPAN CONTROL. A. D. Young and P. R. Owen. 1952. 6p. diagr., tab. (ARC R & M 2767; ARC 7046; ARC 7133. Formerly RAE Tech. Note Aero 1250; RAE Tech. Note Aero 1263)

It is shown on the basis of the linearized theory that the effects of compressibility on the lift and hinge-moment characteristics of a wing and full-span control are functions of aspect ratio. With reduction in aspect ratio, the increase of the lift characteristics with Mach number is reduced appreciably. The same effect is noted for the hinge-moment characteristic b_1. The effects on the hinge-moment characteristics b_2 and b_3 are rather more complicated, but in many practical cases the influence of aspect ratio will be very small.

N-21258*

Royal Aircraft Establishment (Gt. Brit.)
THE YOUNG'S MODULUS, POISSON'S RATIO AND RIGIDITY MODULUS OF SOME ALUMINIUM ALLOYS. PART II. N. Dudzinski. November 1952. 28p. photos., 14 tabs. (RAE Met. 69)

Various binary and ternary chill-cast or sintered aluminium alloys were prepared and their elastic properties investigated. It was found that the nitrides of aluminium, chromium, magnesium, iron, vanadium, titanium, and zirconium caused an appreciable increase in Young's modulus. Ternary intermetallic compounds showed a similar effect. The specific Young's modulus value was improved by the additions of chromium or manganese. The rigidity modulus value in torsion was similar to that calculated from E and Poisson's ratio. The effect of composition and the heat of formation of various intermetallic compounds is discussed.

N-21259*

Ministry of Supply (Gt. Brit.)
ALUMINIUM-COPPER-CADMIUM SHEET ALLOYS. H. K. Hardy. May 22, 1952. 25p. diagrs., photos., 13 tabs. (MOS S & TM 9/52; Fulmer Research Institute Ltd.)

Aluminum-copper-cadmium alloys have been rolled to sheet on a semitechnical scale and showed an exceptional capacity for hot work. The aging characteristics have been examined and an uncoated alloy with 5 percent copper-0.15 percent cadmium gave 25 tons/sq in. for the 0.1 percent proof stress and 30 tons/sq in. maximum stress in both the transverse and longitudinal directions. Cold working prior to artificial aging markedly raised the tensile properties of aluminum-copper alloys but had the unique effect of reducing the properties of the aluminum-copper-cadmium alloys. The proof stress can drop by 3 tons/sq in. but the effect can be prevented if the alloy is given a short partial aging ("incubation") treatment at 165° or 170° C before cold working. Aluminum-copper alloys showed a marked susceptibility to stress corrosion resulting from severe intercrystalline corrosion. Aluminum-copper-cadmium alloys were immune from stress corrosion and showed an intracrystalline attack when sprayed with 3 percent sodium chloride solution.

N-21262*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) AN INVESTIGATION INTO THE PITOT RAKE METHOD OF MEASURING TURBO JET ENGINE THRUST IN FLIGHT. J. Stephenson, R. T. Shields and D. W. Bottle. December 23, 1952. 56p. diagrs., 9 tabs. (AAEE/Res/265)

Tests have been made to establish whether a pitot rake could be used as an absolute measure of the thrust of a jet engine on the ground and in flight. The tests were made to investigate errors due to the assumptions inherent in the single pitot method of estimating thrust in flight, and to establish if a rake can be used to calibrate the single pitot of an uncalibrated engine installed in an aircraft. The tests were also planned to check the generally accepted nondimensional thrust relationship for jet engines. The tests were made on Derwent 5 engines installed in Meteor 4 aircraft. The tests covered a wide range of flight conditions and included test bed

measurements on bare engines and later, measurements of exit static pressure. Although the tests could not all be made on the same engine, the same final nozzle was used in all the main tests. The main conclusions were: (1) Static tubes must be incorporated in the pitot rake to give absolute thrust measurements and even so a discrepancy of 2 percent requires further investigation. (2) The single pitot method of estimating flight thrust based on engine test bed calibration was in error by as much as 6 percent due to changes in total pressure sampled by the single pitot and in the magnitude of the exit static pressure between calibration and test conditions. Using the pitot static rake to calibrate the single pitot of an installed engine introduced flight thrust errors no larger and possible smaller. (3) Nondimensional thrusts at 35,000 ft were some 7 percent lower than corresponding thrusts at 5,000 ft. Further tests are required to establish the magnitude of these effects on other engine types.

N-21311*

Aeronautical Research Council (Gt. Brit.)
EFFECT OF THE CONTROL-CIRCUIT ON FLUTTER. (Einfluss der rudersteürung auf das flattern). K. Leiss. June 17, 1948. 50p. diagrs. (ARC 11,583; 0.734. Trans. from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin. FB 1670, October 10, 1942)

As a result of the participation of the controls, the following types of flutter appear: when the control is slack there is flutter of the system with the control organ and the control surface out of phase, but when the control is stiff there is flutter with the two components in phase. The second type of flutter, in particular, has only been treated incompletely, if at all, up to the present; but because of its appearance the advantage of stiffening the control is doubtful. Mass-balancing of the control surface, and - with occasional exceptions - structural damping in the control system, improve the flutter properties, especially when the control organ and the control surface are in phase with each other. The oscillation of the controls is included in the flutter calculations by means of suitable transformations; this is done in such a way that little more computational work is involved than for the case where the oscillation of the control system is neglected.

N-21394 *

National Gas Turbine Establishment (Gt. Brit.)
THE BURNING OF SINGLE DROPS OF FUEL. PART III. COMPARISON OF EXPERIMENTAL AND THEORETICAL BURNING RATES AND DISCUSSION OF THE MECHANISM OF THE COMBUSTION PROCESS. G. A. E. Godsave. August 1952. 47p. diagrs., photos. (NGTE R.88)

A theoretical and experimental investigation has been made of the factors influencing the rate of decrease in size of a single burning drop, as in a burning fuel spray. The experimental technique adopted in this investigation has been to suspend a single drop of fuel on a fine silica filament, and to measure with a cinematograph camera the rate of decrease in size during combustion in still air. A theoretical treatment given in part I indicates that the heat transfer to the drop is the dominant factor determining its life. The coefficient of heat transfer to the drop is itself a function of the mass evaporation rate. The analysis given enables a solution to be obtained for the heat transfer to the drop in the presence of the evaporative flow of the vapor. The experimental results presented in part II have been examined here in part III on the basis of such a heat-transfer relationship, with due allowance for any siginificant radiation effects. A discussion is given of the mechanism of the combustion process during the burning of a fuel spray.

MISCELLANEOUS

NACA TN 2278

Errata No. 1 on "THEORETICAL SYMMETRIC SPAN LOADING DUE TO FLAP DEFLECTION FOR WINGS OF ARBITRARY PLAN FORM AT SUBSONIC SPEEDS." John DeYoung. January 1951.

NACA TN 2770

Errata No. 1 on "STUDY OF THE PRESSURE RISE ACROSS SHOCK WAVES REQUIRED TO SEPARATE LAMINAR AND TURBULENT BOUNDARY LAYERS." Coleman duP. Donaldson and Roy H. Lange. September 1952.

UNPUBLISHED PAPERS

N-19881*

DIRECT-FORCE MEASUREMENTS OF TURBULENT SKIN FRICTION ON CYLINDERS IN AXIAL FLOW AT SUBSONIC AND SUPERSONIC VELOCITIES. Dean R. Chapman and Robert H. Kester. 1953. 20p. diagrs., photos., tab. (To be presented at annual Institute of the Aeronautical Sciences meeting, New York, January 26-29, 1953.)

The principal results of a study of all known theories for calculating turbulent skin friction in compressible flow are briefly reviewed. These various theories predict widely different effects of Mach number on skin friction, and hence also on heat transfer. Systematic experiments were made to determine the magnitude of turbulent skin friction along the cylindrical portion of cone-cylinder bodies of revolution having over-all fineness ratios of 10, 15, and 25. Data were obtained by directly measuring forces. Boundary-layer surveys were made to determine the correction necessary to apply to the force measurements in order to determine the effective starting position of the turbulent flow. Mach numbers between 0.5 and 3.6, and Reynolds numbers between 4 million and 32 million were investigated. At a Mach number of 2.0, data were obtained (by

distorting the flexible-plate walls of the wind tunnel) for three different pressure distributions in order to evaluate the effect of a moderate pressure gradient on turbulent skin friction.

DECLASSIFIED NACA REPORTS

NACA RM E52F06

MECHANISM OF START AND DEVELOPMENT OF AIRCRAFT CRASH FIRES. I. Irving Pinkel, G. Merritt Preston and Gerard J. Pesman. August 28, 1952. ii, 97p. diagrs., photos., 2 tabs. (NACA RM E52F06) (Declassified from Restricted, 2/27/53)

Full-scale aircraft crashes were made to investigate the mechanism of the start and development of aircraft crash fires. The results are discussed herein. This investigation revealed the characteristics of the ignition sources, the manner in which the combustibles spread, the mechanism of the union of the combustibles and ignition sources, and the pertinent factors governing the development of a crash fire as observed in this program.

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CURRENT NACA REPORTS

NACA TN 2792

DIRECT-READING DESIGN CHARTS FOR 24S-T3 ALUMINUM-ALLOY FLAT COMPRESSION PANELS HAVING LONGITUDINAL FORMED HAT-SECTION STIFFENERS AND COMPARISONS WITH PANELS HAVING Z-SECTION STIFFENERS. William A. Hickman and Norris F. Dow. March 1953. 71p. photos., diagrs., 8 tabs. (NACA TN 2792)

Direct-reading design charts are presented for the determination of the stress and proportions of 24S-T3 aluminum-alloy flat compression panels having longitudinal formed hat-section stiffeners, for given values of intensity of loading, skin thickness, and effective length. Hat- and Z-stiffened panels are compared as compression panels and as the covers of box beams.

NACA TN 2889

ESTIMATION OF HYDRODYNAMIC IMPACT LOADS AND PRESSURE DISTRIBUTIONS ON BODIES APPROXIMATING ELLIPTICAL CYLINDERS WITH SPECIAL REFERENCE TO WATER LANDINGS OF HELICOPTERS. Emanuel Schnitzer and Melvin E. Hathaway. April 1953. 31p. diagrs. (NACA TN 2889)

An approximate method for computing water loads and pressure distributions of lightly loaded elliptical cylinders during oblique water impacts is presented. The method, of special interest for the case of water landings of helicopters, makes use of theory developed and checked for landing impacts of V-bottom seaplanes. Comparisons of results computed by this method with limited experimental data obtained during drops of a circular cylinder at 0° trim and 90° flight-path angle show rough agreement. A detailed computational procedure is included as an appendix.

NACA TN 2905

A RAPID METHOD FOR USE IN DESIGN OF TURBINES WITHIN SPECIFIED AERODYNAMIC LIMITS. Richard H. Cavicchi and Robert E. English. April 1953. 72p. diagrs., 2 tabs. (NACA TN 2905)

Basic thermodynamic relations were applied to axial-flow turbine designs for which specified aerodynamic limits were set in order to evolve a rapid method of determining turbine velocity diagrams. The method is presented in both chart and tabular form. Illustrative examples show the manner of selecting the number of turbine stages, the optimum work division between or among the stages, and the proximity of the staging operation to the aerodynamic limits.

NACA TN 2916

EFFECT OF THERMAL PROPERTIES ON LAMINAR-BOUNDARY-LAYER CHARACTERISTICS. E. B. Klunker and F. Edward McLean. March 1953. 29p. diagrs. (NACA TN 2916)

An iteration method is presented for solving the laminar-boundary-layer equations for compressible flow in the absence of a pressure gradient wherein the temperature variation of all the fluid thermal properties is considered. Friction and heat-transfer characteristics have been calculated for a stream temperature of -67° F for Mach numbers from 1 to 10 with the use of values of the heat capacity, conductivity, and viscosity determined from experiment. Consideration of the temperature variation of all the fluid thermal properties causes the recovery factor to decrease substantially with increasing Mach number. Moreover, the heat-transfer rate is found to be proportional to the difference between an effective enthalpy, which is a function of both the surface temperature and stream Mach number, and the surface enthalpy. In contrast, the heat-transfer rate is proportional to the difference between the recovery enthalpy and the surface enthalpy for solutions which employ a constant Prandtl number. The calculated skin friction and heat-transfer rates based upon the use of the Sutherland equation for viscosity and a Prandtl number of 0.75, however, are in excellent agreement with the results of the present analysis.

NACA TN 2919

THE ASYMMETRIC ADJUSTABLE SUPERSONIC NOZZLE FOR WIND-TUNNEL APPLICATION. H. Julian Allen. March 1953. 30p. diagrs., photos., 2 tabs. (NACA TN 2919. Formerly RM A8E17)

An asymmetric adjustable nozzle for supersonic wind-tunnel application which permits continuous adjustment of the test-section Mach number is described. The characteristics of this nozzle are compared with the more conventional supersonic tunnel nozzles.

NACA TN 2920

INTERIM REPORT ON A FATIGUE INVESTIGATION OF A FULL-SCALE TRANSPORT AIRCRAFT WING STRUCTURE. M. James McGuigan, Jr. April 1953. 36p. photos., diagrs., 2 tabs. (NACA TN 2920)

Results are presented of constant-level fatigue tests conducted on several full-scale C-46 "Commando" airplane wings at a level of 1 ± 0.625g or about 22 ± 14 percent of the design ultimate load factor. The average lifetime for the 34 fatigue failures that occurred was about 200,000 cycles. The spread in lifetime for all failures was 4.4 to 1.0, whereas for failures repeatedly occurring at the same location it was as small as 1.2 to 1.0. Effective stress concentration factors were calculated for all failures and indicated a value of about 4.0 for an inspection cutout and 2.3 for a riveted tension joint. During the tests no change was noted in either the natural frequency or damping characteristics of the test specimens prior to the development of a fatigue crack. When a crack did occur, its rate of growth was rather slow until about 5 to 9 percent of the tension material had failed, after which the rate of crack growth increased rapidly.

NACA TN 2921

THE AERODYNAMIC DESIGN AND CALIBRATION OF AN ASYMMETRIC VARIABLE MACH NUMBER NOZZLE WITH A SLIDING BLOCK FOR THE MACH NUMBER RANGE 1.27 TO 2.75. Paige B. Burbank and Robert W. Byrne. April 1953. 37p. photos., diagrs., 5 tabs. (NACA TN 2921. Formerly RM L50L15)

A method of designing as asymmetric, fixed geometry, variable Mach number nozzle has been developed by using the method of characteristics. A small nozzle conforming to the analytically determined ordinates was constructed and calibrated over a range of Mach numbers extending from 1.27 to 2.75. The results show the variation in Mach number to be ±0.02 or less and in the flow direction to be ±0.2° within the test section. The range of Mach numbers from 1.27 to 2.75 was obtained by translating the lower block in a straight line parallel to the test-section center line for a distance of 2.17 test-section heights.

NACA TN 2922

THE DESIGN OF VARIABLE MACH NUMBER ASYMMETRIC SUPERSONIC NOZZLES BY TWO PROCEDURES EMPLOYING INCLINED AND CURVED SONIC LINES. Clarence A. Syvertson and Raymond C. Savin. March 1953. 35p. diagrs., tab. (NACA TN 2922)

Two procedures are developed for designing asymmetric supersonic nozzles for which the calculated exit flow is essentially uniform over a range of Mach numbers. One procedure is applicable at Mach numbers below approximately 3; the other procedure is used for designs at Mach numbers exceeding 3.

NACA RM E53B17

ANALYSIS OF HEAT TRANSFER AND FLUID FRICTION FOR FULLY DEVELOPED TURBULENT FLOW OF SUPERCRITICAL WATER WITH VARIABLE FLUID PROPERTIES IN A SMOOTH TUBE. Robert G. Deissler and Maynard F. Taylor. April 1953. 29p. diagrs. (NACA RM E53B17)

A previous analysis of turbulent flow and heat transfer for air with variable properties flowing in smooth tubes is generalized in order to make it applicable to supercritical water. The generalization is necessary because all the pertinent properties of supercritical water vary markedly with temperature. Calculated velocity and temperature distributions, as well as relations among Nusselt number, Reynolds number, and friction factor, are presented. The effect of variation of fluid properties across the tube on the Nusselt number and friction factor correlations can be eliminated by evaluating the properties at a reference temperature which is a function of both the wall temperature and the ratio of wall-to-bulk temperatures.

NACA RM L53A09

LANGLEY FULL-SCALE-TUNNEL TESTS OF THE CUSTER CHANNEL WING AIRPLANE. Jerome Pasamanick. April 1953. 57p. diagrs., photos., tab. (NACA RM L53A09)

An investigation has been made in the Langley full-scale tunnel to determine the lift characteristics and some of the stability and control characteristics of an experimental Custer Channel Wing airplane at zero airspeed and over the low airspeed range. Comparison is made of the airplane static lift characteristics as obtained in the absence of and in the presence of a ground effect with and without the horizontal tail surfaces. An evaluation of the flow field about the channel-propeller combination is included.

BRITISH REPORTS

N-11516A*

Aeronautical Research Council (Gt. Brit.)
LIST OF CURRENT PAPERS. (NOS. 51-100)
August 1952. 5p. (ARC CP 100)

This report presents a list of CP's (Nos. 51-100) published by the Aeronautical Research Council.

N-21551*

Aeronautical Research Council (Gt. Brit.)
THE NATURAL FREQUENCIES OF VIBRATION OF PRISMATIC BLADES WITH PARTICULAR REFERENCE TO A 12-STAGE TURBINE. R. Chaplin. 1952. 25p. diagrs., 3 tabs. (ARC CP 95)

The natural frequencies of vibration of the blading of a 12 stage, 3000 rpm turbine have been measured and compared with the values obtained by calculation. In the calculations for the flexural modes, corrections have been introduced for shear and rotary inertia. An empirical correction is used for the influence of the increase in torsional stiffness, due to the platform, on the frequencies of torsional vibration. The agreement of measured and computed frequencies is sufficient for the purpose of computing critical speeds up to a frequency of five kilocycles per second above which limit the discrepancy increases with the order of the mode.

N-21552*

Aeronautical Research Council (Gt. Brit.)
GRAPHICAL SOLUTION OF MULTHOPP'S EQUATIONS FOR THE LIFT DISTRIBUTION OF WINGS. F. Vandrey. 1952. 8p. diagrs. (ARC CP 96)

A simple graphical method is described facilitating the determination of the lift distribution of wings. The basis is Multhopp's method of replacing approximately the integro-differential equation for the circulation by a finite system of linear equations which give the values of the circulation at certain fixed points along the span. The values of the unknown circulations are represented by scales in a set of diagrams for the equations. The multiplication of the approximate values of the unknowns and the constant coefficients of the equations is effected by auxiliary scales in the diagrams. The corrections of the approximate values are transferred from the auxiliary scales to the main scales by a pair of dividers. The lift distribution of a rectangular wing is determined as a practical example.

N-21553*

Aeronautical Research Council (Gt. Brit.)
FLUID DYNAMIC NOTATION IN CURRENT USE AT N.G.T.E. S. Gray. 1952. 26p. diagrs. (ARC CP 97)

This memorandum records and defines the current system of notation which is in general use, at the National Gas Turbine Establishment, for work on axial flow compressors and cascade investigations in general, and which is being applied to some extent to the work on turbines. Heat transfer and supersonic flow aspects and other specialized treatments are excluded. Detailed definitions and explanations are given in classified lists, illustrated by figures, and alphabetical and numerical lists of the symbols, suffixes and indices are included.

N-21554*

Aeronautical Research Council (Gt. Brit.)
SWEPT-WING LOADING. A CRITICAL COMPARISON OF FOUR SUBSONIC VORTEX SHEET THEORIES. H. C. Garner. FOREWORD. L. W. Bryant. 1952. 61p. diagrs., 17 tabs. (ARC CP 102)

From a systematic series of calculations of swept-wing loading the writer has formed an opinion of the accuracy and most useful application of vortex lattice theory and the vortex sheet theories of Weissinger, Multhopp and Küchemann. The results provide a general picture of the effect of sweep and compressibility on lift slope and aerodynamic center.

N-21555*

Aeronautical Research Council (Gt. Brit.)
SOME EFFECTS OF REYNOLDS NUMBER ON A CAMBERED WING AT HIGH SUBSONIC MACH NUMBERS. H. E. Gamble. 1952. 34p. photos., diagrs., 2 tabs. (ARC CP 103)

An untapered, sweptback wing of aspect ratio 4, sweepback 25° and section 12-percent thick (RAE 104 with 1-percent camber, a = 0.6) was tested in the RAE high-speed tunnel. The pressure distribution was measured at the midsemispan section at various Mach numbers up to 0.88 at Reynolds numbers of 0.8, 1.8 and 3.5×10^{6}. There are considerable differences in the shapes of the pressure distributions at the three Reynolds numbers, although the boundary layer was laminar back to about 70-percent of the chord in all cases. At the highest Reynolds number, the suctions on the upper surface at high Mach numbers increase from the leading-edge of the wing right up to about 50 percent or 60 percent of the chord, while at the lowest Reynolds number they remain almost constant from about 30 percent to about 60 percent of the chord. This flat-topped pressure distribution, which is associated with a λ-type shock wave, results in lower lift coefficients and higher pitching-moment coefficients than those obtained at higher Reynolds number. Brief experiments, with transition provoked near the leading edge, indicate that the shape of the pressure distribution at $R = 0.8 \times 10^{6}$ is then something similar to that obtained at $R = 3.5 \times 10^{6}$ with transition free and at about 65 percent chord. It appears however, that inducing early transition artificially at higher Reynolds numbers can seriously alter the pressure distribution at high speed by causing a forward movement of the shock wave and a separation aft of it.

N-21556*

Aeronautical Research Council (Gt. Brit.)
A FROST POINT HYGROMETER FOR SUPERSONIC WIND TUNNELS. D. Beastall and A. Winyard. 1953. 8p. diagrs. (ARC CP 106)

This note describes a frost point hygrometer suitable for measuring the water vapor content of the air in supersonic wind tunnels at any stagnation pressure

within their present range of operation. It uses CO_2 as a coolant and is economical in construction and operation.

N-21557 *

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF ENDPLATES ON SWEPT WINGS. D. Küchemann and D. J. Kettle. 1952. 23p. diagrs. (ARC CP 104)

Existing methods of calculating the effect of endplates on straight wings are modified so as to apply to swept wings. The changes in over-all lift and drag, and also the spanwise distribution of the additional load, can be calculated. The theoretical results are compared with experimental results obtained on swept wings, including new measurements of lift, drag and pitching moment, made on an untapered 45° sweptback wing of aspect ratio 3 at low speed. The method of calculation is also extended to cover the effect of the tip vortex which is formed on wings without endplates.

N-21558 *

Aeronautical Research Council (Gt. Brit.)
THE DESIGN OF JETTISONABLE COCKPIT HOODS. I. L. Keiller. 1952. 34p. photos., diagrs. (ARC CP 105)

In the past much trouble has been experienced in the design of jettisonable cockpit hoods and even after a considerable amount of development many hoods are not really satisfactory. In order that a successful hood jettisoning mechanism can be produced it is essential that the various problems involved should be realized at the design stage. Consideration is given in this paper to the jettisoning problems involved in the design of all types of hoods and cockpit covers. Certain basic design criteria are proposed and the various methods of meeting them are discussed. Recommendations on good design practice are given where possible. With the knowledge that is at present available the design of a satisfactory orthodox hood should present no great problems, but the more advanced designs are likely to cause some difficulty.

N-21559 *

Aeronautical Research Council (Gt. Brit.)
SOME INVESTIGATIONS INTO THE DESIGN OF WIND TUNNELS WITH GAS TURBINE JET ENGINE DRIVES. H. J. Higgs. 1953. 84p. diagrs. (ARC CP 107)

The basic design of wind tunnels suitable for jet engine drives has been investigated by matching the predicted mass flows and total pressure losses of typical tunnel configurations with the estimated mass flow and total pressure rise characteristics of possible pumping systems. There are three possibilities of jet engine pumping (1) induction pumping (2) suction pumping and (3) parallel suction and induction pumping, of which induction pumping is shown to be the most favorable. Using this system a typical 5,000 lb thrust jet engine (such as a R. R. Nene II) can drive (1) a high speed subsonic tunnel of 4 ft^2 working section up to M = 1.0, (2) a supersonic tunnel of 2 ft^2 working section up to M = 1.2, (3) a supersonic tunnel of 1 ft^2 working section up to M = 1.8. For these three cases it has been assumed that humidity effects can be controlled by partial recirculation of the hot engine exhaust gases to raise the working section temperature of 60° C. In the supersonic case 60° might not be sufficient and other methods of humidity control have been discussed in relation to jet engine drives. Induction pumping readily allows multiple engine drive, that is, the above working section areas can be increased in proportion to the number of engines used.

N-21585*

Aeronautical Research Council (Gt. Brit.)
ON THE FLOW PAST A FLAT PLATE WITH UNIFORM SUCTION. B. Thwaites. 1952. 11p. diagrs., tab. (ARC R & M 2481. Formerly ARC 9391; FM 887; Perf. 113)

A new method of performing boundary-layer calculations is introduced in this paper, and is applied to the problem of finding the characteristics of uniform flow past a flat plate through which there is a constant normal velocity. An exact solution to this problem has not yet been found and it is therefore difficult to assess the accuracy of the results obtained. The results, however, are compared with those of two other methods. The new method will be applied to other problems. When the momentum eauation is being used, one obvious advantage of the method is that, in "adding" velocity profiles, the momentum thickness of each may be added to give the momentum thickness of the whole. This is not so in the usual methods of boundary-layer calculations, and great simplification is thereby obtained.

N-21586*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE MAINTENANCE OF LAMINAR-FLOW WINGS. W. E. Gray and H. Davies. 1952. 3p. (ARC R & M 2485; ARC 10,518. Formerly RAE Tech. Note Aero 1862)

The maintenance of laminar-flow wings involves: (1) the prevention of deterioration in the surface itself (for example, cracking of the paint or filler, increase in roughness or waviness, etc., whether due to weathering, stresses in flight, or accidental damage) and (2) the prevention of contamination of the surface with flies, etc. This report gives an account of experience gained at the Royal Aircraft Establishment in dealing with these problems during flight tests on the characteristics of low-drag wings.

N-21587*

Aeronautical Research Council (Gt. Brit.)
A SERIES OF LOW-DRAG AEROFOILS EMBODYING A NEW CAMBER-LINE. Ola Douglas. 1952. 19p. diagrs., tabs. (ARC R & M 2494; ARC 10,620)

A series of low-drag airfoils is displayed in this paper, which introduces a new stock type of camber line. This camber line affords several advantages: in particular, it makes it possible for any one of the parameters C_L range, ρ_L, $C_{L_{opt}}/C_{m0}$ and M_{crit} to take values appreciably higher than can be obtained by previous methods, the remaining parameters being fixed. The method of design follows that of R & M 2166 and the greater part of the work involves standardized computational processes. The design of one of the series is described in detail, and one is also compared, favorably, with a corresponding roof-top airfoil. A method is given of obtaining easily an approximate value for the lower limit of the C_L range when the upper limit is known.

N-21588*

Aeronautical Research Council (Gt. Brit.)
INVESTIGATIONS INTO THE EFFECT OF CONTINUOUS SUCTION ON LAMINAR BOUNDARY-LAYER FLOW UNDER ADVERSE PRESSURE GRADIENTS. B. Thwaites. 1952. 23p. diagrs., tab. (ARC R & M 2514. Formerly ARC 9555; FM 912)

The principal problem considered in this paper is that of the flow along a surface through which fluid is being continuously withdrawn at a constant velocity, the velocity of the stream outside the boundary layer having a constant and negative gradient. When no suction is applied Howarth has solved the flow, and the point of separation is known. With continuous suction, the ordinary methods of using the momentum equation, for example Pohlhausen's method, breakdown, and a new method is used in this paper to find the point of separation when suction of constant velocity is applied. Only partial success may be recorded in this problem, but this account of progress so far is now given in the hope that the problem may attract other workers. The new method of boundary-layer calculation used is not fully described in this paper, and will be explained with examples of its use, in a later paper. It has already been used in R & M 2481, where a particular problem was treated with great ease. The momentum equation of boundary-layer flow is also used to deduce other types of flow in which the velocity of suction or the velocity outside the boundary layer is not constant. These examples are inserted by virtue of the simplifications of method involved, by which the momentum equation may be integrated exactly; one of them is particularly applicable to the velocity distribution near the leading edge of a thin airfoil at high lift coefficient, in which a small amount of suction is sufficient to prevent the stall. There are appended some considerations of the practical applications of the continuous suction principle, and also some figures showing the quantities of fluid required to be sucked in, given for the benefit of designers who may not realize how small are the quantities of fluid sucked when separation of flow is suitably prevented. The application of continuous suction to delay the stall is stressed.

N-21589 *

Aeronautical Research Council (Gt. Brit.)
AEROFOIL THEORY OF A FLAT DELTA WING AT SUPERSONIC SPEEDS. A. Robinson. 1952. 21p. diagrs. (ARC R & M 2548; ARC 10,222. Formerly RAE Aero 2151)

Lift, drag, and pressure distribution of a triangular flat plate moving at a small incidence at supersonic speeds are given for arbitrary Mach number and aspect ratio. The values obtained for lift and drag are compared with the corresponding values obtained by strip theory. The possibility of further applications of the analysis leading up to the above results is indicated.

N-21590*

Aeronautical Research Council (Gt. Brit.)
AN EXPERIMENTAL INVESTIGATION ON THE FLUTTER CHARACTERISTICS OF A MODEL FLYING WING. N. C. Lambourne. 1952. diagrs., photos., 6 tabs. (ARC R & M 2626. Formerly ARC 10,509; 0.655)

This report describes some preliminary experimental work that has been carried out in an attempt to gain information on the flexural-torsional flutter characteristics of flying wing types of aircraft. Tests were made with two flexible tip-to-tip models: (a) rectangular plan form and (b) cranked and tapered plan form. The method of supporting the models in the wind tunnel allowed certain bodily freedoms to be present either singly or simultaneously, and measurements were made of critical speeds and frequencies, and in a few cases the flutter motion was analyzed by means of cinematograph records. The experimental results are in no way conclusive and cannot be directly applied to full-scale problems, but they do point to some of the difficulties in the treatment of the flutter of flying wings. Further the difficulties encountered during the flutter tests themselves lead to suggested modifications in the technique of providing a model in a wind tunnel with the bodily freedoms appropriate to free flight conditions.

N-21591*

Aeronautical Research Council (Gt. Brit.)
A CRITERION FOR THE PREVENTION OF SPRING-TAB FLUTTER. A. R. Collar and G. D. Sharpe. 1952. 19p. diagrs., 3 tabs. (ARC R & M 2637; ARC 9104; ARC 9956. Formerly RAE SME 3346; SME 3378)

The present paper advances a formula which can be used as a criterion for the degree of mass balance

necessary for the avoidance of spring-tab flutter. The formula shows that if the tab is of sufficiently light construction, mass balance may not be required at all; on the other hand, the usual static balance may be inadequate for a tab of high inertia. The criterion comprehends within itself the requirement (given elsewhere) limiting the length of a mass balance arm. While the formula is based on theoretical considerations, the numerical values for the quantities to be used have been deduced from flight experience, which shows excellent correlation with the theory. Two forms for the criterion are given: a simple form suitable for general application, and a slightly elaborated form intended for application to unusually large tabs. The appendix, besides containing the main analysis, also gives consideration to certain factors which for simplicity are omitted in the main text. In particular it is shown that the "limiting length" for a balance arm may be generalized to a "limiting circle" for the position of the balance mass: the circle can often be found from simple geometrical considerations.

N-21592*

Aeronautical Research Council (Gt. Brit.)
PERFORMANCE CALCULATIONS FOR A DOUBLE-COMPOUND TURBO-JET ENGINE OF 12:1 DESIGN COMPRESSOR PRESSURE RATIO. D. H. Mallinson and W. G. E. Lewis. 1952. 29p. diagrs. (ARC R & M 2645; ARC 11,355. Formerly NGTE R. 19)

This report describes a theoretical investigation using conventional component characteristics to discover that division of work between the low and high-pressure compressors of a double-compound simple-jet gas turbine of 12:1 design pressure ratio which is likely to result in the most desirable equilibrium operation over the normal engine speed range. Having decided in favor of a pressure ratio of 3:1 in the low-pressure compressor and 4:1 in the other, a study is then made using more realistic compressor characteristics to determine the probable performance of such an engine under all flight conditions when the design maximum temperature is 900° C (1173° K). The equilibrium running conditions of the engine are investigated with special reference to the problems introduced by the double-compound type of design.

N-21593*

Aeronautical Research Council (Gt. Brit.)
COMPRESSION TESTS ON DURAL-CELLUBOARD SANDWICH PANELS. K. H. V. Britten. 1952. 18p. diagrs., photos., 5 tabs. (ARC R & M 2658; ARC 10,427. Formerly RAE Tech. Note SME 383)

Results are given of compression tests made on 56 dural-Celluboard sandwich panels with birch spruce or whitewood centers. These are compared with results from similar tests on dural-balsa sandwich and all-metal panels, and it is seen that over a range of sizes and weights considered dural-Celluboard can be equally or more efficient for carrying end loads. The birch Celluboard was more efficient than the spruce or whitewood and the thicker sandwiches, and those with thicker skins were more efficient than the thinner specimens. The maximum stress reached in the skin, 48,000 lb/sq in., was equal to the 0.1 percent tensile proof stress of the material. The birch filling had also reached its maximum compression stress, 8,000 lb/sq in. The design had therefore exploited these materials to their fullest extent.

N-21594*

Aeronautical Research Council (Gt. Brit.)
EXPERIMENTS GIVING HINGE MOMENT AND LIFT ON A NACA 0015 AEROFOIL FITTED WITH A 40 PER CENT CONTROL, WITH ESPECIAL REFERENCE TO EFFECT OF CURVATURE OF CONTROL SURFACE. A. S. Batson, J. H. Preston and J. H. Warsap. 1952. 27p. diagrs., photos., 6 tabs. (ARC R & M 2698. Formerly ARC 6666; S & C 1525)

The work described in this report may be considered a continuation of that given in part I of R & M 2008. It may be divided into two parts. The first part consists of experiments giving hinge moment and lift data on an unmodified control forming part of an NACA 0015 airfoil. For the second part similar experiments were undertaken as part of a general research into the effect on the properties of controls of curvature of control surface.

N-21595*

Aeronautical Research Council (Gt. Brit.)
TORSIONAL VIBRATION IN AIRCRAFT POWER PLANTS: METHODS OF CALCULATION. PART I. INTRODUCTION AND GENERAL COMMENTS. PART II. PRACTICAL TREATMENT OF THE GENERAL PROBLEM. PART III. PRACTICAL CALCULATIONS FOR A TYPICAL 12-CYLINDER VEE ENGINE. B. C. Carter. 1952. 63p. diagrs., tabs. (ARC R & M 2739; ARC 3519. Formerly RAE E.3586)

The object of this report is to assist designers of aircraft power plants in avoiding harmful torisonal vibration of the crankshaft-airscrew system.

N-21596*

Aeronautical Research Council (Gt. Brit.)
DESIGN AND CALIBRATION TESTS OF A 5.5 IN. SQUARE SUPERSONIC WIND TUNNEL. J. Lukasiewicz. 1952. 36p.photos., diagrs., 4 tabs. (ARC R & M 2745; ARC 13,425. Formerly RAE Tech. Note Aero 2033, sup. 100)

The main design features of the wind tunnel are described and results are given of the investigations carried out to determine: (a) the minimum pressure ratio required to operate the wind tunnel at Mach numbers up to 3.5, and (b) the uniformity of the velocity distribution in the working section at Mach numbers of 1.57, 1.88, 2.48, 2.85, 3.25 and 3.5. It was found that the tunnel pressure recovery can

be appreciably increased by means of a contraction ("second throat") located between the working section and subsonic diffuser. All nozzles tested were designed with short throats and expansion profiles with the maximum angles of expansion for the given exit Mach number. The axial variation of Mach number over selected intervals of working section (not smaller than 5 in.) was found to be of the order of ±1.0 percent. It was found that condensation in the wind-tunnel nozzle (run with atmospheric air) has a detrimental effect on the velocity distribution in the working section, particularly at small Mach numbers.

N-21597*

Aeronautical Research Council (Gt. Brit.)
INVESTIGATIONS ON STALLING BEHAVIOUR, RUDDER OSCILLATIONS, TAKE-OFF SWING AND FLOW ROUND NACELLES ON THE TUDOR I AIRCRAFT. D. J. Lyons. 1952. 18p. diagrs., 2 tabs. (ARC R & M 2789; ARC 11,412. Formerly RAE Aero 2237)

During the development of the Tudor I aircraft, the Royal Aircraft Establishment cooperated in the flight tests. This report summarizes the results, which are felt to be of general interest. The importance of "deep tufting" in leading to an understanding of varied aerodynamic problems has again been forcibly demonstrated; namely in showing that: (a) early buffeting of the Tudor as the stall is approached was due to a very small airleak around the leading edge of the wing root causing a breakaway of flow, the resultant wake of which hit the tailplane; (b) early wing-tip stalling was shown to be due to small malfitment of the T.K.S. de-ciers; (c) rudder "kicking" arose from flow through the hinge cutouts; (d) excessive take-off swing was due to poor rudder control as a result of the early rudder stall, and to the fact that the aircraft was stalled in the ground attitude; and (e) the inner nacelle needed considerable lengthening.

N-21598*

Aeronautical Research Council (Gt. Brit.)
WIND-TUNNEL MEASUREMENTS OF YAWING MOMENT DUE TO YAWING (n_r) ON A 1/5.5 SCALE MODEL OF THE METEOR MARK F.III. J. G. Ross and R. C. Lock. 1952. 31p. diagrs., photos., 10 tabs. (ARC R & M 2791; ARC 10,786. Formerly RAE Aero 2199)

During recent investigations into the self-excited oscillations in yaw, experienced on Meteor aircraft, the lateral stability derivative n_r was measured in flight, and found to differ considerably during initial experiments from the theoretical estimate. A new technique was therefore devised to measure n_r in the wind-tunnel; and, with its aid, modifications were tested on a model with the object of reducing the self-excited oscillations in flight. Measurements of n_r were made over a range of Reynolds numbers, and for different periods of oscillation of the model. The final comparison of the flight and wind-tunnel tests, after certain refinements in technique of the former, and after corrections for solid friction to the latter had been made, showed that the full-scale measurement of n_r was about 10 percent less than that obtained in the tunnel. Considering the difficulties involved, this agreement may be considered as satisfactory. For the model in the standard condition, the value of n_r was about 20 percent less than the estimated figure of -0.108 at zero lift, but with dorsal fins. It was found possible, without altering the value of n_v, to increase the value of n_r to the estimated value. The "snaking" tendencies of the model, which were more pronounced at small angles of incidence, could be greatly reduced by fitting an upper dorsal fin.

MISCELLANEOUS

NACA TN 2505

Addendum No. 1 to "ON THE ATTACHED CURVED SHOCK IN FRONT OF A SHARP-NOSED AXIALLY SYMMETRICAL BODY PLACED IN A UNIFORM STREAM." S. F. Shen and C. C. Lin. October 1951.

National Advisory Committee for Aeronautics

Research Abstracts

NO.42 APRIL 30, 1953

CURRENT NACA REPORTS

NACA Rept. 1085

DISCUSSION OF BOUNDARY-LAYER CHARACTERISTICS NEAR THE WALL OF AN AXIAL-FLOW COMPRESSOR. Artur Mager, John J. Mahoney and Ray E. Budinger. 1952. ii, 20p. diagrs., photo., tab. (NACA Rept. 1085. Formerly RM E51H07)

Boundary-layer velocity profiles on the casing of an axial-flow compressor behind the guide vanes and rotor were measured and resolved into two components: along the streamline of the flow and perpendicular to it. Boundary-layer thickness and the deflection of the boundary layer at the wall were the generalizing parameters. By use of these results and the momentum-integral equations, the characteristics of boundary layer on the walls of axial-flow compressor are qualitatively discussed. Important parameters concerning secondary flow in the boundary layer appear to be turning of the flow and the product of boundary-layer thickness and streamline curvature outside the boundary layer. Two types of separation are shown to be possible in three dimensional boundary layer.

NACA Rept. 1088

THEORETICAL DAMPING IN ROLL AND ROLLING MOMENT DUE TO DIFFERENTIAL WING INCIDENCE FOR SLENDER CRUCIFORM WINGS AND WING-BODY COMBINATIONS. Gaynor J. Adams and Duane W. Dugan. 1952. ii, 11p. diagrs. (NACA Rept. 1088. Extends analysis of TN 2270)

A method of analysis based on slender-wing theory is developed to investigate the characteristics in roll of slender cruciform wings and wing-body combinations. The method makes use of the conformal mapping processes of classical hydrodynamics which transform the region outside a circle and the region outside an arbitrary arrangement of line segments intersecting at the origin. The method of analysis may be utilized to solve other slender cruciform wing-body problems involving arbitrarily assigned boundary conditions.

NACA TN 2923

STUDY OF MOTION OF MODEL OF PERSONAL-OWNER OR LIAISON AIRPLANE THROUGH THE STALL AND INTO THE INCIPIENT SPIN BY MEANS OF A FREE-FLIGHT TESTING TECHNIQUE. Ralph W. Stone, Jr., William G. Garner and Lawrence J. Gale. April 1953. 28p. diagrs., photos., tab. (NACA TN 2923)

This paper presents the motion of a dynamic model through the stall and into the incipient spin. The results indicate that, after the initial stall, the model became unstalled, inverted, and assumed very low angles of attack before restalling and entering the incipient spin. Altitude loss and angular velocities were relatively small during the early part of the motion and indicated that this time would be the optimum time to terminate the motion by control movement.

NACA TN 2925

LIFT DEVELOPED ON UNRESTRAINED RECTANGULAR WINGS ENTERING GUSTS AT SUBSONIC AND SUPERSONIC SPEEDS. Harvard Lomax. April 1953. 44p. diagrs., 2 tabs. (NACA TN 2925)

Lift forces induced by a vertical gust are estimated on the basis of theoretical calculations. The effects of pitching and wing bending are neglected and only wings of rectangular plan form are considered. However, the effects of Mach number (from 0 to 2) and aspect ratio (2 to ∞) are included, and solutions are given by means of which the response to gusts having arbitrary streamwise gradients can be calculated. Results are presented for sharp-edged and triangular gusts and various wing-air density ratios.

NACA TN 2931

A METHOD FOR DETERMINING CLOUD-DROPLET IMPINGEMENT ON SWEPT WINGS. Robert G. Dorsch and Rinaldo J. Brun. April 1953. 29p. diagrs. (NACA TN 2931)

The general effect of wing sweep on cloud-droplet trajectories about swept wings of high aspect ratio moving at subsonic speeds is discussed. A method of computing droplet trajectories about yawed cylinders and swept wings is presented, and illustrative droplet trajectories are computed. A method of extending two-dimensional calculations of droplet impingement on nonswept wings to swept wings is presented. It is shown that the extent of impinge-

ment of cloud droplets on an airfoil surface, the total rate of collection of water, and the local rate of impingement per unit area of airfoil surface can be found for a swept wing from two-dimensional data for a nonswept wing. The impingement on a swept wing is obtained from impingement data for a nonswept airfoil section which is the same as the section in the normal plane of the swept wing by calculating all dimensionless parameters with respect to flow conditions in the normal plane of the swept wing.

NACA RM E52L23a

FREE FALL AND EVAPORATION OF n-OCTANE DROPLETS IN THE ATMOSPHERE AS APPLIED TO THE JETTISONING OF AVIATION GASOLINE AT ALTITUDE. Herman H. Lowell. April 1953. 25p. diagrs. (NACA RM E52L23a)

In connection with proposed rapid jettisoning of aviation gasoline at altitude, a theoretical study was made of the free fall and evaporation of n-octane droplets in the atmosphere; n-octane was selected for study because of the expected similarity of overall evaporation behavior of n-octane and gasoline. It was concluded that gasoline (or n-octane) droplets larger than 2000 microns in diameter would be unstable; terminal speeds and Reynolds numbers were obtained for droplets not larger than 2000 microns at altitudes to 11,000 feet. The motion data were used in the calculation of n-octane evaporation rates under various conditions. It was found that a droplet having an original diameter of 2000 microns would fall about 4000 feet from 6000 feet under NACA standard atmosphere conditions before coming virtually to rest. Finally, it was concluded that temperature effects are of paramount importance; at highest air temperatures a 1000-foot ground clearance would probably be adequate to prevent ground contamination, whereas at lowest air temperatures only an atomizing spray arrangement would prevent ground contamination, irrespective of ground clearance.

BRITISH REPORTS

N-21216*

Aeronautical Research Council (Gt. Brit.)
ABSTRACTS OF PAPERS PUBLISHED EXTERNALLY. February 1951. 15p. (ARC R & M 2722)

This report contains abstracts of a group of reports recommended for external publication by the Aeronautical Research Council. These reports cover a variety of subjects relating to aeronautics.

N-21712*

Royal Aircraft Establishment (Gt. Brit.)
INTERNAL FRICTION AND GRAIN BOUNDARY VISCOSITY OF SILVER AND OF BINARY SILVER SOLID SOLUTIONS. S. Pearson. January 1953. 22p. diagrs., 4 tabs. (RAE Met. 71)

Measurements have been made of the variation of internal friction with temperature for spectroscopically pure silver and for a series of solid solutions of silver with cadmium, indium, and tin, using a Kê type torsion pendulum apparatus. Some experiments have also been made to investigate the effect of nonmetallic impurity on grain boundary relaxation in silver. The effect of the alloying elements is to increase the grain boundary viscosity and to raise the activation energy for grain boundary relaxation from 22,000 cal/mole for pure silver to 43,000 cal/mole for the solid solutions, the same value being obtained, within the limits of experimental error, for all the alloying elements and for all the solute concentrations investigated. The results of the experiments show exactly the same trend as those obtained previously for a similar series of copper solid solutions. They are in agreement with the general theory of grain boundary relaxation developed by Zener and Kê but do not seem to be in agreement with either of the mechanisms so far put forward to explain grain boundary slip.

N-21717*

Royal Aircraft Establishment (Gt. Brit.)
CURVES FOR ESTIMATING THE WAVE DRAG OF SOME BODIES OF REVOLUTION, BASED ON EXACT AND APPROXIMATE THEORIES. L. E. Fraenkel. August 1952. 15p. diagrs. (RAE Tech. Note Aero 2184)

Curves are presented for estimating the wave drag, at zero incidence, of forebodies and afterbodies having straight and parabolic profiles. The afterbodies are assumed to lie behind an infinitely long cylindrical body. The curves are based on a limited number of exact and second-order solutions which have been generalized by appealing to the supersonic-hypersonic similarity law and to slender body and quasi-cylinder solutions.

N-21719*

Royal Aircraft Establishment (Gt. Brit.)
ON THE GEOMETRICAL CHANGES THAT OCCUR WHEN WINGS ARE ROTATED ABOUT AXES THAT ARE NEARLY NORMAL TO THE WINGS. C. H. E. Warren. November 1952. 10p. diagrs. (RAE Tech. Note Aero 2212)

This note merely presents the geometrical relationships that occur when the wings of an aircraft are rotated about axes that are nearly normal to the planes of the wings. Only elementary, but somewhat cumbersome, trigonometry is involved, but the relationships do depend upon precise definitions of the angles of sweepback and dihedral.

N-21743*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE WAKES BEHIND BODIES MOVING AT HIGH MACH NUMBER. D. W. Holder. March 8, 1952. 11p. photos., diagrs., tab. (ARC 14, 720; FM 1693)

Schlieren photographs are presented to provide examples of apparently periodic, or otherwise unusual, flow in the wakes of bodies moving at high Mach number.

UNPUBLISHED PAPERS

N-22547 *

FUSELAGE SHOCK ABSORBERS. (Amortizatory shassi). 13p. diagrs. (Trans. from Construction of Airplanes, by M. N. Shulzhenko, 1949, p. 403-410).

This report describes the principles of operation and construction of liquid-air shock absorbers.

N-22618 *

THE HYDRODYNAMIC THEORY OF HEAT EXCHANGE AND ITS APPLICATION TO THE EXTERNAL PROBLEM OF THE BOUNDARY LAYER. (O svyazi obobshchennykh integral'nykh sootnoshenii s gidrodinamicheskoi teoriei teploobmena i o ee prilozhenii k raschetu teploobmena v usloviyakh vneshnei zadachi). L. I. Kudryashev. 11p. (Trans. from Akademiia Nauk SSSR, Izvestiia, Otdelenie Tekhnicheskikh Nauk, no. 11, 1951, p.1682-1688).

A connection is established between the generalized integral relations for the hydrodynamic and thermal boundary layers, both laminar and turbulent, and the hydrodynamic theory of heat exchange. The application to the computation of the heat exchange permits solving the problem of the computation of the heat-transfer coefficient in the case of the flow about a flat plate for any law of distribution of the velocities and temperatures in the boundary layer.

N-22619*

THE OXIDIZING NITRATION OF NITROSO COMPOUNDS AND ARYLHYDROXYLAMINES. (Okislitel'nole nitrovanie aromaticheskikh nitrozosoedinenii i arilgidroksilaminov). A. I. Titov and N. G. Laptev. EXPERIMENTAL PROCEDURE, by A. I. Titov, N. G. Laptev and A. N. Baryshnikova. 11p. (Trans. from Zhurnal Obshchei Khimii, v. 18, pt. 1, 1948, p. 741-748).

It is shown that the aromatic nitroso compounds and arylhydroxylamines under the action of nitric acid containing nitrogen oxides may undergo very different transformations leading to the formation of a mixture of the corresponding nitro compounds, diazo compounds, p-dinitroso compounds, p-nitrosodiarylhydroxylamines, oxalic acid, and nitrophenols containing hydroxyl in the para position relative to the place previously occupied by the nitroso group. Mechanisms for these reactions are proposed. Detailed procedure is given for performing the nitration.

N-22620*

ON THE MECHANISM OF THE NITRATION OF AROMATIC COMPOUNDS BY A SULFURO-NITRIC ACID MIXTURE AND OTHER ENERGETICALLY NITRATING MEANS. (O mekhanizme nitrovaniya aromaticheskikh soedinenii sernoazotnoi smes'yu i drugimi energichno nitruyushchimi sredstvani). A. I. Titov. 13p. (Trans. from Zhurnal Obshchei Khimii, v. 18, pt. 1, 1948, p. 733-740).

The nitration by nitric acid of benzene and other aromatics possessing a nuclear affinity equal to or less than that of benzene, occurs principally through an intermediate interaction with various forms of nitrogen dioxide only at low concentrations of the acid. The authors attempt to explain this phenomenon.

National Advisory Committee for Aeronautics

Research Abstracts

NO.43 MAY 22, 1953

CURRENT NACA REPORTS

NACA Rept. 1075

HYDRODYNAMIC IMPACT OF A SYSTEM WITH A SINGLE ELASTIC MODE. II-COMPARISON OF EXPERIMENTAL FORCE AND RESPONSE WITH THEORY. Robert W. Miller and Kenneth F. Merten. 1952. ii, 7p. diagrs., photos., tab. (NACA Rept. 1075. Formerly TN 2343)

Hydrodynamic impact tests were made on an elastic model approximating a two-mass-spring system which had a ratio of sprung mass to hull mass of 0.6 and a natural frequency of 3.0 cycles per second. Tests were made at two combinations of trim and flight-path angles and for a range of flight-path velocity. Comparison of the experimental results with results obtained from the theory of NACA TN 1398 showed good agreement.

NACA Rept. 1078

EFFECTS OF COMPRESSIBILITY ON THE PERFORMANCE OF TWO FULL-SCALE HELICOPTER ROTORS. Paul J. Carpenter. 1952. ii, 8p. diagrs., photo. (NACA Rept. 1078. Formerly TN 2277)

An investigation has been conducted on the Langley helicopter test tower to determine experimentally the effects of compressibility on the performance and blade pitching moments of two full-scale helicopter rotors with twisted and untwisted blades over a tip-speed range from 350 to 770 feet per second.

NACA Rept. 1081

A STUDY OF SECOND-ORDER SUPERSONIC FLOW THEORY. Milton D. Van Dyke. 1952. ii, 23p. diagrs. (NACA Rept. 1081. Formerly TN 2200)

Second-order solutions of supersonic-flow problems are sought by iteration, using the linearized solution as the first step. For plane and axially symmetric flows, particular solutions of the iteration equation are discovered which reduce the second-order problem to an equivalent linearized problem. Comparison of second-order solutions with exact and numerical results shows great improvement over linearized theory. For full three-dimensional flow, only a partial particular solution is found. The inclined cone is solved, and the possibility of treating more general problems is considered.

NACA Rept. 1089

SINGLE-DEGREE-OF-FREEDOM-FLUTTER CALCULATIONS FOR A WING IN SUBSONIC POTENTIAL FLOW AND COMPARISON WITH AN EXPERIMENT. Harry L. Runyan. 1952. ii, 8p. diagrs. (NACA Rept. 1089. Formerly TN 2396)

The effect of Mach number and structural damping on single-degree-of-freedom pitching of a wing is presented. Some experimental results are compared with theory and good agreement is found for certain ranges of an inertia parameter.

NACA TN 2926

STATIC FORCE-DEFLECTION CHARACTERISTICS OF SIX AIRCRAFT TIRES UNDER COMBINED LOADING. Walter B. Horne. May 1953. 92p. diagrs., photos., 2 tabs. (NACA TN 2926)

Static force-deflection tests were made on six aircraft tires. These tests included the vertical loading of the six tire specimens, combined vertical loading and side loading and combined vertical loading and torsional loading of five tire specimens, and combined vertical loading and fore-and-aft (longitudinal) loading of one tire specimen for different initial inflation pressures. Tire deflection, vertical-load center-of-pressure shifts, and tire pressure measurements are presented for the different load combinations. The lateral spring constants for all the tire specimens tested decreased with increasing vertical tire deflection; whereas, the torsional and fore-and-aft spring constants increased with increasing vertical tire deflection. The lateral and fore-and-aft shifts of the vertical-load center of pressure were found to average 75 percent and 25 percent, respectively, of the side and fore-and-aft tire deflections.

NACA TN 2927

DEFLECTION OF DELTA WINGS HAVING A CARRY-THROUGH-BAY CHORD SMALLER THAN THE WING ROOT CHORD. Roger W. Peters and Manuel Stein. May 1953. 25p. diagrs., photo., 2 tabs. (NACA TN 2927)

Experimentally determined influence coefficients are presented for the deflection of two solid delta wings - one wing of constant thickness and the other of constant thickness ratio - having a carry-through-bay chord smaller than the wing root chord. A theoretical method of analysis is demonstrated for the constant thickness wing under tip load, and the theoretical results are compared with the experimental results.

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NACA TN 2928

AXIAL-LOAD FATIGUE PROPERTIES OF 24S-T AND 75S-T ALUMINUM ALLOY AS DETERMINED IN SEVERAL LABORATORIES. H. J. Grover and W. S. Hyler, Battelle Memorial Institute, Paul Kuhn and Charles B. Landers, Langley Aeronautical Laboratory and F. M. Howell, Aluminum Company of America. May 1953. 63p. photos., diagrs., 7 tabs. (NACA TN 2928)

In the initial phase of an NACA program on fatigue research, axial-load tests on 24S-T3 and 75S-T6 aluminum-alloy sheet have been made at the Battelle Memorial Institute and at the Langley Aeronautical Laboratory of the NACA. The test specimens were polished and unnotched. The manufacturer of the material, the Aluminum Company of America, has made axial-load tests on 24S-T4 and 75S-T6 rod material. The test techniques used at the three laboratories are described in detail; the test results are compared with each other and with results obtained on unpolished sheet by the National Bureau of Standards.

NACA TN 2929

EXPERIMENTAL INVESTIGATION OF THE EFFECT OF REAR-FUSELAGE SHAPE ON DITCHING BEHAVIOR. Ellis E. McBride and Lloyd J. Fisher. April 1953. 35p. diagrs., photos., 3 tabs. (NACA TN 2929)

An experimental investigation was conducted to determine the effect of rear-fuselage shape on ditching behavior. The basic fuselages were streamline bodies of revolution of fineness ratios 6 and 9. Variations in longitudinal curvature were obtained by sweeping up or sweeping down the rear half of the center line. A change in the cross section was obtained by splitting the center line in the plan view. The models were landed in calm water at speeds of 30, 40, 50, and 60 feet per second. The effects on ditching behavior of changes in longitudinal curvature, cross section, fuselage fineness ratio, and landing speed are presented in terms of maximum height of the center of gravity, maximum attitude, length of run, and skipping tendency.

NACA TN 2932

WATER-LANDING INVESTIGATION OF A FLAT-BOTTOM V-STEP MODEL AND COMPARISON WITH A THEORY INCORPORATING PLANING DATA. Robert W. Miller. May 1953. 23p. diagrs., photo., 2 tabs. (NACA TN 2932)

This paper presents the results of a fixed-trim smooth-water impacts of a flat-bottom V-step model having a high beam loading. Plots of nondimensional load, draft, vertical velocity, and time against flight-path angle at water contact show results similar to those exhibited by other models having transverse steps, high beam loadings, and different shapes. Time-history comparisons show good agreement between experimental results and results computed by the method of NACA TN 2814 for the V-step case.

NACA TN 2934

RELATION BETWEEN ROUGHNESS OF INTERFACE AND ADHERENCE OF PORCELAIN ENAMEL TO STEEL. J. C. Richmond, D. G. Moore, H. B. Kirkpatrick and W. N. Harrison, National Bureau of Standards. April 1953. 29p. diagrs., photos., 7 tabs. (NACA TN 2934)

The relationship between adherence and roughness of interface between enamel and iron was studied. Porcelain-enamel ground coats were prepared and applied under conditions that gave various degrees of adherence. The variations were produced by (a) varying the amount of cobalt-oxide addition in the frit; (b) varying the type of metallic-oxide addition in the frit, keeping the amount constant at 0.8 weight percent; (c) varying the surface treatment of the metal before application of the enamel, by pickling, sandblasting, and polishing; and (d) varying the time of firing of the enamel containing 0.8 percent of cobalt oxide. A positive correlation was found between adherence and roughness of the interface.

NACA TN 2936

COMBUSTION INSTABILITY IN AN ACID-HEPTANE ROCKET WITH A PRESSURIZED-GAS PROPELLANT PUMPING SYSTEM. Adelbert O. Tischler and Donald R. Bellman. May 1953. 50p. diagrs., photo. (NACA TN 2936. Formerly RM E51G11)

The low-frequency instability problem of a rocket using liquid propellants and a pressurized-gas propellant pumping system was experimentally investigated with a 300-pound thrust acid-heptane rocket. The results were compared to results predicted by an analysis based on the premise that the instability was due to an out-of-phase coupling between propellant flow and combustion-chamber pressure. The calculated instability frequency conformed with those observed experimentally and the analysis predicted many of the observed trends of varying rocket design or operating parameters.

NACA TN 2937

METHOD FOR CALCULATING THE ROLLING AND YAWING MOMENTS DUE TO ROLLING FOR UNSWEPT WINGS WITH OR WITHOUT FLAPS OR AILERONS BY USE OF NONLINEAR SECTION LIFT DATA. Albert P. Martina. May 1953. 41p. diagrs., 11 tabs. (NACA TN 2937)

The methods of NACA Reports 865 and 1090 have been applied to the calculation of the rolling- and yawing-moment coefficients due to rolling for unswept wings with or without flaps or ailerons. The methods allow the use of nonlinear section lift data together with lifting-line theory. Two calculated examples are presented in simplified computing forms in order to illustrate the procedures involved.

NACA TN 2938

ANALYSIS OF HEAT ADDITION IN A CONVERGENT-DIVERGENT NOZZLE. Donald P. Hearth and Eugene Perchonok. April 1953. 18p. diagrs. (NACA TN 2938)

The effect of heat addition to a divergent stream with initially sonic flow is analyzed and the variation of exit Mach number, static pressure, and total pressure is presented. Application of these results to the diverging portion of a convergent-divergent nozzle indicated that nozzle heat addition delays nozzle overexpansion and affects the jet thrust appreciably. Moreover, misleading nozzle coefficients will be computed if heat addition in the nozzle is ignored.

NACA TN 2939

OPTIMUM CONTROLLERS FOR LINEAR CLOSED-LOOP SYSTEMS. Aaron S. Boksenbom, David Novik and Herbert Heppler. April 1953. 27p. diagrs. (NACA TN 2939)

An analysis is made for optimum controllers of general, linear, time-invariant multiloop systems based on minimizing the mean squares or integral squares of errors and constrained variables for either stationary statistical or transient inputs. A general method of using open-loop optimum filter theory is derived that assures structural stability of the closed-multiloop system during the optimization process. General solutions were obtained for certain special cases and applied to examples of turbojet engine control.

NACA TN 2940

EFFECT OF HIGH BULK TEMPERATURES ON BOUNDARY LUBRICATION OF STEEL SURFACES BY SYNTHETIC FLUIDS. S. F. Murray, Robert L. Johnson and Edmond E. Bisson. May 1953. 27p. diagrs., photos., 2 tabs. (NACA TN 2940)

An experimental study was made of the effect of high lubricant bulk temperatures on the boundary lubricating effectiveness with steel surfaces of various types of synthetic fluids considered as lubricants for turbine engines. Synthetic fluids were generally effective lubricants at higher temperatures than comparable petroleums. Lubrication with esters and possibly other fluids is believed to result from formation of a chemisorbed soap film by free acids (contaminants) in the fluid. Failure results from deterioration of metal soap and oxide films, which is influenced by temperature effects on the bulk fluid. Thermal stability can be associated with viscosity grade within a given class; however, no correlation could be made between lubrication failure temperature and the viscosity at failure temperatures for the various fluids. At temperatures up to its decomposition point, a silicate ester showed more promise than the other lubricants studied.

NACA TN 2944

THE ZERO-LIFT DRAG OF A SLENDER BODY OF REVOLUTION (NACA RM-10 RESEARCH MODEL) AS DETERMINED FROM TESTS IN SEVERAL WIND TUNNELS AND IN FLIGHT AT SUPERSONIC SPEEDS. Albert J. Evans. April 1953. 40p. diagrs., tab. (NACA TN 2944)

Presents zero-lift drag data of an NACA RM-10 slender body of revolution with and without stabilizing fins attached. The results from several wind tunnels and in flight are compared. The results cover a Reynolds number range from about 1×10^6 to 40×10^6 for the wind-tunnel models and 12×10^6 to 140×10^6 for the flight models. The Mach numbers covered include 1.5 to 2.4 in the wind tunnels and 0.85 to 2.5 in flight.

NACA TN 2948

INVESTIGATION OF LATERAL CONTROL NEAR THE STALL. FLIGHT INVESTIGATION WITH A LIGHT HIGH-WING MONOPLANE TESTED WITH VARIOUS AMOUNTS OF WASHOUT AND VARIOUS LENGTHS OF LEADING-EDGE SLOT. Fred E. Weick, Maurice S. Sevelson, James G. McClure and Marion D. Flanagan, Agricultural and Mechanical College of Texas. May 1953. 61p. diagrs., photos., 4 tabs. (NACA TN 2948)

Flight tests were made with a light high-wing monoplane to investigate possibilities for obtaining satisfactory lateral control at low flight speeds. The airplane was tested with a plain straight wing, with the wing twisted to various amounts of washout, and with leading-edge slots covering various portions of the span. With each wing configuration the tests were repeated with power on and off and for three center-of-gravity locations. The flow over the wing was observed by means of tufts attached to the upper surface. The results of the tests indicate that reliable control at angles of attack very near the stall can be achieved by the proper use of leading-edge slots and wing washout.

NACA TM 1347

REPORT ON THE SPECIAL FIELD "INTERFERENCE" TO THE WIND-TUNNEL COMMITTEE IN FEBRUARY 1945. (Bericht über das Fachgebiet Interferenz vor dem Windkanalausschuss im Februar 1945). H. Schlichting. Includes: Compilation of Interference Systematics at the Aerodynamic Institute of the Technical Academy Braunschweig. E. Moller. May 1953. 46p. diagrs. (NACA TM 1347. Trans. from Technische Hochschule Braunschweig. Aerodynamisches Institut. Bericht 45/4)

Contains an outline of investigations dealing with interference effects on the static stability of various airplane configurations that were conducted, were being conducted, and were started at the time of this present report. Results of several investigations are presented and discussed briefly. A supplement is attached showing the configurations tested and outlining the various test programs. Suggestions for future investigations are also included.

NACA TM 1353

SOME PROBLEMS OF THE THEORY OF CREEP. (Nekotorye Voprosy Teorii Polzuchesti). Y. N. Rabotnov. April 1953. 19p. diagrs. (NACA TM 1353. Trans. from Vestnik Moskovskovo Universiteta, no. 10, 1948, p.81-91).

A theory of creep is proposed which represents an extension of the theory of elastic heredity of Volterra to plastic deformation. The theory is applied to the problems of relaxation, reverse creep, creep-bending of bars, and creep of a pipe under internal pressure. A special class of three-dimensional problems, in which the relative magnitudes of the stresses at a point remain constant with time, and likewise the relative magnitudes of the strains, is also considered.

BRITISH REPORTS

N-21249 *

Forest Products Research Lab. (Gt. Brit.) MOISTURE RELATIONS OF COMPOSITE WOOD PRODUCTS. THE MOVEMENT OF PLYWOOD (Part IV). PROGRESS REPORT TWENTY-THREE. R. J. Newall and G. E. Soane. February 1953. 4p. (Forest Products Research Lab.)

This report gives data on the swelling of plywood of 30 species. Routine measurements have been made on the movement of samples of all species tested for plywood manufacture.

N-21447 *

Department of Supply (Australia) TORSION AND BENDING OF SWEPT AND TAPERED WINGS WITH RIGID CHORDWISE RIBS. W. H. Wittrick. September 1950. 85p. diagrs., 24 tabs. (Department of Supply. ACA-51)

The problem considered is that of a swept wing, either conical or cylindrical, of arbitrary section, under any system of bending and torsion loads. The wing is assumed to consist of a nonbuckling outer skin, a series of booms and stringers located along generators of the tube, and a series of closely spaced ribs all parallel to the root section. The ribs are assumed to be completely rigid in their own planes but to offer no resistance to warping out of their own planes. For simplicity only single-cell tubes are considered.

N-21676 *

Forest Products Research Lab. (Gt. Brit.) INVESTIGATIONS INTO GLUES AND GLUING. PROGRESS REPORT SEVENTY-ONE - SEPTEMBER 1952. BEHAVIOUR OF GLUED WOOD PRODUCTS IN LIGHT NAVAL CRAFT. THIRD YEAR'S ANALYSIS. R. J. Newall and L. S. Doman. 6p. (Forest Products Research Lab.)

This report presents a summary of results of periodic inspections made during the previous three years on glued wood products used in boats.

N-21803 *

Aeronautical Research Council (Gt. Brit.) NO. 2, $11\frac{1}{2}$-FT WIND-TUNNEL TESTS OF A SMALL SPAN, SMALL CHORD DOUBLE AILERON FOR USE AS A LATERAL CONTROL ON A HIGH-LIFT AIRCRAFT. A. D. Young and W. S. D. Marshall. 1952. 32p. diagrs., 5 tabs. (ARC R & M 2536; ARC 9565. Formerly RAE Aero 2111)

Tests were made on a 1/2.25-scale model of a half wing of the Master. The span of the aileron was 0.22s and the chords were $0.2\bar{c}$ and $0.15\bar{c}$; the aileron was fitted with a balance tab of $0.05\bar{c}$ chord. Measurements were made of the hinge moments, lift increments (from which the rolling moments were deduced), and the pressures in the aileron gaps just above and below the seals. The latter were required for estimating the effect of internal shrouded nose (or pressure) balances. Tests were also made of the effect on the hinge and rolling moments of a small spoiler situated just aft of the front aileron vent; the spoiler was assumed to emerge on the lower surface of the down-going aileron and on the upper surface of the up-going aileron.

N-21804 *

Aeronautical Research Council (Gt. Brit.) INFLUENCE OF TUNED DAMPERS ON FLEXURE-AILERON FLUTTER. Part I: THEORETICAL INVESTIGATION ON THE INFLUENCE OF TUNED DAMPING DEVICES ON FLEXURE-AILERON FLUTTER. R. A. Frazer and W. P. Jones. Part II: SOME FURTHER CALCULATIONS ON THE INFLUENCE OF TUNED DAMPING DEVICES ON FLEXURE-AILERON FLUTTER. W. P. Jones. Part III: EXPERIMENTS ON THE EFFECT OF TUNED DAMPING DEVICES ON FLEXURE-AILERON FLUTTER. C. Scruton, D. V. Dunsdon and P. M. Ray. 1952. 31p. diagrs., 5 tabs. (ARC R & M 2559. Formerly ARC 8581; ARC 9946; ARC 9882)

In part I, a general theory has been developed for the investigation of the influence of damping devices of various types on flexure-aileron flutter. The numerical applications refer to a large transport aircraft, and they are restricted to the case of a mass-balanced aileron-carried damper. From the diagrams given at the end of the part, it is inferred that this type of damper would be unsatisfactory as a flutter preventive. Part II supplements part I and gives results for a partly balanced and for a completely balanced aileron-damper system. It is concluded that tuned dampers of these types would also prove unreliable. Part III describes an experimental investigation into the effect on flexure-aileron flutter of a tuned damping device attached to the aileron. The results confirm the theoretical conclusion that the use of an aileron-carried damper would not be a reliable flutter preventive.

N-21805*

Aeronautical Research Council (Gt. Brit.)
COMBUSTION IN THE GAS TURBINE - A SURVEY OF WAR-TIME RESEARCH AND DEVELOPMENT. Peter Lloyd. 1952. 45p. diagrs., 8 tabs. (ARC R & M 2579; ARC 11, 435. Formerly Power Jets Research and Development, Ltd. Special Rept. 510)

The present report attempts a general survey of the whole field of gas-turbine combustion. The report covers both research and development, and while it is mainly concerned with British work, some mention is also made of German work on the same subject. The related processes of combustion in propulsive ducts are briefly touched on. The report is based on a paper to the Institution of Mechanical Engineers, but with much fresh material, including a comprehensive bibliography. There have been many groups of investigators concerned in this work at the Royal Aircraft Establishment, Power Jets, Joseph Lucas and Co., the Asiatic Petroleum Co., Metropolitan Vickers Ltd., Rolls-Royce, Armstrong Siddeley's, De Havillands and the City and Guilds College. In preparing the present report, full use has been made of the work of all these groups and of the Combustion Panel of the Ministry of Aircraft Production's Gas Turbine Collaboration Committee through which they cooperated; this debt is gratefully acknowledged. On the other hand, the interpretation and assessment of the work are the author's, and for these full responsibility is taken.

N-21806*

Aeronautical Research Council (Gt. Brit.)
THE LAMINAR BOUNDARY LAYER ASSOCIATED WITH THE RETARDED FLOW OF A COMPRESSIBLE FLUID. C. R. Illingworth. 1953. 23p. diagrs., 4 tabs. (ARC R & M 2590. Formerly ARC 9886; FM 975)

Two aspects of the solution of the equations governing steady gas flow in a laminar boundary layer, when the main stream velocity is nonuniform, are considered. In the first place, it is shown that the equations can be reduced to ordinary differential equations, whose solution implies the similarity of the distributions of velocity and temperature in planes perpendicular to the boundary, only in the case when the main stream velocity is uniform. In the second part, an extension of Pohlhausen's method is used to determine the point of separation of the boundary layer in an air flow in which the pressure increases with a uniform gradient.

N-21807 *

Aeronautical Research Council (Gt. Brit.)
THE ASYMPTOTIC THEORY OF BOUNDARY-LAYER FLOW WITH SUCTION. PART I: THE THEORY OF SIMILAR VELOCITY DISTRIBUTIONS. PART II: FLOW WITH UNIFORM SUCTION. PART III: FLOW WITH VARIATION OF SUCTION VELOCITY. E. J. Watson. 1952. 45p. diagrs., 13 tabs. (ARC R & M 2619. Formerly ARC 9906; FM 977; ARC 10,025; FM 993; ARC 10,317; FM 1063; ARC 10,852; FM 1148)

The subject of this report is the steady two-dimensional flow of a boundary layer over a permeable surface through which the fluid is withdrawn at a known rate of suction. This rate of suction is assumed, in accordance with the hypotheses of the boundary layer, to be small compared with the stream velocity, and of order $R^{-1/2}$, where R is the Reynolds number. It is supposed here that the suction is relatively large, though still of the same order. Part I deals with the similar solutions of the boundary-layer equations, part II with an arbitrary pressure distribution but constant suction velocity, and part III with the general problem.

N-21808 *

Aeronautical Research Council (Gt. Brit.)
SANDWICH CONSTRUCTION AND CORE MATERIALS. PART IV. Section I: 'BALSOLITE' IMPREGNATED PAPER CELLULAR MATERIAL AS AN ELASTIC STABILISER. W. J. Pullen. Section II: COMPRESSION TESTS ON SANDWICH PANELS WITH 'BALSOLITE' CORES. R. G. Chapman and S. Pearson. Section III: STRENGTH TESTS OF A TYPHOON TYPE FUSELAGE OF 'BALSOLITE' SANDWICH CONSTRUCTION. J. K. Oaks. 1952. 18p. diagrs., photos., 5 tabs. (ARC R & M 2687; 10,212. Formerly ARC 7267; Strut 746; Plas. 45; RAE SME 268; RAE Test Note 122)

A range of struts each consisting of "Balsolite" filler sandwiched between two faces of 1/16-inch thick birch plywood has been tested in order to assess the efficiency of Balsolite as a stabilizer in sandwich structures. It is concluded that this material compares favorably with other low density materials when used as a stabilizer. Modification of the material, namely the use of transverse and longitudinal tubes alternately, does not appear to be beneficial.

N-21809 *

Aeronautical Research Council (Gt. Brit.)
SOME INVESTIGATIONS ON THIN NOSE-SUCTION AEROFOILS. J. Williams. Part I: A COMPARISON OF THE STALLING PROPERTIES OF SOME THIN NOSE-SUCTION AEROFOILS. Part II: A THEORETICAL INVESTIGATION ON THIN HIGH-LIFT AEROFOILS SPECIALLY DESIGNED FOR NOSE-SLOT SUCTION. 1952. 28p. diagrs., 10 tabs. (ARC R & M 2693. Formerly ARC 11,560; Perf. 455; FM 1255; ARC 12,144; Perf. 528; FM 1334; ARC 13,090)

In part I, the experimental results from stalling tests on thin nose-suction airfoils are compared and the design features of the tested airfoils are analyzed. The airfoils include the 8-percent-thick Lighthill and Glauert sections specially designed for nose-slot suction, the 8-percent-thick H. S. A. V section with distributed suction through a porous nose, and some conventional sections of moderate thickness tested in Germany with slot suction at various positions on the nose. Part II describes a theoretical exploration of possible thin nose-slot

airfoils specially designed to have an abrupt fall in velocity where suction is to be applied on the upper surface of the nose.

N-21810 *

Aeronautical Research Council (Gt. Brit.)
TANK TESTS ON A JET-PROPELLED BOAT-SEAPLANE FIGHTER (SAUNDERS-ROE E6/44). G. L. Fletcher. 1952. 31p. photos., diagrs., 6 tabs. (ARC R & M 2718; ARC 9404. Formerly RAE Aero 2106)

Investigations into porpoising stability, water resistance, and seaworthiness have been made on the hull design of the E6/44. The original lines were unsatisfactory for seaworthiness and porpoising stability at overload and modifications to improve these qualities have been made. Results on the final lines indicate that porpoising stability should be adequate at all loads up to the design overload, and take-off time should be well within the specified limit. Seaworthiness tests show that the limiting condition for satisfactory operation at normal load is a 2-foot sea. The hump spray is severe and, due to likelihood of damage, full advantage of flaps may not be gained unless a preselector control is used.

N-21811*

Aeronautical Research Council (Gt. Brit.)
THE SCOPE AND ACCURACY OF VORTEX LATTICE THEORY. V. M. Falkner. 1952. 30p. diagrs., 16 tabs. (ARC R & M 2740. Formerly ARC 12,743; Perf. 607)

This report gives an outline of the development of the principles on which potential problems in lifting-plane theory are solved by the use of a vortex lattice for the purpose of computing downwash. The conditions of convergence necessary for an accurate solution are defined, and the main purpose of the report is to show that those connected with the lattice have been, or can easily be satisfied.

N-21812*

Aeronautical Research Council (Gt. Brit.)
FLUTTER AND DIVERGENCE OF SWEPT-BACK AND SWEPT-FORWARD WINGS. A. W. Babister. 1953. 13p. diagrs. (ARC R & M 2761; ARC 13,391. Formerly College of Aeronautics, Cranfield, Rept. 39)

In this note, the equations of the flexural-torsional flutter of a swept wing are established, assuming the wing to be semirigid and fixed at the root. The general effects of sweepback, wing stiffness, and position of the inertia axis are determined. The critical speeds for flutter and for wing divergence are determined (1) for incompressible flow and (2) for compressible flow, applying the Glauert correction. The critical flutter speed is, in general, higher for a sweptback wing having the same wing stiffness as the unswept wing; for a sweptforward wing, divergence will occur before flutter.

N-21813 *

Aeronautical Research Council (Gt. Brit.)
A METHOD OF PERFORMANCE REDUCTION FOR HELICOPTERS. F. O'Hara. 1952. 12p. diagrs. (ARC R & M 2770; ARC 11,062. Formerly AFEE Res. 26)

The equations for helicopter performance are derived in a form suitable for the development of performance reduction methods, and the equations obtained provide also a simple method of performance estimation. Formulas are determined for reducing observed performance data to standard temperature conditions and for estimating the effect of weight changes on performance. Charts of the relationships are given for typical values of helicopter and engine characteristics. The general equations are divided into two groups dealing, respectively, with forward and vertical flight. Performance reduction methods are then outlined for the three cases of climbing, level, and vertical flight and are applied to show the effect of weight changes in each case.

N-21976 *

Ministry of Supply (Gt. Brit.)
A GRAPHICAL METHOD FOR THE RAPID ESTIMATION OF HELICOPTER PERFORMANCE. A. Armitage. January 1953. 25p. diagrs. (Ministry of Supply. RD(H)/F. 20/1)

A method of rapid estimation of helicopter flight performance is presented, with nomographic charts which save much time in calculation, for example, up to 75 percent of that taken by other current methods. The method is based on familiar helicopter theory, and was originally evolved by Capt. R. N. Liptrot when head of the department. It has now been revised and extended to cover such aspects as vertical rate of climb, and tip stall at high forward speed. The working charts have also been prepared and are included. The charts are particularly useful in rapid assessment of the worth of new projects, and in estimating the effect of varying one or more design parameters of both new and existing designs. Only standard parameters and three special factors are employed. The method compares favorably with other accepted methods. A specimen calculation performed on an actual helicopter, together with the comparable flight test values, is included as an appendix.

N-21977 *

National Gas Turbine Establishment (Gt. Brit.)
CONVECTIVE HEAT TRANSFER IN A VORTEX CHAMBER. D. G. H. Higgins. December 1952. 24p. diagrs. (NGTE R. 127)

This report describes convective heat-transfer measurements made on a parallel walled "cyclone" vortex chamber, embracing the variables of chamber size, mass flow, inlet temperature, and inlet velocity, and establishes a correlation between Nusselt number and Reynolds number for that portion of the vortex flow unaffected by inlet and outlet

conditions, from which heat-transfer coefficients between gas and wall may be estimated. A curve is given showing the effect of inlet and outlet conditions on this correlation and suggested methods of computing the heat-transfer coefficients in these regions are included. The coefficients so obtained are for the convective component of heat transfer only, radiation effects being neglected in the tests since no combustion of fuel took place within the test chamber itself.

N-21978 *

Royal Aircraft Establishment (Gt. Brit.)
A PULSE-OPERATED AUTO-CORRELATOR. F. W. Stoneman. December 1952. 18p. diagrs. (RAE Tech. Note GW 225)

A pulse-operated auto-correlator offers advantages over other forms of correlator in its comparative simplicity and its ability, under certain conditions of use, to provide a complete correlogram without the necessity of recording the input data. The system involves the storage of information on a series of condensers connected to the contact banks of two uniselectors, the wipers of which can be rotated at the same speed but with any desired angular separation, equivalent to the required values of τ, the correlation interval. Theoretically the results obtained are accurate for a repetitive function if the sampling rate is more than twice the highest frequency component. A test instrument has been built which demonstrates that the principle is sound, and provides the basis of a practical machine. The main difficulties requiring further investigation are listed in the conclusions.

N-21979 *

Aeroplane and Armament Experimental Establishment (Gt. Brit.) GROUND POWER CHECKING OF HELICOPTER ENGINES. TESTS WITH A HOVERFLY 1. D. A. Wilkinson. August 29, 1952. 12p. photos., diagrs., tab. (AAEE/Res/268)

A preliminary investigation has been made on a Hoverfly 1 of the possibility of ground checking the power of helicopter engines. Tests have been made with both standard blades and blades fitted with attachments. These tests confirm that power checks which involve tethering are unsatisfactory and indicate that power checks should be made under low lift conditions. Two methods of achieving this condition were investigated, one using lift spoilers at high pitch, and the other using drag plates at low pitch. The latter method proved to be the more satisfactory and appears to provide a practical solution, without undue handling problems, by which power variations of the order of 2 percent could be detected. This method may be suitable for use by qualified ground crew provided that precautions are are taken to prevent the occurrence of dangerous blade motions.

N-23023 *

Aeronautical Research Council (Gt. Brit.)
THE SOURCE DISTRIBUTION REPRESENTING SUPERSONIC FLOW PAST SLENDER BODIES OF REVOLUTION HAVING DISCONTINUITIES IN THE BOUNDARY GRADIENT. L. J. Morton. November 21, 1951. 14p. diagrs. (ARC 14, 436; FM 1633)

The distribution of source strength along the axis, based on the linearized equation, which represents supersonic flow over a body of revolution is determined for a body having a discontinuity in the boundary gradient. The method consists of a step-by-step process which is applicable when the shape of the boundary is not easily expressible in an analytical form, and formulas are given for the velocity components and change in pressure at the discontinuity.

N-23024 *

Aeronautical Research Council (Gt. Brit.)
A SIMPLE AND ACCURATE METHOD FOR COMPARING MANOMETERS. J. H. Preston. June 8, 1951. 7p. diagr. (ARC 14, 072; TP 340)

It is shown that the simple device of a water-sealed reservoir enables a constant pressure difference to be applied to the manometers under comparison. Effects due to temperature changes in the reservoir and the interaction of the adjustment of one manometer on the indication of the other are negligible compared with the observed effects when a completely closed reservoir is used. A theoretical explanation of this is given. The readings of two manometers can be compared with an accuracy which is limited only by the sensitivity of the manometers and the amount of zero creep due to room temperature changes.

N-23025 *

Aeronautical Research Council (Gt. Brit.)
EXPERIMENTS ON TWO-DIMENSIONAL SUPERSONIC FLOW IN CORNERS AND OVER CONCAVE SURFACES. N. H. Johannesen. January 29, 1952. 20p. diagrs., photos. (ARC 14, 607; FM 1669)

Two simple cases of two-dimensional supersonic flow were investigated by schlieren photography, namely the flow in two consecutive corners and the flow over a circular-arc profile concave to the stream. The flows were photographed for smooth and rough surfaces of the models, that is, with laminar and turbulent boundary layers, and the observed flow patterns are compared with those predicted by inviscid theory. The flow with a turbulent boundary layer was in good agreement with inviscid theory outside the boundary layer, whereas the laminar boundary layer separated and a shock wave originated at the point of separation. In both cases, the agreement was good at points far from the surface. A discussion is given of the flow at the point of intersection of three shock waves, and of a shock wave and a centered compression. For the latter case, photographs show a weak shock wave in the direction of the downstream Mach line at the point of intersection.

N-23036 *

Aeronautical Research Council (Gt. Brit.)
THE FLOW IN THE THREAT OF A SUPERSONIC EFFUSER. W. F. Cope and R. O. Gibson. August 23, 1951. 10p. diagrs. (ARC 14,214; FM 1595)

The velocity profiles have been calculated for two radii of curvature and two values of γ for each radius. They are considerably affected by the radius and hardly at all by γ. Comparison with Hermann's results suggests that his "X shocks" may be a supersaturation phenomenon. It is proposed to calculate the flow further down the effuser by including more terms of the series for the velocity potential and using a boundary curve which has a point of inflection.

MISCELLANEOUS

NACA Rept. 1071

Errata No. 1 on "THEORETICAL SYMMETRIC SPAN LOADING DUE TO FLAP DEFLECTION FOR WINGS OF ARBITRARY PLAN FORM AT SUBSONIC SPEEDS." John DeYoung. 1952.

NACA TN 2890

Errata No. 1 on "A LINEAR TIME-TEMPERATURE RELATION FOR EXTRAPOLATION OF CREEP AND STRESS-RUPTURE DATA." S. S. Manson and A. M. Haferd. March 1953.

NACA TN 2922

Errata No. 1 on "THE DESIGN OF VARIABLE MACH NUMBER ASYMMETRIC SUPERSONIC NOZZLES BY TWO PROCEDURES EMPLOYING INCLINED AND CURVED SONIC LINES." Clarence A. Syvertson and Raymond C. Savin. March 1953.

NACA TM 1317

Errata No. 1 on "A SIMPLE NUMERICAL METHOD FOR THE CALCULATION OF THE LAMINAR BOUNDARY LAYER." K. Schröder. April 1953.

UNPUBLISHED PAPERS

N-18009 *

TEMPERATURE VARIATION AND TEMPERATURE STRESSES IN PLATE AND SHELL-SHAPED BODIES. PART I. (Temperaturverlauf und Temperaturspannungen in platten - und schalenformigen Korpern). K. Marguerre. January 1953. 22p. diagrs. (Trans. from Ingenieur-Archiv, v. 8, June 1937, p. 216-228)

The following bases for a theory of the heat stress on plate (or shell-shaped) bodies are investigated: the (purely thermal) differential equations for the variation of certain mean values of temperature and the (thermoelastic) differential equations for stretching and bending of the plate exposed to a change in temperature.

N-22617 *

MACHINE TOOL CONTROL FROM A DIGITAL-ANALOG COMPUTER. Harry W. Mergler, George J. Moshos and Allen E. Young. 1952. 25p. diagrs., photos. (Presented at American Institute of Electrical Engineers meeting, Albany, New York, October 29-31, 1952)

This report describes the development of automatic machine tool controls for the use in fabrication of turbine blades. The following are described: (1) a technique for preparing the coordinate of dimensional data describing the profile to be machined in the form of punched card intelligence, (2) a device to interpolate between these discrete data points to generate a continuous profile represented as a mechanical position, and (3) a servo system duplicating this mechanical position at a high power level to drive the coordinate controls of a machine tool.

N-22876 *

National Bureau of Standards.
PROTECTIVE VALUE OF SURFACE TREATMENTS FOR MAGNESIUM ALLOYS. Fred M. Reinhart. December 1, 1952. i, 31p. photos., 5 tabs. (National Bureau of Standards. Rept. 2026)

This report presents the results of a study of the relative efficiencies of various surface treatments for magnesium alloys with respect to their ability to improve the adherence of paint and thus improve the general corrosion resistance of these alloys when exposed to marine atmosphere and tidewater environments. The protective value of eleven different painted surface treatments on three types of magnesium alloys in salt fog, marine atmosphere and tidewater environments were determined.

TECHNICAL FILM

NACA Technical Film No. 26 *

NACA CRASH-FIRE RESEARCH. 1 reel, 1600 ft. sound and color.

This film covers full-scale aircraft crashes which were made to investigate the mechanism of the start and development of aircraft crash fires. This investigation revealed the characteristics of the ignition sources, the manner in which the combustibles spread, the mechanism of the union of the combustibles and ignition sources, and the pertinent factors governing the development of crash fire as observed in this program.

National Advisory Committee for Aeronautics

Research Abstracts

NO. 44 JUNE 12, 1953

CURRENT NACA REPORTS

NACA Rept. 1074

HYDRODYNAMIC IMPACT OF A SYSTEM WITH A SINGLE ELASTIC MODE. I - THEORY AND GENERALIZED SOLUTION WITH AN APPLICATION TO AN ELASTIC AIRFRAME. Wilbur L. Mayo. 1952. ii, 17p. diagrs., 2 tabs. (NACA Rept. 1074. Formerly TN 1398)

Solutions of impact of a rigid prismatic float connected by a massless spring to a rigid upper mass are presented. The solutions are based on hydrodynamic theory which has been experimentally confirmed for a rigid structure. Equations are given for defining the spring constant and the ratio of the sprung mass to the lower mass so that the two-mass system provides representation of the fundamental mode of an airplane wing. The forces calculated are more accurate than the forces which would be predicted for a rigid airframe since the effect of the fundamental mode on the hydrodynamic force is taken into account. The response of the two-mass system gives the response of the represented mode and, although no provision is made for taking into account the effect of secondary modes on the hydrodynamic force, means are indicated whereby the results may be used to approximate the response of modes other than the fundamental mode.

NACA Rept. 1076

EFFECTS ON LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A BOEING B-29 AIRPLANE OF VARIATIONS IN STICK-FORCE AND CONTROL-RATE CHARACTERISTICS OBTAINED THROUGH USE OF A BOOSTER IN THE ELEVATOR-CONTROL SYSTEM. Charles W. Mathews, Donald B. Talmage and James B. Whitten. 1952. ii, 17p. diagrs., photo., tab. (NACA Rept. 1076. Formerly TN 2238; RM L50D11)

The longitudinal stability and control characteristics of a B-29 airplane have been measured with a control surface booster incorporated in the elevator-control system. The measurements were obtained with the booster operating to provide various control-force gradients and various maximum rates of control motion. Results are presented which show the effect of these booster parameters on the handling qualities of the test airplane.

NACA Rept. 1087

INTERNAL-LIQUID-FILM-COOLING EXPERIMENTS WITH AIRSTREAM TEMPERATURES TO 2000° F IN 2- AND 4-INCH-DIAMETER HORIZONTAL TUBES. George R. Kinney, Andrew E. Abramson and John L. Sloop. 1952. ii, 21p. diagrs., photos., 5 tabs. (NACA Rept. 1087. Formerly RM E50F19; RM E51C13; RM E52B20)

An experimental investigation of internal-liquid-film cooling was conducted in 2- and 4-inch-diameter straight metal tubes with air flows at 600° to 2000° F and Reynolds numbers from 2.2 to 14 x 10^5. The coolant was water at flows of 0.8 to 12 percent of air flow. Visual observations of liquid-film flows were made in transparent tubes with air flows at 80° and 800° F and diameter Reynolds numbers from 4.1 to 29 x 10^5. Flows of water, water-detergent solutions, and aqueous ethylene glycol solutions were investigated. Liquid-coolant films were established and maintained around and along the tube wall in concurrent flow with the hot air. The tube wall was kept below the boiling temperature of the coolant over the surfaces covered by liquid coolant. Coolant films were relatively smooth unless the coolant flow was sufficiently high so that the liquid film was thick enough to enter the region where turbulent forces predominate over viscous forces; wavelike disturbances then developed on the liquid film. These disturbances resulted in increased loss of coolant from the film and reduced effectiveness of the coolant.

NACA Rept. 1093

HEAT TRANSFER TO BODIES IN A HIGH-SPEED RAREFIED-GAS STREAM. Jackson R. Stalder, Glen Goodwin and Marcus O. Creager. 1952. ii, 10p. diagrs., tab. (NACA Rept. 1093. Formerly TN 2438)

The equilibrium temperature and heat-transfer coefficients for transverse cylinders in a high-speed stream of rarefied gas were measured over a range of Knudsen numbers from 0.025 to 11.8 for Mach numbers from 2.0 to 3.3. Fully developed free-molecule flow was found to first occur at Knudsen numbers of approximately 2.0. The Nusselt number was found to be a function of the Reynolds number only, and the temperature-recovery factor to depend primarily on the Knudsen number.

NACA TN 2908

DETERMINATION OF MEAN CAMBER SURFACES FOR WINGS HAVING UNIFORM CHORDWISE LOADING AND ARBITRARY SPANWISE LOADING IN SUBSONIC FLOW. S. Katzoff, M. Frances Faison and Hugh C. DuBose. May 1953. 43p. diagrs., tab. (NACA TN 2908)

*AVAILABLE ON LOAN ONLY.

ADDRESS REQUESTS FOR DOCUMENTS TO NACA, 1724 F ST., NW., WASHINGTON 25, D. C., CITING CODE NUMBER ABOVE EACH TITLE, THE REPORT TITLE AND AUTHOR.

Methods involving integrations around the wing boundary are presented for computing mean camber surfaces to support uniform chordwise loading, with either uniform or nonuniform spanwise loading, in subsonic flow. For polygonal wings with uniform area loading, analytical expressions are developed for both the slopes and the ordinates of the mean camber surfaces. Mean camber surfaces of several calculated wings are shown.

NACA TN 2924

COMBINED-STRESS FATIGUE STRENGTH OF 76S-T61 ALUMINUM ALLOY WITH SUPERIMPOSED MEAN STRESSES AND CORRECTIONS FOR YIELDING. William N. Findley, University of Illinois. May 1953. 90p. diagrs., photos., 3 tabs. (NACA TN 2924)

Fatigue data for 76S-T61 aluminum alloy are presented for several combinations of bending and torsion with both alternating and mean stresses. Special fatigue equipment for these tests is described. Correction for yielding was applied to the mean stresses in the bending and in the torsion fatigue tests. The literature on the effect of combined stress and of mean stress in fatigue is reviewed and the results of the present series are compared with those of various theories. A new notation for state of stress and a new criterion for combined stress fatigue are discussed. A correction for anisotropy is proposed and its effect discussed. Energy theories of fatigue under combined stress are critically examined and a test proposed. The observed mode of fracturing is described and a qualitative theory of the mechanism of formation and propagation of fatigue cracks is proposed.

NACA TN 2930

STRENGTH ANALYSIS OF STIFFENED THICK BEAM WEBS WITH RATIOS OF WEB DEPTH TO WEB THICKNESS OF APPROXIMATELY 60. L. Ross Levin. May 1953. 11p. photo., diagrs., 2 tabs. (NACA TN 2930)

The results of an experimental investigation of the strength of plane diagonal-tension webs with ratios of web depth to web thickness of about 60 are presented. An analysis of the beams indicated that the methods of strength analysis presented in NACA TN 2661 are applicable to beams with the flanges symmetrically arranged with respect to the web if the portal-frame effect is taken into account.

NACA TN 2935

THE GALVANIC CORROSION THEORY FOR ADHERENCE OF PORCELAIN-ENAMEL GROUND COATS TO STEEL. D. G. Moore, J. W. Pitts, J. C. Richmond and W. N. Harrison, National Bureau of Standards. June 1953. 19p. diagrs., photos. (NACA TN 2935)

The galvanic corrosion theory of adherence between ground-coat enamels and steel was investigated. The theory, which is based on mechanical anchoring of the enamel into pits formed by galvanic attack of the enamel on the steel, was first examined from the standpoint of data on adherence obtained in earlier studies. Also, several experiments were performed which demonstrated that galvanic corrosion could occur during the short firing times encountered in enamel processing. However, inconsistencies were observed in the data which indicated that the mechanism of galvanic attack followed by mechanical anchoring was not the only important factor affecting bond strength.

NACA TN 2941

THE DRAG OF FINITE-LENGTH CYLINDERS DETERMINED FROM FLIGHT TESTS AT HIGH REYNOLDS NUMBERS FOR A MACH NUMBER RANGE FROM 0.5 TO 1.3. Clement J. Welsh. June 1953. 12p. diagrs., photo. (NACA TN 2941. Formerly RM L52C31)

Results of a free-flight investigation to determine the drag of circular, finite-length cylinders are presented for a Mach number range from about 0.5 to 1.3. Also included are drag results of previous experimental tests of infinite-length cylinders. Drag of circular cylinders at supersonic speeds is largely independent of fineness ratio and Reynolds number; whereas, at subsonic speeds, the drag of finite-length cylinders (fineness ratios of about 60 and below) increases as their fineness ratios increase.

NACA TN 2942

PRESSURE DISTRIBUTIONS ABOUT FINITE WEDGES IN BOUNDED AND UNBOUNDED SUBSONIC STREAMS. Patrick L. Donoughe and Ernst I. Prasse. May 1953. 41p. diagrs., photos., 2 tabs. (NACA TN 2942)

An analytical investigation of incompressible flow about wedges was made to determine effects of tunnel-wedge ratio and wedge angle on the wedge pressure distributions. The region of applicability of infinite wedge-type velocity distribution was examined for finite wedges. Theoretical and experimental pressure coefficients for various tunnel-wedge ratios, wedge angles, and subsonic Mach numbers were compared.

NACA TN 2943

THE ATTENUATION CHARACTERISTICS OF FOUR SPECIALLY DESIGNED MUFFLERS TESTED ON A PRACTICAL ENGINE SETUP. George M. Stokes and Don D. Davis, Jr. May 1953. 30p. diagrs., photos., tab. (NACA TN 2943)

Attenuation characteristics of four different resonator mufflers were determined in both cold tests and engine field tests and compared with the theoretical calculations. These mufflers were specifically designed for a helicopter. Engine-exhaust sound pressures, temperatures, and noise levels from the helicopter were measured. The experimental muffler cold tests indicated close a agreement with theory, whereas the engine tests

indicated some discrepancies. Test results show the usefulness of the theoretical equation used for predicting muffler attenuation characteristics.

NACA TN 2945

THE CREEP OF SINGLE CRYSTALS OF ALUMINUM. R. D. Johnson, F. R. Shober and A. D. Schwope, Battelle Memorial Institute. May 1953. 51p. diagrs., photos., tab. (NACA TN 2945)

The creep of single crystals of high-purity aluminum was investigated in the range of temperatures from room temperature to 400° F and at resolved-shear-stress levels of 200, 300, and 400 psi. The tests were designed in an attempt to produce data regarding the relation between the rate of strain and the mechanism of deformation. The creep data are analyzed in terms of shear strain rate and the results are discussed with regard to existing creep theories. Stress-strain curves were determined for the crystals in tensil and constant-load-rate tests in the same temperature range to supplement the study of plastic deformation by creep with information regarding the part played by crystal orientation, differences in strain markings, and other variables in plastic deformation.

NACA TN 2946

A SMALL PIRANI GAGE FOR MEASUREMENTS OF NONSTEADY LOW PRESSURES. M. John Pilny. June 1953. i, 36p. diagrs., photos. (NACA TN 2946)

A small Pirani gage made of surgical grain-of-wheat lamps and its operating equipment for the measurement of 12 channels of low pressures in the range 0.1 to 10 mm Hg abs are described, together with techniques of calibration and use. Theoretical and measured characteristics of small Pirani gages are presented to show the suitability of such gages for the precise measurement of nonsteady low pressures.

NACA TN 2947

A VISUALIZATION STUDY OF SECONDARY FLOWS IN CASCADES. Arthur G. Hansen, Howard Z. Herzig and George R. Costello. May 1953. 93p. photos., diagrs. (NACA TN 2947. Formerly RM E52F19)

Flow-visualization techniques are employed to ascertain the streamline patterns of the nonpotential, secondary flows in the boundary layers of cascades, thereby providing a basis for more extended analyses in turbomachines. The three-dimensional deflection of the end-wall boundary layer results in the formation of a vortex well up in each cascade passage. The size and tightness of the vortex generated depend upon the main flow turning in the cascade passage. Once formed, a vortex resists turning in subsequent blade rows. This results in unfavorable angles of attack and possible flow disturbances on the pressure surfaces of subsequent blade rows when the vortices impinge on these surfaces. Two major tip-clearance effects are observed: the formation of a tip-clearance vortex, and the scraping effect of a blade with relative motion past the wall boundary layer. The flow patterns indicate methods for improving the blade-tip loading characteristics of compressors and of low- and high-speed turbines.

NACA TN 2949

A VARIABLE-FREQUENCY LIGHT SYNCHRONIZED WITH A HIGH-SPEED MOTION-PICTURE CAMERA TO PROVIDE VERY SHORT EXPOSURE TIMES. Walter F. Lindsey and Joseph Burlock. May 1953. 17p. photos., diagrs. (NACA TN 2949)

A new high-speed photographic technique has been developed which employs a variable-frequency light synchronized with a commercially available 16-millimeter high-speed motion-picture camera without appreciable alterations to the camera. The technique is described and results obtained by this technique of photographing the flow past models in a wind tunnel employing the schlieren method of flow visualization are presented. The photographs show that the new technique, through the use of extremely short exposure times (about 4 microseconds), provides more sharply defined pictures throughout the flow field than were obtained by conventional techniques.

NACA TN 2950

A NEW SHADOWGRAPH TECHNIQUE FOR OBSERVATION OF CONICAL FLOW PHENOMENA IN SUPERSONIC FLOW AND PRELIMINARY RESULTS OBTAINED FOR A TRIANGULAR WING. Eugene S. Love and Carl E. Grigsby. May 1953. 16p. diagrs., photos. (NACA TN 2950)

A new shadowgraph technique is presented for the observation of conical flow phenomena in supersonic flow in a plane normal or nearly normal to the axis of propagation. Preliminary results obtained for a triangular wing are also presented.

NACA TN 2951

FLIGHT INVESTIGATION OF THE EFFECT OF TRANSIENT WING RESPONSE ON WING STRAINS OF A FOUR-ENGINE BOMBER AIRPLANE IN ROUGH AIR. Harold N. Murrow and Chester B. Payne. June 1953. 24p. diagrs., 2 tabs. (NACA TN 2951)

The results of a flight investigation on a four-engine bomber airplane to determine the effect of wing flexibility on wing strains show that the average amplification at the wing root station for bending strains per g in gusts was approximately 31 percent higher than the bending strains per g in slow pull-ups. The amplification factor decreased in the outboard direction, except for the most outboard station where it increased slightly. At the inboard stations the vibratory inertia effects on spar shear strains appear to induce the primary strains. At

the outboard stations the amplification factors for the shear strains were approximately the same as those for the bending strains.

NACA TN 2952

IMPINGEMENT OF WATER DROPLETS ON NACA 65_1-208 AND 65_1-212 AIRFOILS AT 4° ANGLE OF ATTACK. Rinaldo J. Brun, Helen M. Gallagher and Dorothea E. Vogt. May 1953. 49p. diagrs. (NACA TN 2952)

The trajectories of droplets in the air flowing past an NACA 65_1-208 airfoil and an NACA 65_1-212 airfoil, both at an angle of attack of 4°, were computed with a mechanical analog. The amount of water in droplet form impinging on the airfoils, the area of droplet impingement, and the rate of droplet impingement per unit area on the airfoil surface affected were calculated from the trajectories.

NACA TN 2953

AN INVESTIGATION OF THE EXPERIMENTAL AERODYNAMIC LOADING ON A MODEL HELICOPTER ROTOR BLADE. John R. Meyer, Jr. and Gaetano Falabella, Jr., Massachusetts Institute of Technology. May 1953. 110p. diagrs., photos. (NACA TN 2953)

Pressure distributions were measured on a model helicopter rotor blade under hovering and simulated forward-flight conditions. Pressures were recorded at advance ratios of 0.10, 0.22, 0.30, 0.40, and 0.50 for a zero-offset flapping-hinge rotor and at 0.10, 0.22, 0.30, 0.45, 0.60, 0.80, and 1.0 for a lifting rotor having a flapping-hinge offset of 13 percent. Analysis of angle of attack at the tip of the retreating blade indicated that an appreciable offset flapping hinge in combination with a low blade mass constant offers a means of postponing stall on the retreating blade.

NACA RM 53D14

EFFECTS OF HIGH DEGREES OF BIAXIAL STRETCH-FORMING ON CRAZING AND OTHER PROPERTIES OF ACRYLIC PLASTIC GLAZING. I. Wolock, B. M. Axilrod and M. A. Sherman. National Bureau of Standards. May 1953. 19p. photos., diagrs., 3 tabs. (NACA RM 53D14)

Tests were conducted on sheets of commercial cast polymethyl methacrylate that were hot-stretched approximately 100 and 150 percent and on unstretched control material. Tensile strength increased only for the 150-percent-stretched material. Total elongation was higher for the stretched materials than for the unstretched but decreased as the degree of stretching increased. None of the stretched specimens crazed in the short-time tensile tests. The threshold stress for stress-solvent crazing with benzene increased from approximately one-fourth of the ultimate strength for the unstretched material to approximately three-fourths for the 100-percent-stretched material. Most of the 150-percent-stretched specimens did not solvent craze at stresses very close to the ultimate strength. Abrasion resistance of the stretched material was appreciably less than that of the unstretched material.

NACA RM E53C26

DE-ICING AND RUNBACK CHARACTERISTICS OF THREE CYCLIC, ELECTRIC, EXTERNAL DE-ICING BOOTS EMPLOYING CHORDWISE SHEDDING. Robert S. Ruggeri. May 1953. 32p. photos., diagrs. (NACA RM E53C26)

The performance characteristics of three cyclic, electric, rubber-clad de-icing boots were evaluated. Each boot was operated in icing at design specifications of 21 watts per square inch for cycled areas, 13 watts per square inch for continuously heated parting strips, a heat-on time of 10 seconds, and a cycle ratio of 10. For a free-stream velocity of approximately 395 feet per second, the range of free-stream total temperature at which the icing protection afforded by the various boots became marginal was from 12° to 15° F for values of liquid-water content employed. The runback characteristics of the boots were similar. The forward cycled segments, upper and lower surfaces, were the most critical areas for the three boots investigated.

NACA RM L53A30

GUST-TUNNEL INVESTIGATION TO DETERMINE EFFECTS OF CENTER-OF-GRAVITY POSITION ON THE GUST LOADS OF A DELTA-WING MODEL WITH LEADING EDGE SWEPT BACK 60°. Thomas D. Reisert and Domenic J. Maglieri. June 1953. 13p. diagrs., photo., 2 tabs. (NACA RM L53A30)

A gust-tunnel investigation to determine the effect of center-of-gravity position on the gust loads on a delta-wing model with the leading edge swept back 60° was made over a range of center-of-gravity positions from 4 percent ahead of to 11 percent behind the leading edge of the mean geometric chord. This investigation indicated that a 1-percent rearward movement of the center-of-gravity position increased the acceleration increment in the sharp-edge gust by 0.5 percent. In a gust with a gradient distance of 6.5 chords, the acceleration increment was increased by approximately 2 percent for the same movement of the center of gravity. Comparison of these results with those for a conventional airplane model indicates that the change in load for both configurations would be nearly the same in a sharp-edge gust, but in a gust with a gradient distance of 6.5 chords, the change in load for a given change in center-of-gravity position would be approximately twice as great for the delta-wing model as for the conventional airplane model.

NACA TM 1350

THE MICROSTRUCTURE OF TURBULENT FLOW. (Mikrostructura turbulentnogo potoka.) A. M. Obukhoff and A. M. Yaglom. June 1953. 41p. diagrs. (NACA TM 1350. Trans. from Prikladnaya Matematika i Mekhanika, v. 15, 1951, p. 3-26).

An attempt is made to describe quantitatively the structure of the velocity, pressure, and acceleration fields for all scales for which the theory of Kolmogoroff is applicable.

BRITISH REPORTS

N-21801 *

Aeronautical Research Council (Gt. Brit.)
THE METHOD OF INFLUENCE FACTORS IN ARITHMETICAL SOLUTIONS OF CERTAIN FIELD PROBLEMS. PART I. A. Thom. PART II. Laura Klanfer. 1953. 30p. diagrs., tab. (ARC R & M 2440. Formerly ARC 9854; FM 968; ARC 11,010; FM 968a)

This paper gives an extension to the squares method of solving certain field problems. The idea of influence factors is used. This enables certain problems to be solved without squaring and reduces the actual arithmetical work in others to a fraction of that otherwise required. As an example, the effect of the channel walls is calculated for the flow of a compressible fluid past given profiles in channels of different widths. A comparison is also made of the resulting blockage factor with the values given by the mass-flow method described in previous work.

N-21802*

Aeronautical Research Council (Gt. Brit.)
TRANSITION AND DRAG MEASUREMENTS ON THE BOULTON PAUL SAMPLE OF LAMINAR-FLOW WING CONSTRUCTION. Part I: MEASUREMENTS IN THE 13 x 9 FT TUNNEL AT THE N. P. L. J. H. Preston and N. Gregory. Part II: MEASUREMENTS IN THE NO. 2, $11\frac{1}{2}$-FT TUNNEL AT THE R. A. E. K. W. Kimber. Part III: DISCUSSION OF RESULTS, AND NOTE. J. H. Preston. 1952. 23p. photos., diagrs., tab. (ARC R & M 2499; ARC 10,123. Formerly RAE Aero 2170)

Transition tests and drag measurements have been carried out on the Boulton Paul sample of laminar-flow wing construction up to $R = 9 \times 10^6$ in the National Physical Laboratory 13- by 9-foot tunnel and in the Royal Aircraft Establishment 11-1/2 by 8-1/2 foot tunnel up to $R = 15 \times 10^6$. At small incidences lying between $\pm 2^\circ$ and at Reynolds numbers up to 9×10^6, the agreement between measurements made in both tunnels is good. At incidences of $\pm 3^\circ$ and $\pm 4^\circ$ the transition moves forward with increase of speed more rapidly in the R. A. E. tunnel than in the N. P. L. tunnel, and the transition front is considerably more irregular in the R. A. E. tunnel. This difference occurs in spite of the appreciably less measured turbulence of the R. A. E. tunnel, which may be expected to show up, on a wing with appreciable waviness, near the limit of the low-drag range. In the N. P. L. tunnel the theoretical low-drag C_L range of ± 0.35 is maintained up to about $R = 7 \times 10^6$ with transition back to beyond 0.4c (pressure minimum at 0.45c). In the R. A. E. tunnel, the corresponding R is slightly less. The low-drag range decreases as R is increased until, at $R = 15 \times 10^6$ in the R. A. E. tunnel, the low-drag range of incidence is only $\pm 1^\circ$. This reduction is attributed to waviness of the model, exaggerated by the turbulence of the tunnel stream. Nevertheless the wing, considering its waviness, has performed remarkably well in both tunnels, especially when compared with previous models of lower waviness.

N-23040 *

Aeronautical Research Council (Gt. Brit.)
SOME EXPERIMENTS ON THE HEAT TRANSFER FROM A GAS FLOWING THROUGH A CONVERGENT-DIVERGENT NOZZLE. O. A. Saunders and P. H. Calder. January 5, 1952. 13p. diagrs., 2 tabs. (ARC 14,539; R. 222)

Heat transfer at high subsonic and supersonic speeds is more complicated than at normal velocities because the cross-sectional temperature distribution is not usually fully developed. The central core of gas is often unaffected by the heat added, in contrast to one-dimensional flow calculations which assume the heat to be spread over the whole cross section. Experiments are described using a water-cooled convergent divergent nozzle of smooth continuous profile through which hot gases at 865° C were passed and the heat transfer measured at different positions along the divergent portion, at Mach numbers up to 1.75. The results are very consistent when plotted in terms of the length Reynolds number measured from the throat. Velocity traverses at the exit also confirm that the boundary layer may be assumed to be turbulent and to commence at the throat. The heat-transfer results also agree very well with the formulas for turbulent flow over a flat plate at low speeds, suggesting that such low speed formulas may be used for supersonic flow in nozzles. Some tests with a straight pipe at high subsonic speeds give results somewhat higher than the flat plate formula, due probably to pipe radius effects.

N-23041 *

Aeronautical Research Council (Gt. Brit.)
THE TURBULENT BOUNDARY LAYER IN DIFFUSING DUCTS. (Abbreviated thesis) R. R. Shaw. January 17, 1952. 42p. diagrs., tabs. (ARC 14,587; FM 1667; Oxford Univ., Engineering Lab. No. 57)

The work reported in this thesis has been primarily a study of the flow in the (turbulent) boundary layer, but with particular emphasis on those aspects of this subject which are pertinent to calculations in a conical diffuser, and the thesis concludes with the application of the results obtained to a few typical calculations on a diffuser. The work has been restricted to the cone of an incompressible fluid, and to the turbulent (as distinct from the laminar) boundary layer.

N-23043 *

Aeronautical Research Council (Gt. Brit.)
SOME DEFICIENCIES IN CURRENT METEOROLOGICAL KNOWLEDGE IN RELATION TO THE OPERATION OF JET AIRCRAFT. P. A. Sheppard. February 20, 1952. 3p. (ARC 14,709; Civ. 258; T. 4793; RAF ARC 304)

Meteorological problems which have emerged in the design and operation of jet aircraft are discussed and the need for further knowledge in this field is pointed out.

N-23121 *

National Gas Turbine Establishment (Gt. Brit.)
THE BURNING OF SINGLE DROPS OF FUEL. Part V. THE COMBUSTION RATES OF SOLID FUEL PARTICLES. G. A. E. Godsave. November 1952. 35p. diagrs., 5 tabs. (NGTE R. 126)

A method of calculating the burning rates of solid spherical particles is proposed, using as a basis Frössling's semiempirical equation for the transfer of mass in the neighborhood of spherical surfaces. The theoretical treatment shows good agreement with published experimental results on the burning rates of carbon spheres. This being so, the theoretical equation may be used to calculate in particular the effects of Reynolds number and partial pressure of oxygen on the combustion rates.

N-23122 *

National Gas Turbine Establishment (Gt. Brit.)
OUTLINED GENERAL TREATMENT OF THE CALCULATION OF WAVE EFFECTS DUE TO SMALL DISTURBANCES OF STEADY STABILISED BURNING. PART I. P. W. H. Howe. November 1952. 51p. diagrs. (NGTE R. 128)

A procedure is outlined for calculating the transient effects caused by typical disturbances of steady burning conditions, in a duct employing a stabilized flame and a fuel with any burning characteristics. The method of solution is to express the available information as analytical formulas applying to simple cases, and then to build up an iterative process using the simple cases.

N-23153*

Aeronautical Research Council (Gt. Brit.)
SOME CURVES FOR USE IN CALCULATIONS OF THE PERFORMANCE OF CONICAL CENTREBODY INTAKES AT SUPERSONIC SPEEDS AND AT FULL MASS FLOW. L. E. Fraenkel. 1953. 33p. diagrs., 2 tabs. (ARC CP 108)

This note presents curves of a number of parameters which frequently occur in calculations of the performance of conical centerbody intakes at supersonic speeds and full mass flow. These parameters follow directly from the theoretical supersonic flow past cones. Semicone angles of 15°, 20°, 22.5°, 25°, and 30° are considered, and the range of free stream Mach number is approximately 1.3 to 3.0.

N-23154*

Aeronautical Research Council (Gt. Brit.)
THE PRESSURE ON THE SURFACE OF A FLAT ELLIPTIC CONE SET SYMMETRICALLY IN A SUPERSONIC STREAM. D. G. Hurley. 1953. 18p. diagrs., tab. (ARC CP 109)

The first order solution of the problem of the supersonic flow past a flat elliptic cone set symmetrically to the wind indicates that the pressure over the surface is constant if the body lies within the Mach cone of the apex. This result is incorrect near the leading edges of the cone and an improved solution is derived here by the introduction of line sources near the leading edges. Numerical results are given for three bodies.

N-23155*

Aeronautical Research Council (Gt. Brit.)
A NOTE ON SHOCK TUBES. D. W. Holder. 1953. 13p. diagrs. (ARC CP 110)

A brief description of the flow in shock tubes is given and some of the problems which have been investigated by using shock tubes are considered.

N-23156*

Aeronautical Research Council (Gt. Brit.)
TAILPLANE LOADS AND NORMAL ACCELERATIONS AFTER AN AUTOMATIC CONTROL FAILURE. J. L. Reddaway. 1953. 36p. diagr., 2 tabs. (ARC CP 111)

A method is given for the calculation of aircraft behavior when failure of the autopilot in pitch produces sudden elevator movements. Expressions for the changes in aircraft normal acceleration, tail unit accelerations and aerodynamic tail loads are derived. These expressions together with their maxima and the times taken to reach these maxima are tabulated. A calculation on a specific aircraft shows the use of the table.

N-23157*

Aeronautical Research Council (Gt. Brit.)
LOW SPEED WIND TUNNEL INVESTIGATION OF TAB HINGE MOMENT CHARACTERISTICS. W. J. G. Trebble and J. F. Holford. 1953. 20p. diagrs., 4 tabs. (ARC CP 112)

Hinge moments have been measured on tabs of 4.7-percent local chord on a tailplane with 14° trailing-edge angle. The range of investigation covered the effects of 32-percent nose balance and of the gap between tab and elevator. For small deflections of the control surfaces c_1 and c_2 are negligible while c_3 is -0.36 and -0.28 for the unbalanced and balanced tabs, respectively. With large angles of

the elevator, and with moderate angles when the elevator gap is open, c_2 tends to the calculated value for this wing without boundary-layer terms. Consequently the curve of tab hinge moment as the tab and elevator both move is not linear. Values of c_1 and c_3 calculated by thick airfoil theory, with Bryant's empirical boundary-layer terms, are in good agreement with measured values for small deflections.

N-23158*

Aeronautical Research Council (Gt. Brit.)
AN APPROXIMATE METHOD OF DERIVING THE TRANSIENT RESPONSE OF A LINEAR SYSTEM FROM THE FREQUENCY RESPONSE. C. A. A. Wass and E. G. Hayman. 1953. 20p. diagrs., 2 tabs. (ARC CP 113)

There are several published methods of deriving the transient response of a linear system from the known frequency response, but these are all rather lengthy. Another method is described, which is much more rapid, although less accurate. It is based on the calculation of the response of the system to a square wave as expressed by a Fourier series. For any system, there is an optimum square wave frequency, and the process of selection of this fundamental frequency is described. It is shown that consideration of responses up to the eleventh harmonic only can give transient response curves which are in error by less than 2 percent. A description is given of a circular computor which speeds the calculations, and two tables of values are included for use with the computer.

N-23159*

Aeronautical Research Council (Gt. Brit.)
A METHOD FOR CALCULATING PRESSURE DISTRIBUTIONS ON CIRCULAR ARC OGIVES AT ZERO INCIDENCE AT SUPERSONIC SPEEDS, USING THE PRANDTL-MEYER FLOW RELATIONS. H. K. Zienkiewicz. 1953. 12p. diagrs., tab. (ARC CP 114)

A method is given for a rapid determination of pressure distributions on circular arc ogives at zero incidence at supersonic speeds. The method is based on the characteristics pressure distributions and involves the use of the two-dimensional Prandtl-Meyer flow relations. It gives very good agreement with characteristics results from other sources and with experimental results. The method can probably be extended to ogives with profiles other than the circular arc.

N-23160*

Aeronautical Research Council (Gt. Brit.)
CHARTS OF THE WAVE DRAG OF WINGS AT ZERO LIFT. T. Lawrence. 1953. 22p. diagrs. (ARC CP 116)

Theoretical calculations of the wave drag at supersonic speeds of nonlifting wings of double wedge and biconvex section are reviewed, and the best method of presenting the results considered. Using this method, a representative selection of the available numerical evaluations of the theory, are presented. These should be of value for wing drag estimation purposes.

N-23161*

Aeronautical Research Council (Gt. Brit.)
ASYMMETRIC TAILPLANE LOADS DUE TO SIDESLIP. Winfried Braun. 1953. 45p. diagrs., 2 tabs. (ARC CP 119)

A method is derived which estimates the tailplane rolling-moment coefficient due to sideslip for use in strength calculations. The investigation covers the contributions to the rolling moment from the end-plate effect at the fin (twin fins are not considered), the dihedral of the tailplane, the effect of the body (which differs on the lee and windward-sides), the effects of sweepback and plan form, and of unsymmetrical lift distribution on the main wing. An allowance is made for the influence of propeller slipstream, and a tolerance suggested to cover inaccuracies of the method. Comparison with experiment shows good agreement. The method is summarized and an example given in appendices.

N-23162*

Aeronautical Research Council (Gt. Brit.)
HIGHER HARMONICS OF FLAPPING ON THE HELICOPTER ROTOR. W. Stewart. 1953. 30p. diagrs. (ARC CP 121)

The amplitudes of the flapping harmonics up to the sixth harmonic have been calculated for a range of blade pitch and blade inertia number for tip speed ratios up to 0.6. The calculations are for a straight (infinitely rigid) blade, and blade stalling is not taken into account. The results are given in the form of generalized curves. For the ordinary helicopter, the amplitude of any harmonic is about one-twelfth of the preceding harmonic, for a tip speed ratio about 0.3.

N-23174*

Forest Products Research Lab. (Gt. Brit.)
TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. SPECIAL TESTS, BLACK POPLAR - POPULUS NIGRA - HOME GROWN. (28 POUNDS PER CUBIC FOOT AT 15 PER CENT MOISTURE CONTENT) PROGRESS REPORT EIGHTEEN. February 1953. 14p. 6 tabs. (Forest Products Research Lab.)

The surface of poplar veneer often presents a rough or woolly appearance, particularly as it leaves the peeler. The main object of the tests described in this report was to see how far this surface condition could be influenced by adjustments of the knife and nosebar positions, by the treatment of the billets and by preventing accumulation of "fuzz." As a secondary object, consideration was given to the possibility of a wider use of poplar in plywood manufacture.

N-23183 *

Explosives Research and Development Establishment (Gt. Brit.) THE THERMODYNAMIC PROPERTIES OF SOME METALS AND THEIR OXIDES AT HIGH TEMPERATURES. N. W. Luft. September 1948. 18p. 10 tabs. (ERDE Tech. Memo. 14/M/48)

This memorandum is an attempt to determine the thermodynamic properties of certain metals and their oxides at high temperatures. The data are required in the assessment of the value of these metals as fuels for rocket propulsion. The metals studied were those of low atomic weight, such as; lithium, beryllium, boron, magnesium, aluminum, and calcium.

N-23196*

Royal Aircraft Establishment (Gt. Brit.)
A SATURABLE-CORE CURRENT REFERENCE CIRCUIT FOR USE WITH MAGNETIC AMPLIFIERS. A. G. Milnes and T. V. Vernon. October 1952. 14p. diagrs., tab. (RAE Tech. Note EL. 46)

A reliable, robust saturable-core type reference circuit suitable for use with magnetic amplifier regulators is described and its theory of operation discussed. Details are given of a practical design for 115V, 400 c/s operation with an output current of about 8 mA in a load of 60 ohms. With a ±10 percent supply voltage and ±7-1/2 percent frequency change an accuracy of better than ±1 percent may be expected during 1,000 hours for a range of ambient temperature from +15° C to +35° C. If the ambient temperature range is wide, for example the service range -65° to +70° C, rough temperature control to within ±5° C is required on two of the components to obtain the same over-all accuracy in the reference current. In the design described the reference draws a current of up to 50 mA from the 115 volt supply, excluding the oven heater load; and the over-all size of the reference circuit complete with the temperature-control oven is 3 in. x 2-1/2 in. x 4-1/4 in.

N-23197*

Royal Aircraft Establishment (Gt. Brit.)
SOME FURTHER OBSERVATIONS ON THE FATIGUE PROCESS IN PURE ALUMINIUM. P. J. E. Forsyth. December 1952. 25p. photos., diagrs. (RAE Met.70)

The fatigue process in pure aluminum has been more fully studied; with special reference to the mechanism of slip under cyclic stresses. The similarities and differences of deformation produced by cyclic and static stressing have been investigated both microscopically, and with the multiple beam interference technique. The effect of cyclic stressing at a higher frequency has been investigated, and it is concluded that cyclic stressing may produce a considerable rise in temperature in the region of slip bands which become more localized at higher frequencies.

N-23198 *

Royal Aircraft Establishment (Gt. Brit.)
RESIDUAL LATTICE STRAINS IN PLASTICALLY DEFORMED ALUMINIUM. Catherine M. Bateman. January 1953. 19p. diagrs., 10 tabs. (RAE Met.72)

The residual lattice strains in three types of aluminum have been measured using X-ray diffraction methods and have been compared quantitatively with the theory of an intergranular microstress system first put forward by G. B. Greenough. A discrepancy between theory and experiment when the specimens are in the form of tensile test pieces has again been observed. It is concluded that these results raise doubts as to the validity of the theory in its present form.

N-23199*

Royal Aircraft Establishment (Gt. Brit.)
ALLOYS OF TITANIUM WITH SILICON. D. A. Sutcliffe and A. C. Spickett. February 1953. 33p. diagrs., photos., 8 tabs. (RAE Met.73)

Binary titanium alloys containing up to 5.5-percent silicon by weight have been prepared by arc melting, and the limit of solid solubility of silicon in titanium determined by quenching and subsequent microscopic examination of the specimens. Tensile and hardness tests have been made on the alloys at temperatures up to 650° C and 800° C, respectively. The results show that silicon has a useful strengthening effect on titanium at elevated temperatures; 4.0-percent silicon increases the U.T.S by approximately 3 times at 650° C. Silicon also improves the oxidation resistance at 800° C and 1000° C. Limited experiments have been made to see whether the alloys were heat treatable. Some observations on the working and machining of the alloys are given.

MISCELLANEOUS

NACA Rept. 1087

Errata No. 1 on "INTERNAL-LIQUID-FILM-COOLING EXPERIMENTS WITH AIR-STREAM TEMPERATURES TO 2000° F IN 2- AND 4-INCH-DIAMETER HORIZONTAL TUBES." George R. Kinney, Andrew E. Abramson and John L. Sloop. 1952.

NACA TN 2792

Errata No. 1 on "DIRECT-READING DESIGN CHARTS FOR 24S-T3 ALUMINUM-ALLOY FLAT COMPRESSION PANELS HAVING LONGITUDINAL FORMED HAT-SECTION STIFFENERS AND COMPARISONS WITH PANELS HAVING Z-SECTION STIFFENERS." William A. Hickman and Norris F. Dow. March 1953.

DECLASSIFIED NACA REPORTS

NACA RM A8B05

EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF SUPPORT INTERFERENCE ON THE DRAG OF BODIES OF REVOLUTION AT A MACH NUMBER OF 1.5. Edward W. Perkins. May 7, 1948. 50p. diagrs., phqtos. (NACA RM A8B05) (Declassified from Confidential, 4/10/53)

This report contains the results of experimental investigation to determine the effects of support interference on the base drag and fore drag of two bodies of revolution. The results show that the rear supports affect the drag of a body of revolution through the immediate influence on the pressures acting over the rear portions of the body and thus depend on the afterbody shape of the model, the Reynolds number of flow, and the condition of the boundary layer.

NACA RM A52A10

EFFECTS OF FINITE SPAN ON THE SECTION CHARACTERISTICS OF TWO 45° SWEPT-BACK WINGS OF ASPECT RATIO 6. Lynn W. Hunton. March 17, 1952. 34p. diagrs. (NACA RM A52A10) (Declassified from Restricted, 4/10/53)

A study has been made of the finite-span effects on the local loading characteristics of two sweptback wings at low speed with a view toward providing some insight into the usefulness of two-dimensional section data and span-loading theory for determining the section characteristics of a swept wing. The two wings considered were identical in plan form having 45° of sweepback of the quarter-chord line, an aspect ratio of 6, and a taper ratio of 0.5 but differed in twist and in sections, the latter being the NACA 64A010 and NACA 64A810. The analysis is based on comparisons of local pressure distributions and local lift characteristics on the wings with comparable two-dimensional section data, all of which were available at large scale.

NACA RM E8G01

PERFORMANCE OF 24-INCH SUPERSONIC AXIAL-FLOW COMPRESSOR IN AIR. II— PERFORMANCE OF COMPRESSOR ROTOR AT EQUIVALENT TIP SPEEDS FROM 800 TO 1765 FEET PER SECOND. Irving A. Johnsen, Linwood C. Wright and Melvin J. Hartmann. January 21, 1949. 31p. diagrs. (NACA RM E8G01) (Declassified from Restricted, 4/13/53)

Results are presented for an experimental supersonic axial-flow compressor over a range of equivalent tip speeds from 800 to 1765 feet per second. The necessity to establish simple radial equilibrium behind the rotor-passage-contained normal shock is pointed out. The performance is compared to that of a similar supersonic compressor previously run in Freon-12 at the NACA Langley Laboratory. The maximum pressure ratio produced in the single stage without inlet-guide vanes was 2.08 at 1765 feet per second and was obtained at an adiabatic efficiency of 0.79 and a weight flow of 64.07 pounds per second.

NACA RM E9L21

APPROXIMATE RELATIVE-TOTAL-PRESSURE LOSSES OF AN INFINITE CASCADE OF SUPERSONIC BLADES WITH FINITE LEADING-EDGE THICKNESS. John F. Klapproth. March 3, 1950. 8p. diagrs. (NACA RM E9L21) (Declassified from Restricted, 4/13/53)

By applying a hyperbolic approximation to the form of the bow waves caused by blunt leading edges on an infinite cascade of supersonic blades, the approximate losses in relative total pressure due to the external bow-wave system arising from blunt edges and subsonic axial entrance velocities were compared. The losses increase linearly with leading-edge radius for any given relative Mach number. For a relative Mach number of 1.60, leading-edge radii may be approximately 1.5 percent of the normal blade gap with a 1-percent loss of relative total pressure.

NACA RM E51H07

DISCUSSION OF BOUNDARY-LAYER CHARACTERISTICS NEAR THE CASING OF AN AXIAL-FLOW COMPRESSOR. Artur Mager, John J. Mahoney and Ray E. Budinger. December 12, 1951. 66p. diagrs., photo., tab. (NACA RM E51H07. Now Rept. 1085) (Declassified from Restricted, 4/10/53)

Boundary-layer velocity profiles on the casing of an axial-flow compressor behind the guide vanes and rotor were measured and resolved into two components: along the streamline of the flow and perpendicular to it. Boundary-layer thickness and the deflection of the boundary layer at the wall were the generalizing parameters. Use of these results and the momentum-integral equations, the characteristics of boundary layer on the walls of axial-flow compressor are qualitatively discussed. Important parameters concerning secondary flow in the boundary layer appear to be turning of the flow and the product of boundary-layer thickness and streamline curvature outside the boundary layer. Two types of separation are shown to be possible in three dimensional boundary layer.

NACA RM L8H13

THEORETICAL AND EXPERIMENTAL ANALYSIS OF LOW-DRAG SUPERSONIC INLETS HAVING A CIRCULAR CROSS SECTION AND A CENTRAL BODY AT MACH NUMBERS OF 3.30, 2.75, AND 2.45. Antonio Ferri and Louis M. Nucci. November 10, 1948. 89p. photos., diagrs. (NACA RM L8H13) (Declassified from Confidential, 4/13/53)

Contains theoretical and experimental analysis of circular inlets having a central body at Mach numbers of 3.30, 2.75, and 2.45. The inlets have been designed in order to have low drag and high pressure

recovery. The pressure recoveries obtained are of the same order of magnitude as those previously obtained by inlets having very large external drag.

NACA RM L9G06

PRELIMINARY ANALYSIS OF AXIAL-FLOW COMPRESSORS HAVING SUPERSONIC VELOCITY AT THE ENTRANCE OF THE STATOR. Antonio Ferri. September 12, 1949. 36p. diagrs. (NACA RM L9G06) (Declassified from Confidential, 4/13/53)

An analysis of the phenomena related to an axial supersonic compressor having supersonic velocity in front of the stator is presented. The analysis shows that compression ratio for stages between 6 and 10 and adiabatic efficiency between 70 and 80 percent can be obtained. Rotor and stator design are discussed on the basis of the results of supersonic cascade tests. Range of performance of the compressor, flow stability, and starting conditions are also discussed.

NACA RM L9G07

ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF 90° SUPERSONIC TURNING PASSAGES SUITABLE FOR SUPERSONIC COMPRESSORS OR TURBINES. Luke L. Liccini. September 12, 1949. 91p. photos., diagrs., 3 tabs. (NACA RM L9G07) (Declassified from Confidential, 4/13/53)

Four 90° two-dimensional turning passages designed by the method of characteristics were tested at an inlet Mach number of 1.71. The measured losses varied from 5 to 15 percent of the inlet stagnation pressure. The smallest loss was obtained for a passage in which separation on the convex surface was minimized through the introduction of a favorable pressure gradient.

NACA RM L9J05a

INVESTIGATION OF AN IMPULSE AXIAL-FLOW COMPRESSOR. John R. Erwin and Wallace M. Schulze. February 8, 1950. 51p. diagrs., photos. (NACA RM L9J05a) (Declassified from Restricted, 4/13/53)

An investigation was made of the possibility of obtaining high pressure coefficients by applying the constant-pressure principle to axial-flow compressors. Use of blade sections developed by cascade tests permitted the design of a rotor for 75° turning and a total-pressure coefficient of 2.40. This rotor was tested at low speeds with and without stator blades. A rotor total-pressure coefficient of 2.30 with an efficiency of 98.3 percent and a stage pressure coefficient of 2.05 with an efficiency of 89.6 percent were measured at a design quantity-flow coefficient of 0.82.

NACA RM L9K14a

TANK TESTS AT SUBCAVITATION SPEEDS OF AN ASPECT-RATIO-10 HYDROFOIL WITH A SINGLE STRUT. Kenneth L. Wadlin, John A. Ramsen and John R. McGehee. July 20, 1950. 31p. diagrs., photos. (NACA RM L9K14a) (Declassified from Confidential, 2/12/53)

An investigation was made in Langley tank No. 2 to determine the lift and drag of a high-aspect-ratio rectangular hydrofoil supported by a single strut. The model was tested at various depths below the water surface at speeds up to 35 feet per second corresponding to a Reynolds number of 2.0×10^6. A maximum lift-drag ratio of 25.4 was obtained with the hydrofoil at a depth of 1/2 chord. This ratio decreased and the lift coefficient at which it occurred increased with depth. The effects of the water surface were negligible at a depth of 2 chords or greater. The data in the speed range covered showed good agreement with corresponding aerodynamic data from wind-tunnel tests.

NACA RM L50F21a

EXPERIMENTAL INVESTIGATION OF THE MIXING LOSS BEHIND THE TRAILING EDGE OF A CASCADE OF THREE 90° SUPERSONIC TURNING PASSAGES. Luke L. Liccini. August 15, 1950. 31p. diagrs., photos., tab. (NACA RM L50F21a) (Declassified from Confidential, 4/13/53)

A two-dimensional cascade of three 90° turning passages, designed by the method of characteristics, was tested at an inlet Mach number of 1.18. The total loss across the cascade was 9 percent. Of this total, approximately 5 percent is chargeable to the mixing process downstream of the trailing edges. Although a variation of the boundary-layer thickness occurred across the span and resulted in a nonuniform turning angle, the effective turning was of the order of 90°. The wake survey indicates that the velocity tends to become uniform very rapidly behind the trailing edge in the blade wake.

NACA RM L50F27a

INVESTIGATION OF AN IMPULSE AXIAL-FLOW COMPRESSOR ROTOR OVER A RANGE OF BLADE ANGLES. Wallace M. Schulze, John R. Erwin and Willard R. Westphal. August 29, 1950. 34p. diagrs., photos. (NACA RM L50F27a) (Declassified from Confidential, 4/13/53)

An investigation was made of an impulse axial-flow rotor with blades designed for 75° turning to study its performance characteristics over a wide range of blade-angle settings and quantity rates of flow. Special emphasis was given to the stall-point area. A total-pressure-rise coefficient of 3.00 at 93 percent efficiency, and at a different blade-angle setting a static-pressure-rise coefficient of 0.53 at 90 percent efficiency were realized. Information on the stall charateristics of highly cambered blading and the conditions under which a rotor induces a flow were also discovered.

NACA RM L50G05

INVESTIGATION OF A SHROUDED AND AN UNSHROUDED AXIAL-FLOW SUPERSONIC COMPRESSOR. Emanuel Boxer and John R. Erwin. September 15, 1950. 54p. diagrs., photos., tab. (NACA RM L50G05) (Declassified from Confidential, 4/13/53)

Details of the design and results of tests of an unshrouded NACA supersonic axial-flow compressor in Freon 12 are presented. Blade sections thicker than previously used permitted operation without an attached shroud. Tests were made at tip speeds ranging from 866 feet per second to 1680 feet per second when converted to sea-level air. At equivalent tip speed of 1610 feet per second with guide vanes, the rotor produced a pressure ratio of 2.03 with 83.5 percent at an air-flow rate of 28.0 pounds per second; without vanes, the values are 2.20, 84.5 percent, and 27.8, respectively. In addition, shrouded-rotor results are compared with those obtained in air at the NACA Lewis Flight Propulsion Laboratory.

NACA RM L52B06

APPLICATION OF SUPERSONIC VORTEX-FLOW THEORY TO THE DESIGN OF SUPERSONIC IMPULSE COMPRESSOR- OR TURBINE-BLADE SECTIONS. Emanuel Boxer, James R. Sterrett and John Wlodarski. April 24, 1952. 70p. diagrs., photos., 4 tabs. (NACA RM L52B06) (Declassified from Confidential, 4/13/53)

A method of designing related supersonic turbine or compressor blade sections is developed based upon a known solution of supersonic vortex flow. A major part of the turning is accomplished by concentric circular streamlines which are generated by uniquely shaped transition arcs near the leading edge of blade surfaces. An examination of the supersonic starting criteria was made as well as means of thickening the leading- and trailing-edge portions. Cascade test results of four blade passages are presented.

NACA RM L52J27a

A SIMPLIFIED MATHEMATICAL MODEL FOR CALCULATING AERODYNAMIC LOADING AND DOWNWASH FOR MIDWING WING-FUSELAGE COMBINATIONS WITH WINGS OF ARBITRARY PLAN FORM. Martin Zlotnick and Samuel W. Robinson, Jr. January 16, 1953. 36p. diagrs. (NACA RM L52J27a) (Declassified from Restricted, 4/10/53)

It is shown that a satisfactory mathematical model for a midwing wing-fuselage combination in subsonic flow can be developed from a simple vortex-image system. Using this scheme, a method for calculating the lift on the fuselage in the presence of the wing is presented and illustrated by a numerical example. In addition it is shown how the simplified mathematical model can be used for calculating the downwash behind the wing and for calculating the spanwise lift distribution on the wing in the presence of the fuselage.

National Advisory Committee for Aeronautics

Research Abstracts

NO.45 **JULY 10, 1953**

NOTICE

The NACA has recently received a stock of NACA Rept. 824 entitled "Summary of Airfoil Data." Copies are available upon request. Distribution will be on a first come first served basis.

CURRENT NACA REPORTS

NACA Rept. 1086

ANALYSIS OF THE EFFECTS OF WING INTERFERENCE ON THE TAIL CONTRIBUTIONS TO THE ROLLING DERIVATIVES. William H. Michael, Jr. 1952. ii, 12p. diagrs. (NACA Rept. 1086. Formerly TN 2332)

An analysis of the effects of wing interference on the tail contributions to the rolling stability derivatives of complete airplane configurations is made by calculating the angularity of the air stream at the vertical tail due to rolling and determining the resulting forces and moments. Some sidewash results are presented for a limited range of wing plan forms and vertical-tail sizes. Equations for using the sidewash results to determine the tail contributions to the rolling derivatives are given and some comparisons with experimental data are made.

NACA Rept. 1092

FLIGHT INVESTIGATION OF THE EFFECT OF CONTROL CENTERING SPRINGS ON THE APPARENT SPIRAL STABILITY OF A PERSONAL-OWNER AIRPLANE. John P. Campbell, Paul A. Hunter, Donald E. Hewes and James B. Whitten. 1952. ii, 17p. diagrs., photo., 2 tabs. (NACA Rept. 1092. Formerly TN 2413)

A flight investigation has been conducted on a typical high-wing personal-owner airplane to determine the effect of control centering springs on apparent spiral stability. The centering springs were used in both the aileron and rudder control systems to provide both a positive centering action and a means of trimming the airplane.

NACA Rept. 1100

ON REFLECTION OF SHOCK WAVES FROM BOUNDARY LAYERS. H. W. Liepmann, A. Roshko and S. Dhawan, California Institute of Technology. 1952. ii, 29p. diagrs., photos., tab. (NACA Rept. 1100. Formerly TN 2334)

Measurements are presented at Mach numbers from about 1.3 to 1.5 of reflection characteristics and the relative upstream influence of shock waves impinging on a flat surface with both laminar and turbulent boundary layers. The difference between impulse and step waves is discussed and their interaction with the boundary layer is compared. General considerations on the experimental production of shock waves from wedges and cones and examples of reflection of shock waves from supersonic shear layers are also presented.

NACA TN 2694

A METHOD FOR STABILIZING SHOCK WAVES IN CHANNEL FLOW BY MEANS OF A SURGE CHAMBER. Stanford E. Neice, Cornell University. June 1953. 46p. photos., diagrs. (NACA TN 2694)

In order to stabilize normal-shock waves in channel flow against the effect of disturbances originating downstream, a method based on mass removal from the channel by means of a surge chamber was developed and experimentally tested in an intermittent blowdown-type wind tunnel at Cornell University. A theoretical analysis was applied to a channel shape similar to that used in a typical supersonic wind tunnel and indicated that the mass-removal technique was effective in damping the motion of the normal shock caused by a strong pulse originating downstream. Experimental results were in direct agreement with the theoretical analysis. Further experiments indicated that the mass-removal technique was effective in damping the oscillatory motion of the normal shock caused by continuous small, random, downstream disturbances.

NACA TN 2933

BEHAVIOR OF MATERIALS UNDER CONDITIONS OF THERMAL STRESS. S. S. Manson. July 1953. 105p. diagrs., photos., 6 tabs. (NACA TN 2933)

*AVAILABLE ON LOAN ONLY.

ADDRESS REQUESTS FOR DOCUMENTS TO NACA, 1724 F ST., NW., WASHINGTON 25, D. C., CITING CODE NUMBER ABOVE EACH TITLE; THE REPORT TITLE AND AUTHOR.

A review is presented of available information on the behavior of brittle and ductile materials under conditions of thermal stress and thermal shock. For brittle materials, simple formulas relating physical properties to thermal-shock resistance are derived and used to determine the relative significance of two indices currently in use for rating materials. The importance of simulating operating conditions in thermal-shock testing is deduced from the formula and is experimentally illustrated by showing that BeO could be both inferior or superior to Al_2O_3 in thermal shock depending on the testing conditions. For ductile materials, thermal-shock resistance depends upon the complex interrelation among several metallurgical variables which seriously affect strength and ductility. These variables are briefly discussed and illustrated from literature sources. The importance of simulating operating conditions in tests for rating ductile materials is especially to be emphasized because of the importance of testing conditions in metallurgy. A number of practical methods that have been used to minimize the deleterious effects of thermal stress and thermal shock are outlined.

NACA TN 2954

THE STRUCTURE OF TURBULENCE IN FULLY DEVELOPED PIPE FLOW. John Laufer, National Bureau of Standards. June 1953. 53p. diagrs. (NACA TN 2954)

Measurements, principally with a hot-wire anemometer, were made in fully developed turbulent flow in a 10-inch pipe at speeds of 10 and 100 feet per second. It is shown that rates of turbulent-energy production, dissipation, and diffusion have sharp maximums near the edge of the laminar sublayer and that there exist a strong movement of kinetic energy away from this point and an equally strong movement of pressure energy toward it. It is suggested that the flow field may be divided into three regions: Wall proximity where turbulence production, transfer, and viscous action are of about equal importance; the central region of the pipe where energy diffusion predominates; and the intermediate region where the local rate of change of turbulent-energy production dominates the energy received by diffusive action.

NACA TN 2956

CREEP-BUCKLING ANALYSIS OF RECTANGULAR-SECTION COLUMNS. Charles Libove. June 1953. 24p. diagrs. (NACA TN 2956)

A previous analysis of the creep behavior of a slightly curved pin-ended H-section column under constant load is extended to the slightly curved solid rectangular-section column. The analysis leads to a differential equation for the plastic strains at the midheight cross section. The form of the equation indicates the significant parameters which may be useful in plotting test data on the creep life of columns. These are a lifetime parameter t'_{cr}, an initial-straightness parameter S or S', and the ratio of the average applied stress to the Euler stress $\bar{\sigma}/\sigma_E$. A numerical method of solving the differential equation, suitable for use with a high-speed digital computer, is described, and typical computed results are given. The existence of a finite lifetime, although not evident from the differential equation, is argued intuitively and confirmed by the numerical computations.

NACA TN 2957

SURVEYS OF THE FLOW FIELDS AT THE PROPELLER PLANES OF SIX 40° SWEPTBACK WING-FUSELAGE-NACELLE COMBINATIONS. Vernon L. Rogallo and John L. McCloud III. June 1953. 57p. diagrs., photos. (NACA TN 2957)

The flow fields at the propeller planes of six 40° sweptback, semispan wing-fuselage-nacelle combinations have been surveyed. The significance of the flow-field parameters in terms of propeller-oscillating aerodynamic loads is indicated. Comparisons of measured and predicted upflow angles are made for all six models.

NACA TN 2958

REACTION PROCESSES LEADING TO SPONTANEOUS IGNITION OF HYDROCARBONS. Charles E. Frank and Angus U. Blackham, University of Cincinnati. June 1953. 27p. diagrs., 6 tabs. (NACA TN 2958)

The vapor-phase oxidation of isooctane at 500° C under conditions leading to rapid quenching of the reaction yields hydrogen peroxide, diisobutylene, and isobutylene as the major reaction products. As the reaction time increases, the formation of acetone and formaldehyde becomes of primary importance. Under otherwise similar conditions, n-heptane is attacked at 350° C to yield a mixture of organic peroxides as the major initial product. The next phase of reaction develops with extreme rapidity, leading mainly to the formation of a mixture of aldehydes and ketones (principally formaldehyde). The marked differences between the oxidation behavior of these two hydrocarbons are interpreted on the basis of the temperature required for oxidative attack and of the thermal stability of the alkyl and peroxy radicals obtained. Preliminary results on the oxidation of isobutane and 2, 2, 5-trimethylhexane afford additional evidence for these generalizations.

NACA TN 2959

THEORETICAL INVESTIGATION OF THE SUPERSONIC LIFT AND DRAG OF THIN, SWEPTBACK WINGS WITH INCREASED SWEEP NEAR THE ROOT. Doris Cohen and Morris D. Friedman. June 1953. 51p. diagrs. (NACA TN 2959)

Formulas are derived by the use of linear theory for the lift and drag due to lift, at supersonic speeds, of thin flat wings having a discontinuity in the leading-edge sweep, with the inboard portion of the leading edge very highly swept, the outboard portion less so. Examples show the effect of the bend in the leading edge on the pressure distribution, the lift-curve slope, and drag. The results are also related to the effect of a wing-fuselage juncture on the lift on the wing.

NACA TN 2960

DRAG OF CIRCULAR CYLINDERS FOR A WIDE RANGE OF REYNOLDS NUMBERS AND MACH NUMBERS. Forrest E. Gowen and Edward W. Perkins. June 1953. 26p. diagrs., photos. (NACA TN 2960. Formerly RM A52C20)

Pressure distribution measurements on a two-dimensional circular cylinder have been made at high subsonic and supersonic speeds. Drag coefficients obtained from these measurements are presented with results from other sources. It was found that a maximum drag coefficient of about 2.1 occurs near sonic velocity. As the Mach number was increased to 2.9 the drag coefficient decreased to about 1.34. No effects of Reynolds number were found at supercritical Mach numbers. Effects of fineness ratio on drag of three-dimensional cylinders at supersonic speeds were investigated and found to be small.

NACA TN 2961

SUBSONIC FLOW OF AIR THROUGH A SINGLE-STAGE AND A SEVEN-STAGE COMPRESSOR. Chung-Hua Wu. June 1953. 32p. diagrs., 2 tabs. (NACA TN 2961)

A method recently developed for solving the steady flow of a nonviscous compressible fluid along a relative stream surface between two adjacent blades in a turbomachine is applied to investigate the low- and high-speed subsonic air flow through a single and through a seven-stage axial compressor. Appreciable radial flow results from the radially increasing values of the angular momentum of the air particles associated with the "symmetrical velocity diagram at all radii" used in the examples. The axial-velocity distribution obtained for the example checked well with a simple approximation solution obtained previously by assuming simple sinusoidal radial-flow paths.

NACA TN 2962

EFFECT OF ICE AND FROST FORMATIONS ON DRAG OF NACA 65_1-212 AIRFOIL FOR VARIOUS MODES OF THERMAL ICE PROTECTION. Vernon H. Gray and Uwe H. von Glahn. June 1953. 68p. diagrs., photos. (NACA TN 2962)

Studies were made to determine the effect of ice and frost formations on the drag of an 8-foot-chord NACA 65_1-212 airfoil. At high angles of attack (8°), glaze-ice formations on the upper surface near the leading edge of an airfoil caused large increases in drag and incipient stalling of the airfoil. Runback icing on the lower surface, except for heavy spanwise ice ridges, presented no serious drag problems. Rime-ice formations on the leading edge did not cause large drag increases. Cyclic de-icing of the leading edge successfully decreased the drag almost to the bare airfoil drag value. Frost formations on airfoil surfaces caused large drag increases and may result in stalling of the airfoil.

NACA TN 2963

EFFECT OF VARIATION IN RIVET STRENGTH ON THE AVERAGE STRESS AT MAXIMUM LOAD FOR ALUMINUM-ALLOY, FLAT, Z-STIFFENED COMPRESSION PANELS THAT FAIL BY LOCAL BUCKLING. Norris F. Dow, William A. Hickman and B. Walter Rosen. June 1953. 17p. diagrs., 2 tabs. (NACA TN 2963)

A study is made of the effect of variation in rivet strength on the average stress at maximum load for 75S-T6 aluminum-alloy, flat, Z-stiffened compression panels that fail by local buckling. A curve is presented for the determination of the relationship between strength, diameter, and pitch of the rivets and the strength of stiffened, flat compression panels of such proportions that failure is by local buckling.

NACA TN 2964

A REVISED FORMULA FOR THE CALCULATION OF GUST LOADS. Kermit G. Pratt. June 1953. 15p. diagrs. (NACA TN 2964)

A revised gust-load formula with a new gust factor is derived to replace the gust-load formula widely used in gust studies. The revised formula utilizes the same principles and retains the same simple form of the original formula. The gust factor is calculated on the basis of a one-minus-cosine gust shape and is presented as a function of mass ratio as compared to the ramp gust shape and wing loading, respectively, used for the alleviation factor.

NACA TN 2968

PROPELLER-NOISE CHARTS FOR TRANSPORT AIRPLANES. Harvey H. Hubbard. June 1953. 47p. diagrs., photos., tab. (NACA TN 2968)

Calculations of rotational-noise and vortex-noise levels at a distance of 300 feet for engine ratings of 1,000 to 10,000 horsepower have been made for a large number of propellers in static operation. Propellers with three, four, six, and eight blades and diameters of 8, 12, 16, and 20 feet are considered. The results are presented in chart and table form for rapid estimation of the noise levels and spectrums in the range of tip Mach numbers from 0.40 to 1.00. Applications of the data to tandem and dual-rotating configurations are given and the supersonic-type propeller is also briefly considered.

NACA TN 2969

THE CONDENSATION LINE OF AIR AND THE HEATS OF VAPORIZATION OF OXYGEN AND NITROGEN. George T. Furukawa and Robert E. McCoskey, National Bureau of Standards. June 1953. 30p. diagrs., 8 tabs. (NACA TN 2969)

The condensation pressure of air was determined over the range of temperature from 60° to 85° K. The experimental results were slightly higher than the calculated values based on the ideal solution law. Heat of vaporization of oxygen was determined at four temperatures ranging from about 68° to 91° K and of nitrogen similarly at four temperatures ranging from 62° to 78° K.

NACA TN 2970

PHYSICAL PROPERTIES OF CONCENTRATED NITRIC ACID. W. L. Sibbitt, C. R. St. Clair, T. R. Bump, P. F. Pagerey, J. P. Kern and D. W. Fyfe, Purdue University. June 1953. 19p. diagrs., 2 tabs. (NACA TN 2970)

From a review of the literature and additional experimental measurements, recommended values of the physical properties of white fuming nitric acid were determined for the temperature range of approximately -35° to 300° F. These properties included thermal conductivity, dynamic viscosity, specific heat, density, and vapor pressure. Values were determined within an accuracy of 5 percent for all physical properties except the vapor pressure.

NACA RM E53C27

COMPARISON OF SEVERAL METHODS OF CYCLIC DE-ICING OF A GAS-HEATED AIRFOIL. Vernon H. Gray and Dean T. Bowden. June 1953. 66p. diagrs., photos., 2 tabs. (NACA RM E53C27)

Several methods of cyclic de-icing of a gas-heated airfoil were investigated to determine ice-removal characteristics and heating requirements. The cyclic de-icing system with a spanwise ice-free parting strip in the stagnation region and a constant-temperature gas-supply duct gave the quickest and most reliable ice removal. Heating requirements for the several methods of cyclic de-icing are compared, and the savings over continuous ice prevention are shown. Data are presented to show the relation of surface temperature, rate of surface heating, and heating time to the removal of ice.

NACA RM E53D06

INVESTIGATION OF EFFECTS OF GRAIN SIZE UPON ENGINE LIFE OF CAST AMS 5385 GAS TURBINE BLADES. C. A. Hoffman and C. A. Gyorgak. July 1953. 21p. diagr., photos., 5 tabs. (NACA RM E53D06)

An investigation was conducted to (a) determine the effects of pouring temperature and grain size upon uniformity of lives and initial failure times of groups of experimentally cast AMS 5385 gas turbine blades aged 24 hours at 1350° F and (b) relate individual lives of these experimentally cast blades to grain size. Grain size varied from 4 to 11, 200 (A. S. T. M. 8) grains per cross section. Commercially produced AMS 5385 blades were used as a control group. The blades were operated in a small gas turbine at a temperature of 1450° F and a midspan stress of 19, 000 pounds per square inch. A correlation was found to exist between number of grains per blade cross section and blade life for the experimentally cast blades; longer life was associated with the coarser grain sizes. Initial failure time and uniformity of life was better for the experimentally cast blades poured at the higher nominal temperature than those poured at the lower nominal temperature. The experimentally cast coarse-grained blades had better uniformity, similar initial failure time, but lower mean life than a group of commercially cast coarse-grain blades.

NACA RM E53D23

PROCEDURE FOR MEASURING LIQUID-WATER CONTENT AND DROPLET SIZES IN SUPERCOOLED CLOUDS BY ROTATING MULTICYLINDER METHOD. William Lewis, Porter J. Perkins and Rinaldo J. Brun. Appendix C: ALTERNATE METHOD OF REDUCING ROTATING MULTICYLINDER DATA. Paul T. Hacker. June 1953. 48p. diagrs., photos., 4 tabs. (NACA RM E53D23)

The rotating multicylinder method for in-flight determination of liquid-water content, droplet size, and droplet-size distribution in icing clouds is described. The theory of operation, the apparatus required, the technique of obtaining data in flight, and detailed methods of calculating the results, including necessary charts and tables, are presented.

NACA RM L53E04a

PRELIMINARY INVESTIGATIONS OF STRENGTH CHARACTERISTICS OF STRUCTURAL ELEMENTS AT ELEVATED TEMPERATURES. Eldon E. Mathauser and Charles Libove. June 1953. 12p. diagrs. (NACA RM L53E04a)

Methods for predicting structural strength of columns, plates, and stiffened panels at uniform elevated temperature are surveyed. For columns and plates, the material stress-strain curve is needed in determining short-time strength where creep effects are negligible, and, for stiffened panels, an "effective" stress-strain curve is useful. A method for determining the long-time, or creep, strength of columns is given. Some data obtained from creep tests on stiffened panels are included.

BRITISH REPORTS

N-23167 *

Department of Scientific and Industrial Research (Gt. Brit.) RESULTS OF EXPERIMENTS ON DISC-TESTERS WITH ROLLERS OF BALL-BEARING STEEL AND 'NITRODUR' IN LINEAR CONTACT WITH HARDENED TEST-PIECES. (Erfahrungen mit rollen aus kugellagerstahl und Nitrodur bei den versuchen an den walzenprüfständen mit linienberührung an gehärteten prüflingen.) K. -W. Kraupner. 10p. diagrs., photos. (DSIR Sponsored Research (Germany) Rept. 20. Trans. from Technische Hochschule Braunschweig, Institut für Maschinenelemente, Einzelbericht 132, October 27, 1950)

This report presents the results of experiments with normal rollers of ball-bearing steel in linear contact and experiments with pressure rollers of 'Nitrodur 81.'

N-23398*

Royal Aircraft Establishment (Gt. Brit.)
THE ESTIMATION OF ATMOSPHERIC REFRACTION FROM AZIMUTH AND ELEVATION DATA. D. J. Richardson. February 1953. 13p. diagrs. (RAE Tech. Note GW 235)

A method is proposed for estimating atmospheric refraction from azimuth and elevation data simultaneously with the determination of position coordinates, taking the curvature of the earth also into account.

N-23401*

Royal Aircraft Establishment (Gt. Brit.)
CABIN AIR CONDITIONING IN HIGH SPEED FLIGHT. F. V. Davies. January 1953. 31p. diagrs., 3 tabs. (RAE Tech. Note Aero 2196)

Some heat transfer problems of air conditioning at high speeds are discussed and tentative requirements given for $0.5 < M < 2.0$. A rational formulation of requirements cannot be obtained until there is a background of experimental data on heat transfer and temperature distributions within the cabin itself and for the thermal resistance of the cabin walls. Cooling requirements become more severe as speeds increase and there are indications that unless the heat flow through the walls can be considerably reduced by insulation a cooling system supplementary to the air conditioning plant may be necessary for exceptional flight conditions.

N-23403*

Royal Aircraft Establishment (Gt. Brit.)
D. V. L. HIGH SPEED WIND TUNNEL TESTS ON A CUSPED TRAILING EDGE AEROFOIL NACA 0 00 12 - 0.55 50/0.5. F. N. Kirk. January 1953. 18p. diagrs. (RAE Tech. Note Aero 2216)

This note presents a few results from German high speed wind tunnel tests made, in 1945, on a cusped trailing edge symmetrical section. The results of the tests on the corresponding airfoil (chord = 0.350 m) with the full trailing edge angle are not available and no direct comparison is possible. Some of the effects of cusping, however, are shown by comparison with results of tests of a 0.5 m chord of the full trailing edge airfoil.

N-23475*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE BOUNDARY LAYER NEAR A STAGNATION POINT. J. C. Cooke. June 18, 1952. 4p. 2 tabs. (ARC 15,016; FM 1742)

Homann's equation for the symmetrical flow of fluid over a body of revolution near the stagnation point is shown to be reducible to a well-known equation of Falkner and Skan, solved by Hartree. The numerical solution of Homann's equation is given here to four decimal places as a comparison with the solution obtained directly by Miss Hannah.

N-23476*

Aeronautical Research Council (Gt. Brit.)
ON THE FLOW BETWEEN TWO COAXIAL ROTATING DISCS. K. Stewartson. June 30, 1952. 9p. diagrs. (ARC 15,035; FM 1747)

The steady motion of a viscous fluid confined between two coaxial rotating disks is discussed both experimentally and theoretically. It is found experimentally that when the disks rotate in the same sense the main body of the fluid rotates as well, but if they rotate in opposite senses the main body of the fluid is almost at rest. An adequate theory is found to explain this.

N-23516*

National Gas Turbine Establishment (Gt. Brit.)
THE BURNING OF SINGLE DROPS OF FUEL. PART IV. THE FLOW OF HEAT AND CARBON RESIDUE FORMATION IN DROPS OF FUEL. G. A. E. Godsave. October 1952. 30p. diagrs., 3 tabs. (NGTE R. 125)

Investigations have been made of the flow of heat in single drops of evaporating and burning fuel. Curves are given showing the distribution of temperature with time within these single drops. Data for the density, heat capacity, and thermal conductivity of petroleum products are presented in such a manner that the generalized temperature distribution curves can be applied to drops of any petroleum product, given only the normally specified value of the specific gravity at 60° F/60°F. These investigations are of general interest in connection with the associated studies of the heat transfer to evaporating and burning single drops of fuel. They have also added significance in that calculations based on the results enable conclusions to be drawn concerning the detailed mechanism of carbon residue formation during the combustion of drops of heavy fuels.

MISCELLANEOUS

NACA Rept. 871

Errata No. 2 on "DETERMINATION OF ELASTIC STRESSES IN GAS-TURBINE DISKS." S. S. Manson. 1947.

UNPUBLISHED PAPERS

N-15887 *

California U., Berkeley.
BOUNDARY LAYER EFFECT ON THE SURFACE PRESSURE OF AN INFINITE CONE IN SUPERSONIC FLOW. T. C. Lin, S. A. Schaaf and F. S. Sherman. March 5, 1951. i, 10p. diagrs. (California U., Berkeley. HE-150-80)

The theory of Taylor and Maccoll gives the surface pressure on an infinite cone in supersonic flow as a function of the cone vertex angle and the free stream Mach number and static pressure for a gas of vanishing viscosity. When a slender conical probe is used together with an impact pressure probe to determine the static pressure and Mach number in a low density gas stream, it is desirable to have some theoretical estimate of the effect of viscous boundary layer on the probe readings. A simple approximation for a conical probe based on linearized supersonic flow and compressible boundary-layer theory is presented here.

N-24096*

Institute of Engineering Research, U. of Calif.
VISCOUS EFFECTS ON IMPACT PROBES IN A SUBSONIC RAREFIED GAS FLOW. E. D. Kane and S. A. Schaaf. March 9, 1951. 21p. photos., diagrs., tab. (Institute of Engineering Research, U. of Calif. HE-150-82)

The investigations described in this report were made to demonstrate the viscous effect on impact pressure measurements and to evaluate it by determining experimentally the relation between the measured impact pressure, the local reservoir pressure, the Mach and the Reynolds number in subsonic compressible flow.

N-24097*

Mount Washington Observatory.
SUMMARY OF A STUDY OF NEW PRINCIPLES APPLICABLE TO THE MEASUREMENT OF PARAMETERS OF THE ICING CLOUD. D. Davidson. 1953. 44p. diagrs., 2 tabs. (Mount Washington Observatory)

This report describes work done on the development of a simple practical means for measuring icing parameters in natural clouds. The report includes descriptions of four devices developed and used at the Mount Washington Observatory together with the results of observations made with these devices.

N-24250*

DIFFERENTIAL EQUATIONS OF GAS TURBINES WITH INFINITE NUMBER OF BLADES AND THEIR INTEGRALS. (Differentsial'nye uravneniya gazovykh turbin s besknonechno bol'shim chislom lopastei i ikh integraly.) V. M. Astafyev. 6p. (Trans. from Akademiîa Nauk SSSR, Doklady, vol. 68, No. 3, 1949, p. 449-452.)

The schematization of the flow in turbines by replacing the finite number of blades by an abstract system with infinite number of thin blades was considered as early as 1905-07 by Stodola. In the present paper, a new variant is given of the representation of this abstract model which leads to new results.

DECLASSIFIED NACA REPORTS

NACA RM A6G22

A STUDY OF SEVERAL PARAMETERS CONTROLLING THE TRAJECTORIES OF A SUPERSONIC ANTIAIRCRAFT MISSILE POWERED WITH SOLID- OR LIQUID-FUEL ROCKETS. Ralph F. Huntsberger. April 24, 1947. 42p. diagrs. (NACA RM A6G22) (Declassified from Restricted, 6/5/53)

The trajectories for a supersonic antiaircraft missile were calculated by a step-by-step integration method for a number of different conditions. The effects of changing drag, initial thrust ratio, and weight ratio, which are the principal variables controlling the trajectory for a fixed launching angle, were investigated.

NACA RM A7A31

DEVELOPMENT OF NACA SUBMERGED INLETS AND A COMPARISON WITH WING LEADING-EDGE INLETS FOR A 1/4-SCALE MODEL OF A FIGHTER AIRPLANE. Emmet A. Mossman and Donald E. Gault. August 7, 1947. 41p. diagrs., photos. 11 tabs. (NACA RM A7A31) (Declassified from Restricted, 6/5/53)

Characteristics of NACA submerged duct entries and wing leading-edge inlets designed for a 1/4-scale flow model of a fighter-type airplane powered by a jet engine in the fuselage are presented. Duct total-head losses at the simulated entrance to the jet engine and pressure distributions over the duct entries are shown. A comparison of the dynamic pressure recovery and critical Mach number of the two intake systems is made. Included is a discussion of methods of ameliorating a duct-flow instability which may appear with a twin-entrance submerged duct system.

NACA RM A7D11

MEASUREMENTS OF THE DAMPING IN ROLL OF LARGE-SCALE SWEPT-FORWARD AND SWEPT-BACK WINGS. Lynn W. Hunton and Joseph K. Dew. July 30, 1947. 39p. diagrs., photos., 2 tabs. (NACA RM A7D11) (Declassified from Restricted 6/5/53)

Wind-tunnel tests of five large-scale tapered wings which had angles of sweep of 0°, $\pm 30^{\circ}$, and $\pm 45^{\circ}$ have been conducted to determine the effects of both scale and sweep on the damping-in-roll parameter C_{l_p}. Rolling moment and pressure distribution were measured for each plain wing while in steady roll for an angle-of-attack range of -1° to 29°. The effects of both Reynolds number and deflection of partial-span split flaps were determined from less comprehensive tests. Several methods of predicting both the damping-in-roll and autorotational characteristics of the swept wings have been analyzed, and predicted results have been compared with the experimental data.

NACA RM A7F06

AN INVESTIGATION AT LOW SPEED OF A LARGE-SCALE TRIANGULAR WING OF ASPECT RATIO TWO. I - CHARACTERISTICS OF A WING HAVING A DOUBLE-WEDGE AIRFOIL SECTION WITH MAXIMUM THICKNESS AT 20-PERCENT CHORD. Adrien E. Anderson. November 13, 1947. 59p. diagrs., photos., tab. (NACA RM A7F06) (Declassified from Restricted, 6/5/53)

An investigation has been made of the low-speed characteristics of a 25-foot span triangular wing having an aspect ratio of 2. The airfoil section of the wing was a symmetrical double wedge with 5-percent maximum thickness at 20-percent chord. Force and moment data were obtained at several angles of sideslip for various configurations of 18.5-percent area, constant-chord split flaps, 10-percent-chord nose flaps, and semispan split-flap-type ailerons. Lift and drag data were obtained from the plain wing through a limited angle-of-attack range for Reynolds number varying between 13 and 34 million, as based on the mean aerodynamic chord.

NACA RM A7F30

A SUGGESTED METHOD OF ANALYZING FOR TRANSONIC FLUTTER OF CONTROL SURFACES BASED ON AVAILABLE EXPERIMENTAL EVIDENCE. Albert L. Erickson and Jack D. Stephenson. December 16, 1947. 59p. diagrs., photos., 2 tabs. (NACA RM A7F30) (Declassified from Confidential, 6/5/53)

Results of a transonic flutter investigation using a three-dimensional wing with a 65_1-213, a = 0.5 airfoil section are analyzed. An empirical theory is developed and checked against the results of two additional tests of small-scale models.

NACA RM A7G18

WING-FLOW TESTS OF A TRIANGULAR WING OF ASPECT RATIO TWO. I. EFFECTIVENESS OF SEVERAL TYPES OF TRAILING-EDGE FLAPS ON FLAT-PLATE MODELS. George A. Rathert, Jr. and George E. Cooper. November 14, 1947. 61p. diagrs., photos. (NACA RM A7G18) (Declassified from Confidential, 6/5/53)

This report contains the results of an investigation conducted by the wing-flow method of the effectiveness of several different types of longitudinal control flap on a flat-plate triangular plan form of aspect ratio 2. The control effectiveness parameters $d\alpha/d\delta_f$ and $dC_m/d\delta_f$ were determined for $C_N=0$ from a Mach number of 0.50 to 1.10 at Reynolds numbers of 500,000 to 1,300,000. Neither the basic plan form nor any of the controls exhibited any critical stick-fixed characteristics in the transonic speed range.

NACA RM A7H19

CHARACTERISTICS OF A 15-PERCENT-CHORD AND A 35-PERCENT-CHORD PLAIN FLAP ON THE NACA 0006 AIRFOIL SECTION AT HIGH SUBSONIC SPEEDS. Richard J. Ilk. October 2, 1947. 33p. diagrs., tab. (NACA RM A7H19) (Declassified from Restricted, 5/6/53)

Wind-tunnel tests have been made to determine the aerodynamic characteristics of a 15-percent- and a 35-percent-chord plain trailing-edge flap on the NACA 0006 airfoil section. Simultaneous measurements of section lift, drag, and pitching moment were made over a range of Mach numbers from 0.3 to approximately 0.9 at angles of attack ranging from -8° to 12° for flap deflections of 0°, 5°, and 10°. Increments of section lift coefficient and changes in airfoil angle of attack necessary to maintain constant lift with unit changes in flap deflection are presented as a measure of the effectiveness at high subsonic speeds of a plain flap employed on a very thin profile.

NACA RM A7H28

AN INVESTIGATION AT LOW SPEED OF A LARGE-SCALE TRIANGULAR WING OF ASPECT RATIO TWO. II - THE EFFECT OF AIRFOIL SECTION MODIFICATIONS AND THE DETERMINATION OF THE WAKE DOWNWASH. Adrien E. Anderson. December 10, 1947. 78p. diagrs., photos., tab. (NACA RM A7H28) (Declassified from Restricted, 6/5/53)

This report contains force and moment data obtained throughout the angle-of-attack range for a triangular wing having a symmetrical double-wedge airfoil section and various degrees of rounding of the wing leading edge and maximum thickness. The dynamic pressure and downwash angle in the wake are also presented.

NACA RM A7I29

TESTS OF SUBMERGED DUCT INSTALLATION ON A MODIFIED FIGHTER AIRPLANE IN THE AMES 40- BY 80-FOOT WIND TUNNEL. Norman J. Martin. December 11, 1947. 25p. diagrs., photos., 2 tabs. (NACA RM A7I29) (Declassified from Confidential, 6/5/53)

An investigation of an NACA submerged intake installation on a modified fighter airplane was conducted to determine the full-scale aerodynamic characteristics of this installation. In addition, tests were conducted on the submerged inlet with revised entrance lips and deflectors to determine the configuration which would result in the best dynamic pressure recovery measured at the inlet for this installation without a major rework of the entrance.

NACA RM A7L11

LOW-SPEED INVESTIGATION OF A SMALL TRIANGULAR WING OF ASPECT RATIO 2.0. II - FLAPS. Leonard M. Rose. August 9, 1948. 17p. diagrs., photo. (NACA RM A7L11) (Declassified from Restricted, 6/11/53)

Split and plain trailing-edge flaps were tested on flat-plate models having an aspect ratio of 2.0 and 63.4° sweepback of the leading edge. A constant chord flap was found to be the most effective and a skewed wing tip flap the least effective. Some additional tests of short-span split flaps at several chordwise locations indicate the possibility of obtaining balancing moments without loss in lift or changes in lift without change in attitude or balance.

NACA RM A8C03

LOW-SPEED INVESTIGATION OF A SMALL TRIANGULAR WING OF ASPECT RATIO 2.0. III - STATIC STABILITY WITH TWIN VERTICAL FINS. Leonard M. Rose. August 24, 1948. 11p. diagrs. (NACA RM A8C03) (Declassified from Restricted, 6/11/53)

Twin vertical fins were tested on a triangular wing. It was found that these fins maintained substantially constant effectiveness throughout the angle-of-attack range. The addition of the twin fins resulted in a loss in maximum lift and a reduction in static longitudinal stability at lift coefficients above 0.4.

NACA RM A9I26

ESTIMATION OF THE FORCES AND MOMENTS ACTING ON INCLINED BODIES OF REVOLUTION OF HIGH FINENESS RATIO. H. Julian Allen. November 14, 1949. 27p. diagrs. (NACA RM A9I26) (Declassified from Restricted, 6/11/53)

An approximate theory including an allowance of the effects of viscosity on inclined bodies of revolution is developed. Calculations based on this theory are compared with experiment. Discussion of the probable effects of Reynolds and Mach number is included.

NACA RM E7B11a

COOLING OF GAS TURBINES. I - EFFECTS OF ADDITION OF FINS TO BLADE TIPS AND ROTOR, ADMISSION OF COOLING AIR THROUGH PART OF NOZZLES, AND CHANGE IN THERMAL CONDUCTIVITY OF TURBINE COMPONENTS. W. Byron Brown. February 11, 1947. 26p. diagrs. (NACA RM E7B11a) (Declassified from Restricted, 6/5/53)

An analysis was developed for calculating the radial temperature distribution in a gas turbine with only the temperatures of the gas and the cooling air and the surface heat-transfer coefficients known. This analysis was applied to determine the temperatures of a complete wheel of a conventional single-stage impulse exhaust-gas turbine. The temperatures were first calculated for the case of the turbine operating at design conditions of speed, gas flow, etc., and with only the customary cooling arising from exposure of the outer blade flange and one face of the rotor to the air. Calculations were next made for the case of fins applied to the outer blade flange and the rotor. Finally the effects of using part of the nozzles for supplying cooling air and the effects of varying the metal thermal conductivity from 12 to 260 Btu per hour per foot per °F on the wheel temperatures were determined. The gas temperatures at the nozzle box used in the calculations ranged from 1600° F to 2000° F.

NACA RM E7B11b

COOLING OF GAS TURBINES. II - EFFECTIVENESS OF RIM COOLING OF BLADES. Lincoln Wolfenstein, Gene L. Meyer and John S. McCarthy. March 18, 1947. 31p. diagrs. (NACA RM E7B11b) (Declassified from Restricted, 6/5/53)

An analysis is presented of rim cooling of gas-turbine blades; that is, reducing the temperature at the base of the blade (wheel rim), which cools the blade by conduction alone. Formulas for temperature and stress distributions along the blade are derived and, by the use of experimental stress-rupture data for a typical blade alloy, a relation is established between blade life (time for rupture), operating speed, and amount of rim cooling for several gas temperatures. The effect of a blade parameter combining the effects of blade dimensions, blade thermal conductivity, and heat-transfer coefficient is determined. The effect of radiation on the results is approximated.

NACA RM E7G23

INVESTIGATION OF THRUST AUGMENTATION OF A 1600-POUND THRUST CENTRIFUGAL-FLOW-TYPE TURBOJET ENGINE BY INJECTION OF REFRIGERANTS AT COMPRESSOR INLETS. William L. Jones and Harry W. Dowman. August 25, 1947. 44p. diagrs., photo., tab. (NACA RM E7G23) (Declassified from Restricted, 6/5/53)

The performance of a centrifugal-flow-type turbojet engine (having a normal military rating of 1600-lb thrust at a rotor speed of 16,500 rpm), has been investigated at zero flight speed with injection of refrigerants at the compressor inlets. The largest part of these investigations was devoted to the injection of water and water-alcohol mixtures; brief investigations were also conducted with the injection of kerosene and carbon dioxide.

NACA RM E7G29

FLIGHT INVESTIGATION OF THRUST AUGMENTATION OF A TURBOJET ENGINE BY WATER-ALCOHOL INJECTION. Carl Ellisman. September 29, 1947. 20p. diagrs., photos. (NACA RM E7G29) (Declassified from Restricted, 6/5/53)

Thrust augmentation by injection of water-alcohol mixtures into compressor inlets of turbojet engines was investigated in flight at sea level, 5,000 and 10,000 feet to determine water-alcohol mixture and injection rate for optimum thrust augmentation. The mixture of 20 percent alcohol by weight and an injection rate of 1.45 pounds per second produced maximum thrust augmentation at 10,000 feet. This injection rate was equivalent to a water-alcohol-to-air ratio of approximately 0.05 and gave a 21 percent increase in net thrust. Below 10,000 feet the optimum water-alcohol-to-air ratio was within the range of 0.03 to 0.05.

NACA RM E7G30

COOLING OF GAS TURBINES. VII - EFFECTIVENESS OF AIR COOLING OF HOLLOW TURBINE BLADES WITH INSERTS. Joseph R. Bressman and John N. B. Livingood. October 20, 1947. 51p. diagrs., 2 tabs. (NACA RM E7G30. Now Rept. 994) (Declassified from Restricted, 6/5/53)

Contains results of analytical investigation to determine reduction in cooling-air requirements and increase in effective gas temperature for same quantity of cooling air resulting from use of insert in cooling-air passage of hollow air-cooled turbine blade. Effects of neglecting radiation and radial heat conduction on dilution and effects of variations in blade-root, average insert, and blade-root cooling-air temperatures on blade temperature are included. Insert that reduced cooling-air mass flow to minimum hot-gas flow ratio one-half reduced air mass flow two-thirds and three-fifths for adequate cooling.

NACA RM E7I22a

COOLING OF GAS TURBINES. VIII - THEORETICAL TEMPERATURE DISTRIBUTIONS THROUGH GAS TURBINE WITH SPECIAL BLADES AND COOLING FINS ON THE RIM. W. Byron Brown and John N. B. Livingood. February 17, 1948. 21p. diagrs. (NACA RM E7I22a) (Declassified from Restricted, 6/11/53)

Presents effects on blade life and effective gas temperature of analytical investigation of addition of cooling fins on the rim. Also contains two-dimensional temperature distributions through the turbine and three-dimensional temperature distributions through a section of the rim near a blade root, both obtained by relaxation. Addition of cooling fins on the rim doubled blade life and permitted a 30° F increase in effective gas temperature. Proof was obtained that a one-dimensional distribution is sufficiently accurate for most applications.

NACA RM E7I25

A COMPARISON OF THE SIMULATED-ALTITUDE PERFORMANCE OF TWO TURBOJET COMBUSTOR TYPES. Ray E. Bolz, Thomas T. Schroeter and Eugene V. Zettle. October 7, 1948. 34p. diagrs. (NACA RM E7I25) (Declassified from Restricted, 6/11/53)

Performance of German Jumo 004 can-type combustor and of two contemporary turbojet combustors of U. S. design, annular and can type, were compared to determine whether advance stage in combustor design had been reached with Jumo 004 and to determine whether there are basic, inherent differences in performance achieved with either can or annular type. Combustors are compared with respect to altitude operational limits, combustion efficiency, and total-pressure loss across combustors. Neither of two U. S. combustor types showed basic inherent advantages or disadvantages when compared. The German combustor under given conditions of investigation resulted in performance that is generally poorer than that of U. S. combustors.

NACA RM L6H28a

INVESTIGATION OF THE CHARACTERISTICS OF A HIGH-ASPECT-RATIO WING IN THE LANGLEY 8-FOOT HIGH-SPEED TUNNEL. Richard T. Whitcomb. August 28, 1946. 77p. diagrs., photos., 3 tabs. (NACA RM L6H28a) (Declassified from Restricted, 6/5/53)

An investigation of the characteristics of a wing with an aspect ratio of 9.0 and an NACA 65-210 airfoil section has been made at Mach numbers up to 0.925. The wing tested has a taper ratio of 2.5:1.0, no twist, dihedral, or sweepback, and 20-percent-chord 37.5-percent-semispan plain ailerons. Results presented include the normal-force, span-loading, pitching-moment, drag, and wake-width data for the wing alone with undeflected straight-sided ailerons.

NACA RM L6H28b

PRELIMINARY INVESTIGATION OF DOWNWASH FLUCTUATIONS OF A HIGH-ASPECT-RATIO WING IN THE LANGLEY 8-FOOT HIGH-SPEED TUNNEL. Antonio Ferri. August 28, 1946. 25p. diagrs. (NACA RM L6H28b) (Declassified from Restricted, 6/5/53)

A series of tests has been made in the wake of a high-speed wing of high aspect ratio at Mach numbers up to approximately 0.90 to determine the fluctuations of the downwash in the zone of possible tail locations. Serious fluctuations occurred in the wake of the wing. The fluctuations extended beyond the wake boundaries but with decreasing amplitude. For a high angle of attack of the wing and high Mach numbers the fluctuations were very large and extended as high as approximately 0.90 chord above the chord line of the wing. For medium angles of attack important fluctuations occurred up to about 0.70 chord above the chord line of the wing.

NACA RM L6H28c

INVESTIGATION OF DIVE BRAKES AND A DIVE-RECOVERY FLAP ON A HIGH-ASPECT-RATIO WING IN THE LANGLEY 8-FOOT HIGH-SPEED TUNNEL. Axel T. Mattson. August 28, 1946. 118p. diagrs., photos., tab. (NACA RM L6H28c) (Declassified from Restricted, 6/5/53)

The results of tests made to determine the aerodynamic characteristics of a solid brake, a slotted brake, and a dive-recovery flap mounted on a high-aspect-ratio wing at high Mach numbers are presented. The data were obtained in the Langley 8-foot high-speed tunnel for corrected Mach numbers up to 0.940. The results have been analyzed with regard to the suitability of dive-control devices for a proposed high-speed airplane in limiting the airplane terminal Mach number by the use of dive brakes and in achieving favorable dive-recovery characteristics by the use of a dive-recovery flap.

NACA RM L6H28d

AN INVESTIGATION OF A HIGH-ASPECT-RATIO WING HAVING 0.20-CHORD PLAIN AILERONS IN THE LANGLEY 8-FOOT HIGH-SPEED TUNNEL. Arvo A. Luoma. August 28, 1946. 124p. diagrs., photos., 2 tabs. (NACA RM L6H28d) (Declassified from Restricted, 6/5/53)

A three-dimensional lateral-control investigation was made at high speeds of a wing of high aspect ratio having 0.20-chord straight-sided profile plain ailerons with a span 37.5-percent of the wing semispan. Spanwise loadings and moments and rolling-moment coefficients were obtained from pressure-distribution measurements, and hinge-moment data were obtained by an electrical strain gage for Mach numbers up to 0.925 at aileron deflections from -10° to 10° and at various angles of attack.

NACA RM L6J31

PRELIMINARY INVESTIGATION OF A NEW TYPE OF SUPERSONIC INLET. Antonio Ferri and Louis M. Nucci. November 27, 1946. 35p. diagrs., photos. (NACA RM L6J31. Now TN 2286) (Declassified from Restricted, 6/5/53)

A supersonic inlet with supersonic deceleration of the flow entirely outside of the inlet is considered. A particular arrangement with fixed geometry having a central body with a circular annular intake is analyzed, and it is shown theoretically that this arrangement gives high pressure recovery for a large range of Mach number and mass flow and therefore is practical for use on supersonic airplanes and missiles. For some Mach numbers the drag coefficient for this type of inlet is larger than the drag coefficient for the type of inlet with supersonic compression entirely inside, but the pressure recovery is larger for all flight conditions. The differences in drag can be eliminated for the design Mach number.

NACA RM L6L10a

AN INVESTIGATION OF THE HINGE-MOMENT FLUCTUATIONS OF 0.20-CHORD PLAIN AILERONS ON A HIGH-ASPECT-RATIO WING IN THE LANGLEY 8-FOOT HIGH-SPEED TUNNEL. Arvo A. Luoma and Luke L. Liccini. January 10, 1947. 9p. diagrs. (NACA RM L6L10a) (Declassified from Restricted, 6/5/53)

Concurrently with a three-dimensional lateral-control investigation made in the Langley 8-foot high-speed tunnel of a wing of high aspect ratio having 0.20-chord, straight-sided-profile plain ailerons, a few photographic records of aileron vibrations were obtained by means of an oscillograph connected to the electrical strain gage used to measure aileron hinge moments. At supercritical Mach numbers, frequencies of the order of magnitude of 50 to 100 cycles per second were observed for the hinge-moment fluctuations of the aileron of the model. For a 104.5-foot-span airplane, full-scale hinge-moment-fluctuation frequencies (based on the model frequencies) are indicated to be of the same order of magnitude as the wing natural frequencies for an airplane of this size.

NACA RM L6L10b

INVESTIGATION AT HIGH SPEEDS OF A HORIZONTAL-TAIL MODEL IN THE LANGLEY 8-FOOT HIGH-SPEED TUNNEL. Ralph P. Bielat. January 31, 1947. 102p. diagrs., 3 tabs. (NACA RM L6L10b)(Declassified from Restricted, 6/5/53)

Pressure-distribution measurements and elevator hinge-moment measurements were made to determine the aerodynamic characteristics of a horizontal-tail model having an NACA 65-108 airfoil section equipped with a 30-percent-chord sealed unbalanced elevator and a 10-percent-chord plain trim tab. The tests were made for various angles of attack and control-surface deflections at Mach numbers ranging from 0.40 to 0.90. Data are presented for tests made with the surfaces of the model smooth and also with boundary-layer transition fixed at the 0.10-chord station by a row of carborundum grains on each surface.

NACA RM L6L16

EFFECTS OF COMPRESSIBILITY ON THE CHARACTERISTICS OF FIVE AIRFOILS. Bernard N. Daley. April 25, 1947. 73p. diagrs., photos., tab. (NACA RM L6L16) (Declassified from Restricted, 6/5/53)

Pressure-distribution tests were made for determination of the effects of compressibility on the characteristics of the following 5-inch-chord airfoils: the NACA 66, 2-215, the NACA 66, 2-015, and the NACA 65(216)-418 sections representing the low-drag sections; the NACA 16-212 section, typical of the type designed for high critical speeds; and the NACA 23015 section, one of the older conventional airfoils. Schlieren photographs of the air flow and limited data concerning the wake characteristics were also obtained for the conventional airfoil. Data are presented for an approximate Mach number range from 0.34 to 0.75; the corresponding Reynolds number range is from 700,000 to 1,800,000.

NACA RM L7B27

INITIAL TEST IN THE TRANSONIC RANGE OF FOUR FLUTTER AIRFOILS ATTACHED TO A FREELY FALLING BODY. J. G. Barmby and S. A. Clevenson. May 5, 1947. 16p. diagrs., photo., 2 tabs. (NACA RM L7B27) (Declassified from Restricted, 6/5/53)

Results of the first test in the transonic range of four flutter airfoils attached to a freely falling body are reported. Failures of the airfoils were telemetered and recorded. These airfoils were designed in an attempt to spread the range of flutter speeds. Telemeter records show that three of the airfoils failed at Mach numbers between 0.87 and 0.90 at an altitude of 14,000 feet, and the fourth airfoil apparently failed at a Mach number of 1.025 at 1900 feet above sea level.

NACA RM L7J08

INITIAL FLIGHT TEST OF THE NACA FR-1-A, A LOW-ACCELERATION ROCKET-PROPELLED VEHICLE FOR TRANSONIC FLUTTER RESEARCH. Ellwyn E. Angle. 25p. diagrs., photos. (NACA RM L7J08) (Declassified from Restricted, 6/11/53)

The first of a series of flutter rockets, designated the NACA FR-1-A, was successfully launched and flown at the Pilotless Aircraft Research Station, Wallops Island, Va. Two identical swept wings were tested; the left wing failed at 967 feet per second (659 miles per hour, Mach number M = 0.89), and the right wing remained on the model throughout the entire flight (maximum Mach number of 1.0). The experimental value of failure speed obtained at a Mach number of 0.89 was 76.2 percent greater than the flutter speed obtained using the two-dimensional, incompressible, unswept-wing flutter theory.

NACA RM L7K17

FLUTTER INVESTIGATION IN THE TRANSONIC RANGE OF SIX AIRFOILS ATTACHED TO THREE FREELY FALLING BODIES. S. A. Clevenson and William T. Lauten, Jr. May 6, 1948. 32p. diagrs., photos., 2 tabs. (NACA RM L7K17) (Declassified from Restricted, 6/11/53)

Results of six flutter airfoils attached to three freely falling bodies are reported. Four similar airfoils, two unswept and two with 45° sweepback, fluttered at transonic Mach numbers. Flutter frequencies and phasing were recorded. One unswept airfoil reached the top Mach number of the bomb, M = 1.145, without flutter or failure. The results compare favorably with previous bomb and rocket tests.

NACA RM L8C24

FLIGHT TEST OF NACA FR-1-B, A LOW-ACCELERATION ROCKET-PROPELLED VEHICLE FOR TRANSONIC FLUTTER RESEARCH. Ellwyn E. Angle, Sherman A. Clevenson and Reginald R. Lundstrom. July 20, 1948. 22p. diagrs., photos., 3 tabs. (NACA RM L8C24) (Declassified from Restricted, 6/11/53)

A technique has been developed using a low acceleration rocket with strain-gage-type telemeter for determining the quantitative flutter characteristics of wings in a free air stream. Two 45° swept wings similar to those tested on the NACA FR-1-A rocket fluttered in a symmetrical mode at a frequency of 37 cycles per second at a Mach number of 0.65.

NACA RM L9L09

THE EFFECT OF CHANGES IN THE LEADING-EDGE RADIUS ON THE AERODYNAMIC CHARACTERISTICS OF A SYMMETRICAL, 9-PERCENT-THICK AIRFOIL AT HIGH-SUBSONIC MACH NUMBERS. Milton D. Humphreys and Raymond A. Robinson. August 7, 1950. 48p. diagrs., photos., tab. (NACA RM L9L09) (Declassified from Confidential, 5/25/53)

Wind-tunnel tests of the NACA 0009-64, 0009-54, and 0009-44 airfoils indicated that their leading-edge radii did not greatly influence their high-speed aerodynamic characteristics for Mach numbers up to 0.825. At a Mach number of 0.85 the drag of the NACA 0009-54 airfoil, having a leading-edge radius of 0.620 percent chord, appeared to be 12 to 25 percent lower than that of the other airfoils for normal-force coefficients in the range 0 to 0.3.

NACA RM L53B18

A METHOD FOR CALCULATING THE AERODYNAMIC LOADING ON WING-TIP-TANK COMBINATIONS IN SUBSONIC FLOW. Samuel W. Robinson, Jr. and Martin Zlotnick. April 7, 1953. 43p. diagrs. (NACA RM L53B18) (Declassified from Restricted, 4/9/53)

An analytical method for calculating the aerodynamic loading on wing-tip-tank combinations in subsonic flow is developed using a simple horseshoe vortex-image system for the case of the tank axis in the plane of the wing. An illustrative example is given in the appendix, in which wing and tip-tank loadings are calculated for three configurations. The calculated results are shown to be in good agreement with experimental data.

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1095

TRANSONIC FLOW PAST A WEDGE PROFILE WITH DETACHED BOW WAVE. Walter G. Vincenti and Cleo B. Wagoner. 1952. ii, 30p. diagrs., tab. (NACA Rept. 1095. Formerly TN 2339; TN 2588)

A theoretical study has been made of the aerodynamic characteristics at zero angle of attack of a thin, doubly symmetrical double-wedge profile in the range of supersonic flight speed in which the bow wave is detached. The analysis utilizes the equations of the transonic small-disturbance theory and involves no assumptions beyond those implicit in this theory. The mixed flow about the front half of the profile is calculated by relaxation solution of a boundary-value problem for the transonic small-distrubance equation in the hodograph plane (that is, the Tricomi equation). The methods follow established lines except for the somewhat novel treatment of the boundary conditions along the shock polar and sonic line. The purely supersonic flow about the rear of the profile is found by means of the method of characteristics specialized to the transonic small-disturbance theory. Complete calculations were made for four values of the transonic similarity parameter. These were found sufficient to bridge the gap between the previous results of Guderley and Yoshihara at a Mach number of 1 and the results which are readily obtained when the bow wave is attached and the flow is completely supersonic.

NACA TN 2966

PROPELLER-PERFORMANCE CHARTS FOR TRANSPORT AIRPLANES. Jean Gilman, Jr. July 1953. 70p. diagrs. (NACA TN 2966)

The preliminary selection of a propeller on the basis of cruising and take-off performance for application to transport airplanes at flight Mach numbers up to 0.8 can be accomplished by the use of the charts and methods presented. The charts are of sufficient scope to permit a fairly rapid evaluation of the propeller performance for engine power ratings of 1,000 to 10,000 horsepower. The method is presented primarily in the interest of propeller-noise abatement.

NACA TN 2971

IMPINGEMENT OF WATER DROPLETS ON WEDGES AND DIAMOND AIRFOILS AT SUPERSONIC SPEEDS. John S. Serafini. July 1953. 62p. diagrs. (NACA TN 2971)

An analytical solution has been obtained for the equations of motion of water droplets impinging on a wedge in a two-dimensional supersonic flow field with a shock wave attached to the wedge. The closed-form solution yields analytical expressions for the equation of the droplet trajectory, the local rate of impingement and the impingement velocity at any point on the wedge surface, and the total rate of impingement. The analytical expressions are utilized to determine the impingement on the forward surfaces of diamond airfoils in supersonic flow fields with attached shock waves. The results presented include the following conditions: droplet diameters from 2 to 100 microns, pressure altitudes from sea level to 30,000 feet, free-stream static temperatures from 420° to 460° R, free-stream Mach numbers from 1.1 to 2.0, semi-apex angles for the wedge from 1.14° to 7.97°, thickness-to-chord ratios for the diamond airfoil from 0.02 to 0.14, chord lengths from 1 to 20 feet, and angles of attack from zero to the inverse tangent of the airfoil thickness-to-chord ratio.

NACA TN 2972

THEORETICAL PRESSURE DISTRIBUTIONS AND WAVE DRAGS FOR CONICAL BOATTAILS. John R. Jack. July 1953. 14p. diagrs. (NACA TN 2972)

Afterbody pressure distributions and wave drags were calculated using a second-order theory for a variety of conical boattails at zero angle of attack. Results are presented for Mach numbers from 1.5 to 4.5, area ratios from 0.200 to 0.800, and boattail angles from 3° to 11°. The results indicate that for a given boattail angle, the wave drag decreases with increasing Mach number and area ratio. The wave drag, for a constant area ratio, increases with increasing boattail angle. For a specific Mach number, area ratio, and fineness ratio, a comparison of the wave-drag coefficients for conical, tangent-parabolic, and secant-parabolic boattails showed the conical boattail to have the smallest wave drag.

NACA TN 2973

EFFECT OF PRESTRAINING ON RECRYSTALLIZATION TEMPERATURE AND MECHANICAL PROPERTIES OF COMMERCIAL, SINTERED, WROUGHT MOLYBDENUM. Kenneth C. Dike and Roger A. Long. July 1953. 25p. diagrs., photos., 3 tabs. (NACA TN 2973)

Given three presumably identical lots of commercial, sintered, wrought molybdenum, the 1-hour recrystallization temperature of one lot remained above

2900° F by limiting the amount of effective prestraining to 35 percent or less. Different recrystallization temperatures were obtained in various atmospheres, the highest in argon and the lowest in hydrogen. Metal thus fabricated and then stress-relieved possessed an ultimate tensile strength at room temperature within 10 percent of metal swaged 99 percent and also possessed equivalent ductility. At 1800° F, equivalent strength and ductility was obtained irrespective of the amount of swaging over the range of 10 to 99 percent. The amount of swaging greatly influenced the recrystallized grain size but the difference in grain size is not the major controlling factor which determines whether recrystallized molybdenum is ductile or brittle at room temperature.

NACA TN 2974

EXPERIMENTS ON MIXED-FREE- AND -FORCED-CONVECTIVE HEAT TRANSFER CONNECTED WITH TURBULENT FLOW THROUGH A SHORT TUBE. E. R. G. Eckert, Anthony J. Diaguila and Arthur N. Curren. July 1953. 59p. diagrs., photo. (NACA TN 2974)

Convective heat-transfer experiments were conducted for turbulent, mixed-free- and -forced-convection flow through a vertical heated tube with a length-to-diameter ratio of 5. Studies were made with forced air flowing parallel or opposite to the free convection flow. The Grashof numbers ranged from 10^9 to 10^{13} and the Reynolds numbers, from 36×10^3 to 377×10^3. These experiments together with results obtained by other investigators revealed that the total flow regime characterized by the Reynolds and Grashof numbers can be divided into a forced-flow regime, a free-flow regime, and a mixed-free- and -forced-convection regime. The limits for the different regimes were established.

NACA TN 2975

STRUCTURAL EFFICIENCIES OF VARIOUS ALUMINUM, TITANIUM, AND STEEL ALLOYS AT ELEVATED TEMPERATURES. George J. Heimerl and Philip J. Hughes. July 1953. 16p. diagrs., tab. (NACA TN 2975)

Efficient temperature ranges are indicated for two high-strength aluminum alloys, two titanium alloys, and three steels for some short-time compression-loading applications at elevated temperatures. Only the effects of constant temperatures and short exposure to temperature are considered, and creep is assumed not to be a factor. The structural efficiency analysis is based upon preliminary results of short-time elevated-temperature compressive stress-strain tests of the materials. The analysis covers strength under uniaxial compression, elastic stiffness, column buckling, and the buckling of long plates in compression or in shear.

NACA TN 2977

TECHNIQUES FOR CALCULATING PARAMETERS OF NONLINEAR DYNAMIC SYSTEMS FROM RESPONSE DATA. Benjamin R. Briggs and Arthur L. Jones. July 1953. ii, 67p. diagrs., 4 tabs. (NACA TN 2977)

A study has been made of the problem of determining parameters of dynamic systems, such as aircraft or servomechanisms, whose measured responses are nonlinear. The parameters studied were functions of displacement or velocity. The problem of determining such parameters involves both the recognition of the degree of nonlinearity of the data and the development of techniques of evaluation of the parameters.

NACA TN 2981

THE HIGH-SPEED PLANING CHARACTERISTICS OF A RECTANGULAR FLAT PLATE OVER A WIDE RANGE OF TRIM AND WETTED LENGTH. Irving Weinstein and Walter J. Kapryan. July 1953. 29p. diagrs., photo., 2 tabs. (NACA TN 2981)

The principal high-speed planing characteristics for a prismatic surface having an angle of dead rise of 0° (flat bottom) have been determined over a wide range of planing variables. Wetted length, resistance, center-of-pressure location, and draft were determined at speed coefficients ranging up to 25.0, beam loadings up to 87.3, and trims up to 30°. Mean wetted lengths up to 7.0 beams were obtained wherever possible.

NACA RM E53E04

MEASUREMENTS OF HEAT-TRANSFER AND FRICTION COEFFICIENTS FOR AIR FLOWING IN A TUBE OF LENGTH-DIAMETER RATIO OF 15 AT HIGH SURFACE TEMPERATURES. Walter F. Weiland and Warren H. Lowdermilk. July 1953. 19p. diagrs. (NACA RM E53E04)

Measurements of average heat-transfer and friction factors were obtained for air flowing through a smooth, electrically heated tube with a bellmouth entrance and a length-to-diameter ratio of 15 for a range of average surface temperature from 875° to 1735° R and corresponding surface-to-bulk temperature ratio from 1.6 to 2.8, Reynolds number from 2200 to 300,000, and heat fluxes up to 230,000 Btu/hr/ft^2 of heat-transfer area. The data of this investigation correlated with data obtained in previous investigations with longer tubes on the basis that the heat-transfer coefficient varies as the -0.1 power of the length-to-diameter ratio. No effect of the length-to-diameter ratio was observed on the average friction factor.

NACA RM E53E07

INVESTIGATION OF AERODYNAMIC AND ICING CHARACTERISTICS OF A FLUSH ALTERNATE-INLET INDUCTION-SYSTEM AIR SCOOP. James P. Lewis. July 1953. 42p. diagrs., photos. (NACA RM E53E07)

An investigation of the aerodynamic and icing characteristics of a full-scale induction-system air-scoop assembly incorporating a flush-type alternate inlet was conducted in the NACA Lewis icing research tunnel. The investigation was made over a range of mass-air-flow ratios, angles of attack, airspeeds, air temperatures, liquid-water content, and droplet sizes. The ram inlet gave good pressure recovery

in both clear air and icing, but rapid blocking of the carburetor screen occurred in icing. The alternate inlet had poor pressure recovery in both clear air and icing, but no serious screen icing was obtained. The investigation included the use of preheat air alone and in combination with ram- and alternate-inlet air.

NACA RM L52L29b

AN EXPERIMENTAL STUDY OF THE RELATION BETWEEN AIRPLANE AND WIND-VANE MEASUREMENTS OF ATMOSPHERIC TURBULENCE. H. B. Tolefson, K. G. Pratt and J. K. Thompson. July 1953. 20p. diagrs., photos., 3 tabs. (NACA RM L52L29b)

Analysis of simultaneous measurements of atmospheric turbulence by wind vanes mounted on a tower and by an airplane flying in the immediate vicinity of the tower indicates good correlation between the gust data for both sets of measurements. This correlation indicates that surface and airplane measurements of turbulence might be used interchangeably for engineering and meteorological purposes.

NACA RM L53E05a

SOME MEASUREMENTS OF LANDING CONTACT CONDITIONS OF TRANSPORT AIRPLANES IN ROUTINE OPERATIONS. Norman S. Silsby, Emanuel Rind and Garland J. Morris. July 1953. 8p. diagrs., photos. (NACA RM L53E05a)

Measurements have been obtained by means of a specially built motion-picture camera of 126 landings of current transport airplanes during routine operations at the Washington National Airport in clear-air daytime conditions. From these measurements, sinking speeds, roll attitude angles, and rolling velocities have been evaluated and a brief statistical analysis of the results has been made.

NACA TM 1357

AIR ADMIXTURE TO EXHAUST JETS. (Luftzumischung zu Abgasstrahlen). E. Sänger. July 1953. 35p. diagrs. (NACA TM 1357. Trans. from Ingenieur-Archiv, v. 18, no. 5, 1950, p. 310-323).

The problem of thrust increase by air admixture to exhaust jets of rockets, turbojet, ram- and pulse-jet engines is investigated theoretically. The optimum ratio of mixing chamber pressure to ambient pressure and speed range for thrust increase due to air admixture is determined for each type of jet engine.

NACA TM 1359

AIR-WATER ANALOGY AND THE STUDY OF HYDRAULIC MODELS. (La Similitudine Aria-Acqua e lo Studio dei Modelli Idraulici). Giulio Supino. July 1953. 22p. diagrs. (NACA TM 1359. Trans. from Energia Elettrica, v. 28, no. 11, Nov. 1951).

The author first sets forth some observations about the theory of models. Then he establishes certain general criteria for the construction of dynamically similar models in water and in air, through reference to the perfect fluid equations and to the ones pertaining to viscous flow. It is, in addition, pointed out that there are more cases in which the analogy is possible than is commonly supposed.

BRITISH REPORTS

N-23173*

Department of Scientific and Industrial Research (Gt. Brit.) EXPERIMENTS ON DISC-TESTING MACHINES. (Bericht über dem stand der versuche an den walzenprüfständen). O. Kraupner. ii, 26p. diagrs. (DSIR Sponsored Research (Germany) Rept.2. Trans. from Technische Hochschule Braunschweig, Institut für Maschinenelemente, Einzelbericht 117, October 20, 1949)

The report presents experimental information on materials, alinement, types of loading, lubricant viscosity, rotational speed, and size of roller bearings.

N-23175*

Forest Products Research Lab. (Gt. Brit.) TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. GABOON - (AUCOUMEA KLAINEANA PIERRE) FRENCH EQUATORIAL AFRICA. (27 POUNDS PER CUBIC FOOT AT 15 PER CENT MOISTURE CONTENT) PROGRESS REPORT NINETEEN. (Superseding Progress Report six, February 1950) February 1953. 20p. 6 tabs. (Forest Products Research Lab.)

This report presents the results of tests on gaboon, a wood to be used in the manufacture of plywood.

N-23829*

Royal Aircraft Establishment (Gt. Brit.) SOME ELECTRONIC MULTIPLIERS BASED ON DIODE FUNCTION SHAPERS. O. H. Lange and G. J. Herring. April 1953. 35p. diagrs., photos. (RAE Tech. Note GW 245)

Various types of analogue multipliers using electronic diodes are described in this report. They are either of the indirect type based on the relation $xy = \sin\alpha \sin\beta = \frac{\cos(\alpha - \beta) - \cos(\alpha + \beta)}{2}$ or on the parabolic law $4xy = (x + y)^2 - (x - y)^2$ or direct multipliers of a more general application. The design procedure is given, and as examples some indirect square law multipliers have been built, experimental results being presented. Figures obtained from two different circuits showed an error of less than 1 percent of the maximum value.

N-23830*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) DIFFERENTIAL PERFORMANCE REDUCTION METHODS FOR TURBO-PROPELLER AIRCRAFT. K. J. Lush. May 6, 1953. 16p. 2 tabs. (AAEE/Res/275)

Reduction methods for level speed, climb, and fuel consumption tests have been derived, which are, in the absence of compressibility effects, suitable for use with turbopropeller aircraft at the present stage. The methods require individual treatment of the particular engine installation, as they deal only with the reduction equation which would result from any given engine behavior. Numerical generalization about engine behavior did not seem worth while at the present stage, but simplifying generalizations are briefly discussed, which might become possible when experience is gained, and the simplifying assumptions are indicated.

N-23831*

Royal Aircraft Establishment (Gt. Brit.)
PILOT ESCAPE FROM SPINNING AIRCRAFT. T. H. Kerr. December 1952. 24p. photos. (RAE Tech. Note Aero 2199)

A series of pilot escape tests from models of elementary and advanced trainers, and fighter aircraft in the spin are presented. Escapes were made from varying points relative to the wing chord, on the inboard and outboard sides of the spin. The analyzed results show that if the pilot requires to bail out from a spinning aircraft, it is best to leave on the outboard side of the aircraft and in the crouching attitude. In this condition, it is most probable that he will clear the aircraft cleanly and be outside the spiral flight path within a half turn of the spin. If he bails out on the inboard side, his flight path will probably be through or very near the propeller disk and it will probably take at least two turns of the spin for him to clear the helical flight path of the aircraft.

N-23865*

Aeronautical Research Council (Gt. Brit.)
THE SKIN FRICTION ON INFINITE CYLINDERS MOVING PARALLEL TO THEIR LENGTH. G. K. Batchelor. August 6, 1952. 15p. diagrs. (ARC 15, 105; FM 1772)

This paper is concerned with the three-dimensional unidirectional motion that is generated by the forced motion of an infinite cylinder parallel to its length in a viscous incompressible fluid. The cylinder and the fluid are at rest initially, and the cylinder is brought to a velocity W which remains steady thereafter; the subsequent motion of the fluid is to be determined.

UNPUBLISHED PAPERS

N-24151*

Massachusetts Inst. of Tech.
A RADIATION THERMOMETER FOR METEOROLOGICAL USE. J. C. Johnson. March 15, 1953. 43p. diagrs., photos., 3 tabs. (Massachusetts Inst. of Tech.)

The theory, design, and construction of an infrared pyrometer calibrated as a thermometer is described. The instrument is termed a radiation thermometer. The radiation thermometer utilizes the 14.7μ band of radiation from the carbon dioxide always present in air as an indicator of free air temperature. The principle, though successful, averages the radiation over a path of the order of 2 miles. Because of this, the temperature measurement obtained will have limited significance. The same instrument will measure the temperature in the interior of clouds, averaging over a path whose length is of the order of the visual range. It is in this capacity that the radiation thermometer may be most useful.

DECLASSIFIED NACA REPORTS

NACA RM A7K03

LOW-SPEED INVESTIGATION OF A SMALL TRIANGULAR WING OF ASPECT RATIO 2.0. I - THE EFFECT OF COMBINATION WITH A BODY OF REVOLUTION AND HEIGHT ABOVE A GROUND PLANE. Leonard M. Rose. August 27, 1948. 41p. diagrs., photos., 7 tabs. (NACA RM A7K03) (Declassified from Restricted, 6/11/53)

Tests were made of triangular wing of aspect ratio 2.0 with a symmetrical double-wedge section with a maximum thickness of 5 percent of the chord. Results are presented for the wing alone and in two locations on a body of fineness ratio 12.5. Further data are also presented for the wing at several heights above a ground plane.

NACA RM A7K05

TESTS OF A TRIANGULAR WING OF ASPECT RATIO 2 IN THE AMES 12-FOOT PRESSURE WIND TUNNEL. I - THE EFFECT OF REYNOLDS NUMBER AND MACH NUMBER ON THE AERODYNAMIC CHARACTERISTICS OF THE WING WITH FLAP UNDEFLECTED. George G. Edwards and Jack D. Stephenson. January 22, 1948. 42p. diagrs., photos. (NACA RM A7K05) (Declassified from Restricted, 6/11/53)

This report presents results of tests of a semispan model of a wing having a triangular plan form, an aspect ratio of 2, and a double-wedge uncambered airfoil section with the maximum thickness at 20 percent of the chord. The effects of the addition of a fuselage and of minor modifications to the airfoil section were investigated. Aerodynamic characteristics of the model are presented for a range of Reynolds numbers from 5,000,000 to 27,500,000 at 0.18 Mach number and for a range of Mach number from 0.18 to 0.95 at 5,300,000 Reynolds number. Change in Reynolds number had little effect, and increasing the Mach number to the highest obtainable in the tunnel did not introduce sudden or abrupt changes in the wing characteristics.

NACA RM A7L05

AN INVESTIGATION OF THE DOWNWASH AND WAKE BEHIND LARGE-SCALE SWEPT AND UNSWEPT WINGS. William H. Tolhurst, Jr. February 2, 1948. 25p. diagrs., photo. (NACA RM A7L05) (Declassified from Restricted, 6/11/53)

This report contains the results of an investigation to determine, at large scale, the downwash and wake behind wings of 0°, $\pm 30^{\circ}$, and $\pm 45^{\circ}$ of sweep. The results include contour maps of downwash angle in a vertical plane located at a distance behind the wing approximating a normal tail position, and the spanwise variation of wake limits and pressure losses in the wake for several angles of attack.

NACA RM A8D02

AERODYNAMIC STUDY OF A WING-FUSELAGE COMBINATION EMPLOYING A WING SWEPT BACK 63° - INVESTIGATION OF A LARGE-SCALE MODEL AT LOW SPEED. Gerald M. McCormack and Walter C. Walling. January 21, 1949. 20p. diagrs., photos. (NACA RM A8D02) (Declassified from Restricted, 6/29/53)

Aerodynamic characteristics are presented for the wing alone and for the wing-fuselage combination. Experimental results are compared with characteristics predicted theoretically. The relationships between the aerodynamic characteristics and flow conditions existing over the wing are discussed.

NACA RM A8D27

WIND-TUNNEL INVESTIGATION OF TRANSONIC AILERON FLUTTER OF A SEMISPAN WING MODEL WITH AN NACA 23013 SECTION. Angelo Perone and Albert L. Erickson. July 12, 1948. 23p. diagrs., photos., tab. (NACA RM A8D27) (Declassified from Confidential, 6/11/53)

An investigation of aileron flutter with one degree of freedom up to 0.822 Mach number on a wing with an NACA 23013 section and the effect of wing-tip relief in alleviating aileron flutter are discussed. The beneficial effect of a low aileron-span-to-wing-span ratio is considered. The agreement that existed between the predicted and the actual flutter frequency was sufficient to indicate that sections of the type tested will not alter the existing recommendations for flutter analysis.

NACA RM A8E03

TESTS OF A TRIANGULAR WING OF ASPECT RATIO 2 IN THE AMES 12-FOOT PRESSURE WIND TUNNEL. II - THE EFFECTIVENESS AND HINGE MOMENTS OF A CONSTANT-CHORD PLAIN FLAP. Jack D. Stephenson and Arthur R. Amuendo. September 21, 1948. 82p. diagrs., photos., 9 tabs. (NACA RM A8E03) (Declassified from Restricted, 6/11/53)

This report presents the results of tests of a semispan model of a triangular wing having an aspect ratio of 2. The effects of deflecting a constant-chord plain flap were investigated for a Mach number range from 0.18 to 0.95 at a Reynolds number of 5,300,000 and at low speed for a Reynolds number range from 5,300,000 to 15,000,000. The data have been used in the calculation of some longitudinal characteristics of a triangular-wing tailless airplane. Increasing the Mach number from 0.18 to 0.95 caused systematic increases in longitudinal stability, lift, and control effectiveness, and algebraic decreases in the hinge-moment coefficients. Little effect due to variation in Reynolds number or to minor modifications of the airfoil section was noted.

NACA RM A8H03

SOME PRELIMINARY RESULTS IN THE DETERMINATION OF AERODYNAMIC DERIVATIVES OF CONTROL SURFACES IN THE TRANSONIC SPEED RANGE BY MEANS OF A FLUSH-TYPE ELECTRICAL PRESSURE CELL. Albert L. Erickson and Robert C. Robinson. October 8, 1948. 40p. diagrs., photos., 3 tabs. (NACA RM A8H03) (Declassified from Confidential, 6/11/53)

A method of measuring fluctuating aerodynamic forces by using electrical pressure cells is presented along with the analysis of one cycle of motion of a control surface during transonic flutter with one degree of freedom. The report shows the differences between upper- and lower-surface hinge moments and explains these differences to some extent.

NACA RM A9B17

CHORDWISE AND SPANWISE LOADINGS MEASURED AT LOW SPEED ON LARGE TRIANGULAR WINGS. Adrien E. Anderson. April 19, 1949. 78p. diagrs., photos., 2 tabs. (NACA RM A9B17) (Declassified from Restricted, 6/11/53)

Pressure distributions have been obtained from three triangular wing models: a wing-alone model having an aspect ratio of 2.04 and a modified double-wedge airfoil section; the same wing combined with a body of fineness ratio 12.5; and a mock-up of a triangular wing airplane which had an aspect ratio of 2.31 and an NACA 65-006.5 airfoil section. Pressure data were obtained through an angle-of-attack range at zero angle of sideslip. Chordwise pressure distribution, section lift characteristics, section centers of pressure, and span load distribution are presented.

NACA RM A9D04

FLIGHT INVESTIGATION OF THE EFFECT OF BOUNDARY-LAYER SUCTION ON PROFILE-DRAG COEFFICIENT AT SUPERCRITICAL MACH NUMBERS. Richard B. Skoog. September 20, 1949. 30p. diagrs., photos. (NACA RM A9D04) (Declassified from Confidential, 6/29/53)

Results of flight tests to study at high Reynolds number the effect of boundary-layer removal aft of the shock wave on airfoil drag at supercritical Mach numbers showed that no measurable effect of the suction existed for the available suction coefficient even though separation was present. The drag increase with Mach number was due primarily to pressure changes associated with supersonic flow on upper and lower surfaces which resulted in increased pressure drag.

NACA RM A9G13

TESTS OF A MODEL HORIZONTAL TAIL OF ASPECT RATIO 4.5 IN THE AMES 12-FOOT PRESSURE WIND TUNNEL. I - QUARTER-CHORD LINE SWEPT BACK 35°. Bruce E. Tinling and Jerald K. Dickson. September 9, 1949. 118p. diagrs., photo., tab. (NACA RM A9G13) (Declassified from Restricted, 6/11/53)

This report presents results of tests of a semispan model of a horizontal tail of aspect ratio 4.5 with the quarter-chord line swept back 35°; the NACA 64A010 airfoil section; and a plain, sealed elevator with tab. The Reynolds number was varied from 2,000,000 to 11,000,000 at a Mach number of 0.21 and Mach number was varied from 0.21 to 0.94 at a Reynolds number of 2,000,000. Lift, drag, pitching moment, elevator hinge moment, streamwise distribution of static pressure at the mid-semispan, tab effectiveness, tab hinge moment, and pressure difference across the elevator-nose seal were measured.

NACA RM A9G18

EFFECTS OF SYSTEMATIC CHANGES OF TRAILING-EDGE ANGLE AND LEADING-EDGE RADIUS ON THE VARIATION WITH MACH NUMBER OF THE AERODYNAMIC CHARACTERISTICS OF A 10-PERCENT-CHORD-THICK NACA AIRFOIL SECTION. James L. Summers and Donald J. Graham. September 26, 1949. 81p. diagrs., photos., 9 tabs. (NACA RM A9G18) (Declassified from Restricted, 6/11/53)

The effects of systematic changes in trailing-edge angle and leading-edge radius on the variation with Mach number of the aerodynamic characteristics of a 10-percent-chord-thick symmetrical NACA airfoil section are evaluated from wind-tunnel tests at Mach numbers from 0.3 to 0.9. Reductions in both parameters are shown to be beneficial to the section lift-curve slope at Mach numbers below that for the lift break, and to the maximum section lift coefficient at Mach numbers above 0.7 and detrimental to the drag-divergence Mach number at low section lift coefficients.

NACA RM A9H04

AN INVESTIGATION AT LOW SPEED OF A LARGE-SCALE TRIANGULAR WING OF ASPECT RATIO TWO. III. CHARACTERISTICS OF WING WITH BODY AND VERTICAL TAIL. Adrien E. Anderson. October 14, 1949. 96p. diagrs., photos., 3 tabs. (NACA RM A9H04) (Declassified from Restricted, 6/11/53)

An investigation has been made to determine the aerodynamic characteristics in sideslip of a triangular wing of aspect ratio 2.04 in combination with a body of fineness ratio 12.5 and a vertical tail surface. Force and moment data were obtained at several angles of sideslip for various configurations of constant-chord split flaps, semispan split-flap-type ailerons and a constant-chord rudder. The Reynolds number was 15.4×10^6 and the Mach number 0.13.

NACA RM A9H11a

TESTS OF A MODEL HORIZONTAL TAIL OF ASPECT RATIO 4.5 IN THE AMES 12-FOOT PRESSURE WIND TUNNEL. II - ELEVATOR HINGE LINE NORMAL TO THE PLANE OF SYMMETRY. Bruce E. Tinling and Jerald K. Dickson. October 17, 1949. 106p. diagrs., photo., tabs. (NACA RM A9H11a) (Declassified from Restricted, 6/11/53)

This report presents results of tests of a semispan model of a horizontal tail of aspect ratio 4.5 with the hinge line normal to the plane of symmetry; the NACA 64A010 airfoil section; and a plain, sealed elevator with tab. The Reynolds number was varied from 2,000,000 to 11,000,000 at a Mach number of 0.21 and the Mach number was varied from 0.21 to 0.88 at a Reynolds number of 2,000,000. Lift, drag, pitching moment, elevator hinge moment, chordwise distribution of static pressure at the mid-semispan, tab effectiveness, tab hinge moment, and pressure difference across the elevator-nose seal were measured. Results are compared to those of a previous investigation of a model which differed primarily in that its quarter-chord line had 35° of sweepback.

NACA RM A9K02a

EFFECTS OF BOUNDARY-LAYER CONTROL ON THE LONGITUDINAL CHARACTERISTICS OF A 45° SWEPT-FORWARD WING-FUSELAGE COMBINATION. Gerald M. McCormack and Woodrow L. Cook. February 2, 1950. 73p. diagrs., photo., 2 tabs. (NACA RM A9K02a) (Declassified from Restricted, 6/29/53)

An investigation has been conducted to determine the benefits obtainable by applying boundary-layer control to a 45° sweptforward wing-fuselage combination. Force and pressure-distribution data are presented for the model with and without boundary-layer control with leading-edge and trailing-edge flaps. The results showed that with suction applied through a slot at the wing-fuselage juncture separation could be postponed from a lift coefficient between 30 and 50 percent of the maximum to a lift coefficient between 78 and 93 percent of the maximum.

NACA RM A9K02b

A DESIGN STUDY OF LEADING-EDGE INLETS FOR UNSWEPT WINGS. Robert E. Dannenberg. June 30, 1950. 56p. diagrs., photos., 3 tabs. (NACA RM A9K02b) (Declassified from Restricted, 6/11/53)

A method is presented for calculating the profile coordinates for an inlet to be placed in the leading edge of an airfoil from formulas. The method includes an application of the principles of thin-airfoil theory which permits the change in velocity distribution caused by a variation in inlet profile to be calculated. Wind-tunnel tests of leading-edge inlets in an airfoil having the NACA 63_1-012 section were made to evaluate the effects of the inlets on the aerodynamic characteristics of the airfoil. The results indicated that the airfoil with an inlet devised by the design method had satisfactory aerodynamic characteristics.

NACA RM A50D04

EFFECTS OF LEADING-EDGE RADIUS AND MAXIMUM THICKNESS-CHORD RATIO ON THE VARIATION WITH MACH NUMBER OF THE AERODYNAMIC CHARACTERISTICS OF SEVERAL THIN NACA AIRFOIL SECTIONS. Robert E. Berggren and Donald J. Graham. July 3, 1950. 65p. diagrs., 7 tabs. (NACA RM A50D04) (Declassified from Restricted, 6/11/53)

The results of a wind-tunnel investigation at Mach numbers to approximately 0.9 and Reynolds numbers from 1×10^6 to 2×10^6 indicate no significant effects of leading-edge-radius variation on the variation with Mach number of the aerodynamic characteristics of 4- and 6-percent-chord-thick NACA 4-digit-series airfoil sections. The results indicate beneficial effects of maximum thickness reduction on lift and drag characteristics and no important effects on moment characteristics.

NACA RM A50E02

PRESSURE-DISTRIBUTION AND RAM-RECOVERY CHARACTERISTICS OF NACA SUBMERGED INLETS AT HIGH SUBSONIC SPEEDS. Joseph L. Frank. July 7, 1950. 41p. diagrs., photo. (NACA RM A50E02) (Declassified from Confidential, 6/11/53)

Presented are results of tests of NACA submerged inlets at four fuselage stations on a model of a hypothetical fighter airplane. Ram-recovery ratios were generally maximum for mass-flow ratios between 0.60 and 0.80. The inlet in the most forward position provided the highest ram recovery for almost all test conditions. Inlets in the region of high-velocity flow induced by the wing had compressibility losses beginning at 0.70 Mach number.

NACA RM E7K19

PRELIMINARY INVESTIGATION OF CONE-TYPE DIFFUSERS DESIGNED FOR MINIMUM SPILLAGE AT INLET. Roger W. Luidens and Henry Hunczak. May 3, 1948. 31p. photos., diagrs. (NACA RM E7K19) (Declassified from Confidential, 6/11/53)

Presents an investigation at a Mach number of 1.85 of cone-type diffuser designed for minimum spillage at the inlet. Pressure recoveries of stationary-cone configurations are presented as functions of cone angle, outlet-inlet area ratio, throat length, and angle of attack. Pressure recoveries of a 30° movable-cone configuration are presented as functions of contraction ratio and outlet-inlet area ratio. Stabilization of the normal shock within the diffuser by use of perforations is experimentally verified.

NACA RM E7L05

ANALYTICAL INVESTIGATION OF DISTRIBUTION OF CENTRIFUGAL STRESSES AND THEIR RELATION TO LIMITING OPERATING TEMPERATURES IN GAS-TURBINE BLADES. Richard H. Kemp and William C. Morgan. April 12, 1948. 25p. photo., diagrs. (NACA RM E7L05) (Declassified from Restricted, 6/11/53)

The distribution of centrifugal stresses at maximum operating conditions are presented for six turbine-blade designs and the limitation imposed on the permissible centrifugal stresses by the operating temperatures is discussed. It was found that this temperature limitation was important. In the case of one blade, several recorded surface failures have occurred in the region indicated as critical by this analysis.

NACA RM E8A26

FREE-FLIGHT INVESTIGATION OF 16-INCH-DIAMETER SUPERSONIC RAM-JET UNIT. George F. Kinghorn and John H. Disher. May 28, 1948. 20p. diagrs., photos. (NACA RM E8A26) (Declassified from Confidential, 6/11/53)

In order to determine the performance of ram-jet units in flight at supersonic speeds and to study methods for improving the performance, an investigation of a series of 16-inch-diameter ram-jet engines is being conducted in free flight. Supersonic flight speeds are obtained by releasing the unit from an airplane at an altitude of approximately 30,000 feet and allowing the engine thrust and the force of gravity to accelerate the unit.

NACA RM E8H03

COOLING OF GAS TURBINES. IX - COOLING EFFECTS FROM USE OF CERAMIC COATINGS ON WATER-COOLED TURBINE BLADES. W. Byron Brown and John N. B. Livingood. October 13, 1948. 26p. diagrs. (NACA RM E8H03) (Declassified from Restricted, 6/11/53)

Calculations of the effect of a ceramic coating on blade-metal and gas temperatures are prepared and comparisons of these effects with the changes produced by moving the cooling passages nearer the trailing edge are made. Results indicate that very low-conductivity ceramics, such as mica and porcelain, or material with similar conductivities, must be used to secure practical results.

NACA RM E8K05

PRESSURE DISTRIBUTIONS ON THIN CONICAL BODY OF ELLIPTIC CROSS SECTION AT MACH NUMBER 1.89. Stephen H. Maslen. January 20, 1949. 18p. diagrs., photo. (NACA RM E8K05) (Declassified from Confidential, 6/11/53)

Experimental pressure distributions at Mach number 1.89 are presented for a conical body of elliptic cross section. Data are presented for range of angles of yaw from -16° to 16° and angles of attack from -10° to 10°. Over the entire range of calculations, linearized theory checked closely with experiment.

NACA RM E50B02

CHARACTERISTICS OF PERFORATED DIFFUSERS AT FREE-STREAM MACH NUMBER 1.90. Henry R. Hunczak and Emil J. Kremzier. May 8, 1950. 69p. diagrs., photos. (NACA RM E50B02) (Declassified from Confidential, 6/11/53)

An investigation was conducted at Mach number 1.90 to determine pressure recovery and mass-flow characteristics of series of perforated convergent-divergent supersonic diffusers. Pressure recoveries as high as 96 percent were obtained, but at reduced mass flows through the diffuser. Theoretical considerations of effect of perforation distribution on shock stability in converging section of diffuser are presented and correlated with experimental data. A method of estimating relative importance of pressure recovery and mass flow on internal thrust coefficient basis is given and a comparison of various diffusers investigated is made.

NACA RM E50H22

EFFECT OF RAM-JET PRESSURE PULSATIONS ON SUPERSONIC-DIFFUSER PERFORMANCE. James F. Connors. November 20, 1950. 29p. photos., diagrs. (NACA RM E50H22) (Declassified from Confidential, 6/11/53)

Experimental study of effects of combustion roughness and controlled mechanical oscillations on diffuser operation was conducted on an 8-inch ram jet at Mach number 1.87. Within experimental accuracy, the optimum mean combustion-chamber static pressure occurred when the maximum instantaneous static pressure equalled the optimum steady-flow value and the corresponding decrement in optimum mean static pressure was equal to one-half the total amplitude of the pressure pulsations. A marked attenuation of amplitude of cold-buzz pressure fluctuations was effected over limited range of subcritical diffuser operation by means of properly tuned rotating disk located in combustion chamber.

NACA RM E50K07

AN INVESTIGATION OF CONVERGENT-DIVERGENT DIFFUSERS AT MACH NUMBER 1.85. DeMarquis D. Wyatt and Henry R. Hunczak. February 2, 1951. 60p. diagrs., photos., tab. (NACA RM E50K07) (Declassified from Restricted, 6/11/53)

Total-pressure recoveries and internal static-pressure distributions for a series of convergent-divergent supersonic diffusers operating at a Mach number of 1.85 are presented. The effect of inserting a cylindrical section between the supersonic inlet and the subsonic diffuser on shock stability is experimentally determined.

NACA RM E51B10

THE USE OF PERFORATED INLETS FOR EFFICIENT SUPERSONIC DIFFUSION. John C. Evvard and John W. Blakey. (Revised) April 13, 1951. 36p. diagrs., photo. (NACA RM E51B10) (Declassified from Restricted, 6/11/53)

The use of wall perforations on supersonic diffusers to avoid the internal contraction-ratio limitation is described. Experimental results at a Mach number of 1.85 on a preliminary model of a perforated diffuser having a geometric internal contraction ratio of 1.49 (the isentropic value) are presented. A theoretical discussion of the flow coefficients as well as the size and the spacing of the perforations is also included. At angles of attack of 0°, 3°, and 5°, total-pressure recoveries of 0.931, 0.920, and 0.906, respectively, were obtained.

NACA RM E51B13

THEORETICAL AND EXPERIMENTAL INVESTIGATION OF ADDITIVE DRAG. Merwin Sibulkin. May 21, 1951. 33p. diagrs. (NACA RM E51B13) (Declassified from Confidential, 6/11/53)

The significance of additive drag is discussed and equations for determining its approximate value are derived. Charts are presented giving values of additive drag for open-nose inlets and for annular-nose inlets with conical flow at the inlet. The effects of variable inlet total-pressure recovery and static pressures on the center body are investigated, and an analytical method of predicting the variation of pressure on the center body with mass-flow ratio is given. Experimental values of additive drag are compared with values predicted by the methods presented.

NACA RM L7G09

INVESTIGATION OF HIGH-LIFT AND STALL-CONTROL DEVICES ON AN NACA 64-SERIES 42° SWEPTBACK WING WITH AND WITHOUT FUSELAGE. Robert R. Graham and D. William Conner. October 14, 1947. 47p. diagrs., photos., 2 tabs. (NACA RM L7G09) (Declassified from Restricted, 6/25/53)

Contains low speed, high Reynolds number characteristics of a 42° sweptback wing with aspect ratio 4 and NACA 64-series sections tested with various combinations of high-lift and stall-control devices and a fuselage. Combinations of outboard leading-edge flaps or slats with inboard split flaps substantially increased the maximum lift coefficient while maintaining longitudinally stable characteristics at the stall. Neither upper-surface fences nor outboard upper-surface split flaps were effective in improving longitudinal stability for those combinations where sizeable positive pitching-moment increases occurred beyond the stall.

NACA RM L7J20

INITIAL FLIGHT TESTS OF THE NACA FR-2, A HIGH-VELOCITY ROCKET-PROPELLED VEHICLE FOR TRANSONIC FLUTTER RESEARCH. J. G. Barmby and J. M. Teitelbaum. March 4, 1948. 21p. diagrs., photos. (NACA RM L7J20) (Declassified from Restricted, 6/11/53)

The initial flight tests of two simplified flutter vehicles, which were launched at the Langley Pilotless Aircraft Research Station at Wallops Island, Va., are described in this report. The results of the tests are in agreement with the results of the freely-falling-body test in that the wing failures in the transonic range occurred at velocities greater than the flutter velocity calculated from the two-dimensional, incompressible theory. Although the simple bread-wire system seems satisfactory for exploratory tests, the scope of the investigation could be ex-

tended by use of a frequency-recording telemeter. The use of high-velocity-rocket test vehicles of this type offers promise for flutter testing in the transonic and the supersonic regions.

NACA RM L7K06

TWO-DIMENSIONAL WIND-TUNNEL INVESTIGATION AT HIGH REYNOLDS NUMBERS OF AN NACA 65A006 AIRFOIL WITH HIGH-LIFT DEVICES. Robert J. Nuber and Stanley M. Gottlieb. February 4, 1948. 28p. diagrs., photos., tab. (NACA RM L7K06) (Declassified from Restricted, 6/29/53)

An investigation was made of an NACA 65A006 airfoil equipped with high-lift devices consisting of a 0.15-chord drooped-nose flap and a 0.20-chord plain trailing-edge flap. The airfoil section lift, pitching-moment, and drag characteristics, obtained at high Reynolds numbers and low Mach numbers ($M \leq 0.14$) with the flaps deflected individually and simultaneously, are presented.

NACA RM L8D29

WIND-TUNNEL INVESTIGATION OF HIGH-LIFT AND STALL-CONTROL DEVICES ON A 37° SWEPTBACK WING OF ASPECT RATIO 6 AT HIGH REYNOLDS NUMBERS. William Koven and Robert R. Graham. September 2, 1948. 70p. diagrs., photos., tab. (NACA RM L8D29) (Declassified from Restricted, 6/29/53)

Stall-control devices including an extensible round-nose leading-edge flap, a leading-edge slat, and a drooped leading edge were investigated; half- and full-span trailing-edge split and double slotted flaps were also investigated on the plain wing and in combination with the leading-edge devices. Force and moment data and stall studies are presented for all configurations; downwash and dynamic-pressure measurements are given for one combination of slat and double slotted flap. Typical plots of variation of spanwise position of load centroid with lift coefficient are included.

NACA RM L8E18

THE EFFECT OF BOUNDARY-LAYER CONTROL BY SUCTION AND SEVERAL HIGH-LIFT DEVICES ON THE LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A 47.5° SWEPTBACK WING-FUSELAGE COMBINATION. Jerome Pasamanick and Anthony J. Proterra. November 4, 1948. 44p. diagrs., photo., 2 tabs. (NACA RM L8E18) (Declassified from Restricted, 6/29/53)

An investigation has been made in the Langley full-scale tunnel of a 47.5° sweptback wing-fuselage combination equipped for boundary-layer control by suction. The wing aspect ratio was 3.5, the taper ratio was 0.5, and the airfoil sections normal to the quarter-chord line were NACA 64_1-A112. The wing configurations tested included the wing with various combinations of extensible leading-edge and split flaps. The effect of Reynolds number, suction-slot location, and suction flow coefficient on the aerodynamic characteristics was determined for the model at zero yaw over a range of angle of attack.

NACA RM L8E21

THE EFFECT OF BOUNDARY-LAYER CONTROL BY SUCTION AND OF SEVERAL HIGH-LIFT DEVICES ON THE AERODYNAMIC CHARACTERISTICS IN YAW OF A 47.5° SWEPTBACK WING-FUSELAGE COMBINATION. Jerome Pasamanick. October 28, 1948. 36p. diagrs., photo. (NACA RM L8E21) (Declassified from Restricted, 6/29/53)

An investigation has been made in the Langley full-scale tunnel of a 47.5° sweptback wing-fuselage combination equipped for boundary-layer control by suction. The wing aspect ratio was 3.5, the taper ratio was 0.5, and the airfoil sections normal to the quarter-chord line were NACA 64_1-A112. Tests included the plain wing and the wing with various combinations of extensible leading-edge and split flaps. The investigation was made to determine the effect of boundary-layer control by suction on the aerodynamic characteristics in yaw and on the effectiveness of a split-flap-type aileron for a range of angle of attack and suction-flow coefficient at a Reynolds number of 4.2×10^6 corresponding to a Mach number of approximately 0.07.

NACA RM L8J29

PRESENT STATUS OF RESEARCH ON BOUNDARY-LAYER CONTROL. Albert E. von Doenhoff and Laurence K. Loftin, Jr. January 12, 1949. 40p. diagrs. (NACA RM L8J29) (Declassified from Confidential, 6/29/53)

A survey has been made of the present status of boundary-layer control and its applications in aeronautics. The possible improvements in airplane characteristics resulting from boundary-layer control are discussed and the general lines of future research are indicated.

NACA RM L9B04

HYDRODYNAMIC CHARACTERISTICS OF AERODYNAMICALLY REFINED PLANING-TAIL HULLS. Robert McKann and Claude W. Coffee. March 28, 1949. 41p. diagrs., photos. (NACA RM L9B04) (Declassified from Confidential, 6/11/53)

The hydrodynamic characteristics of two aerodynamically refined planing-tail hulls were determined from dynamic model tests in Langley tank no. 2. Stable take-offs could be made for a wide range of location of the center of gravity. The lower porpoising limit was high but no upper limit was encountered. The hump load-resistance ratios were low. Stable landings were made at the center-of-gravity locations tested for a wide range of contact trim.

NACA RM L9D15

HYDRODYNAMIC CHARACTERISTICS OF A SWEPT PLANING-TAIL HULL. Robert E. McKann, Claude W. Coffee and Donald D. Arabian. September 12, 1949. 34p. diagrs., photos., tab. (NACA RM L9D15) (Declassified from Confidential, 6/11/53)

The hydrodynamic characteristics of an aerodynamically refined swept planing-tail hull were determined from dynamic model tests in Langley tank no. 2. Acceptable propeller spray characteristics were obtained by the use of vertical spray strips. Stable take-offs could be made with a large range of elevator deflections and center-of-gravity location. Stable landings were made for a wide range of center-of-gravity location and contact trim. The hump load-resistance ratio was low.

NACA RM L9F08

AERODYNAMIC CHARACTERISTICS OF AN AIRFOIL-FOREBODY SWEPT FLYING-BOAT HULL WITH A WING AND TAIL SWEPT BACK 51.3° AT THE LEADING EDGE. Rodger L. Naeseth and Richard G. MacLeod. September 9, 1949. 27p. diagrs., photo., tab. (NACA RM L9F08) (Declassified from Confidential, 6/11/53)

Results of tests in the Langley 300 MPH 7- by 10-foot tunnel of an airfoil-forebody swept flying-boat hull mounted on a wing swept back 51.3° at the leading edge are presented. Aerodynamic characteristics of the hull (including wing interference) and longitudinal and lateral stability characteristics of the complete configuration (hull, wing, 51.3° sweptback tail) with stall-control devices and lift flaps are presented.

NACA RM L9G15

INVESTIGATION AT LARGE SCALE OF THE PRESSURE DISTRIBUTION AND FLOW PHENOMENA OVER A WING WITH THE LEADING EDGE SWEPT BACK 47.5° HAVING CIRCULAR-ARC AIRFOIL SECTIONS AND EQUIPPED WITH DROOPED-NOSE AND PLAIN FLAPS. Roy H. Lange, Edward F. Whittle, Jr. and Marvin P. Fink. September 8, 1949. 72p. diagrs., 3 tabs. (NACA RM L9G15) (Declassified from Restricted, 6/29/53)

The results of an investigation of the effects of drooped-nose-flap and plain-flap deflection on the pressure distribution over a wing with the leading edge swept back 47.5° and having symmetrical circular-arc airfoil sections conducted in the Langley full-scale tunnel at a Reynolds number of 4.3×10^6 and a Mach number of 0.07 are included in this paper. The configurations tested include the basic wing, the wing with a full-span drooped-nose flap, an inboard semispan plain flap, and a combination of these two flap configurations.

NACA RM L9H10

INVESTIGATION OF HIGH-SUBSONIC PERFORMANCE CHARACTERISTICS OF A 12° 21-INCH CONICAL DIFFUSER, INCLUDING THE EFFECTS OF CHANGE IN INLET-BOUNDARY-LAYER THICKNESS. Martin R. Copp and Paul L. Klevatt. March 24, 1950. 51p. diagrs., photos. (NACA RM L9H10) (Declassified from Restricted, 6/11/53)

An investigation of performance characteristics and boundary-layer growth of a 12° 21-inch conical diffuser over a Reynolds number range of 1.45×10^6 to 7.45×10^6 and a Mach number range of 0.11 to approximately choking are presented for two thicknesses of inlet boundary layer. The mean value, over the entire range of inlet velocities, of the displacement thickness of the thinner inlet boundary layer was approximately 0.035 inch and that of the thicker inlet boundary layer was approximately six times this value. Performance parameters, static-pressure distributions, and boundary-layer measurements are presented for both thicknesses of inlet boundary layer.

NACA RM L9K10

THE EFFECT OF THE INLET MACH NUMBER AND INLET-BOUNDARY-LAYER THICKNESS ON THE PERFORMANCE OF A 23° CONICAL-DIFFUSER - TAIL-PIPE COMBINATION. Jerome Persh. March 21, 1950. 53p. diagrs. (NACA RM L9K10) (Declassified from Restricted, 6/11/53)

An investigation was made of the effect of the inlet Mach number and entrance-boundary-layer thickness on the performance of a 23° 21-inch conical-diffuser - tail-pipe combination with a 2:1 area ratio over an inlet Mach number range of 0.17 to 0.89 and corresponding Reynolds numbers of 1,700,000 to 7,070,000. Performance coefficients, longitudinal static-pressure distributions, and the results of boundary-layer surveys made at six stations along the diffuser wall are presented.

NACA RM L50B15

FULL-SCALE INVESTIGATION OF BOUNDARY-LAYER CONTROL BY SUCTION THROUGH LEADING-EDGE SLOTS ON A WING-FUSELAGE CONFIGURATION HAVING 47.5° LEADING-EDGE SWEEP WITH AND WITHOUT FLAPS. Jerome Pasamanick and Thomas B. Sellers. April 5, 1950. 55p. diagrs., photo., 2 tabs. (NACA RM L50B15) (Declassified from Restricted, 6/29/53)

Presents results of the investigation in the Langley full-scale tunnel of leading-edge boundary-layer control by suction in combination with high-lift devices on a wing-fuselage configuration having 47.5° leading-edge sweep. The wing aspect ratio was 3.4, the taper ratio was 0.51, and the airfoil sections normal to the quarter-chord line were NACA 64_1A112. The data include the effects of suction-slot location and suction-flow quantities on the force measurements, visual-flow studies, and surface-pressure-distribution measurements at zero yaw over a range of angle of attack. Reynolds number effects were determined from 3.0×10^6 to 7.5×10^6 for the wing in the sealed and faired condition.

NACA RM L50C02a

HIGH-SUBSONIC PERFORMANCE CHARACTERISTICS AND BOUNDARY-LAYER INVESTIGATIONS OF A 12° 10-INCH-INLET-DIAMETER CONICAL DIFFUSER. B. H. Little, Jr. and Stafford W. Wilbur. May 11, 1950. 62p. diagrs., photos. (NACA RM L50C02a) (Declassified from Restricted, 6/11/53)

An investigation was made of the effect of inlet-boundary-layer thickness and Mach number on the performance of a 12° 10-inch-inlet-diameter conical diffuser of 2:1 area ratio. Inlet Mach number was varied from 0.2 to choking and Reynolds number (based on inlet diameter) from 1×10^6 to 3.9×10^6. Performance coefficients, static-pressure distributions, boundary-layer profiles at seven stations in the diffuser, and boundary-layer parameters are presented.

NACA RM L52G31

CALIBRATION OF STRAIN-GAGE INSTALLATIONS IN AIRCRAFT STRUCTURES FOR THE MEASUREMENT OF FLIGHT LOADS. T. H. Skopinski, William S. Aiken, Jr. and Wilber B. Huston. October 8, 1952. 71p. diagrs., 10 tabs. (NACA RM L52G31) (Declassified from Confidential, 6/29/53)

A general procedure is developed for calibrating strain-gage installations in aircraft structures for application to flight measurements of loads. The basic procedure can be modified as necessary to suit the requirements of any particular structure. The application of the procedure is illustrated by results for two typical structures.

National Advisory Committee for Aeronautics

Research Abstracts

NO. 47 AUGUST 19, 1953

CURRENT NACA REPORTS

NACA TN 2955

ESTIMATION OF FORCES AND MOMENTS DUE TO ROLLING FOR SEVERAL SLENDER-TAIL CONFIGURATIONS AT SUPERSONIC SPEEDS. Percy J. Bobbitt and Frank S. Malvestuto, Jr. July 1953. 71p. diagrs. (NACA TN 2955)

A method, based on conformal-transformation techniques, for solving two-dimensional boundary-value problems has been used to evaluate the velocity potentials, span loadings, pressure distributions, and associated stability derivatives for several slender-tail arrangements performing a steady rolling motion. Illustrative variations of the rolling stability derivatives for several series of tail shapes, as well as sample span loadings and pressure distributions, are included.

NACA TN 2967

AN ANALYSIS OF THE POWER-OFF LANDING MANEUVER IN TERMS OF THE CAPABILITIES OF THE PILOT AND THE AERODYNAMIC CHARACTERISTICS OF THE AIRPLANE. Albert E. von Doenhoff and George W. Jones, Jr. August 1953. 42p. diagrs. (NACA TN 2967)

A theoretical analysis of the power-off landing maneuver is presented in which an attempt is made to consider both the aerodynamic characteristics of the airplane and the human capabilities of the pilot. Certain factors are derived which allow for the variations in pilot judgment in a manner which is directly connected to pilot capabilities; however, future research is needed for the actual numerical evaluation of the factors. An analysis including these factors is set up by means of which the minimum length of landing field required for landing an airplane safely could be found.

NACA TN 2976

A STUDY OF THE STABILITY OF THE INCOMPRESSIBLE LAMINAR BOUNDARY LAYER ON INFINITE WEDGES. Neal Tetervin. August 1953. 41p. diagrs., 4 tabs. (NACA TN 2976)

Hartree's numerical solutions of the boundary-layer equations for the flow over infinite wedges are used to confirm a result previously obtained by the use of Schlichting's approximate method for the calculation of the laminar boundary layer; namely, that in a region of falling pressure a thick velocity profile can be more stable than a thin profile although the velocity at the edge of the boundary layer and the pressure gradient are the same for both profiles. The investigation also leads to the inference that the calculated effects of a change in boundary-layer thickness on the stability and on the local roughness Reynolds number should be essentially unchanged by replacing the Schlichting single-parameter family of velocity profiles by the Hartree single-parameter family of velocity profiles.

NACA TN 2980

THE AERODYNAMIC CHARACTERISTICS OF AN ASPECT-RATIO-20 WING HAVING THICK AIRFOIL SECTIONS AND EMPLOYING BOUNDARY-LAYER CONTROL BY SUCTION. Bennie W. Cocke, Jr., Marvin P. Fink and Stanley M. Gottlieb. August 1953. 63p. diagrs., photos., 2 tabs. (NACA TN 2980)

An investigation has been conducted to study the aerodynamic characteristics of an aspect-ratio-20 wing employing thick airfoil sections and boundary-layer control by suction. Data from models tested in the Langley full-scale tunnel and the Langley low-turbulence pressure tunnel are included in this report. The results indicate the effects of varying suction flow rate, suction-slot configuration, wing surface condition, flap deflection, and Mach number.

NACA TN 2982

SUPERSONIC FLOW PAST OSCILLATING AIRFOILS INCLUDING NONLINEAR THICKNESS EFFECTS. Milton D. Van Dyke. July 1953. 41p. diagrs. (NACA TN 2982)

A solution to second order in thickness is derived for harmonically oscillating two-dimensional airfoils in supersonic flow. For slow oscillations of an arbitrary profile, the result is found as a series including the third power of frequency. For arbitrary frequencies, the method of solution for any specific profile is indicated, and the explicit solution derived for a single wedge. Nonlinear thickness effects are found generally to reduce the torsional damping, and so enlarge the range of Mach numbers within which torsional instability is possible.

NACA TN 2985

A FLIGHT INVESTIGATION OF THE EFFECT OF STEADY ROLLING ON THE NATURAL FREQUENCIES OF A BODY-TAIL COMBINATION. Norman R. Bergrun and Paul A. Nickel. August 1953. 27p. diagrs., photo., 2 tabs. (NACA TN 2985)

Flight data have been obtained with a freely falling body-tail combination to show the effects of steady

rolling on the response in the pitching and yawing motions. Observed effects are compared with those predicted by theory, and reasonably good agreement is obtained. Charts are also presented to provide a rapid means for estimating the effective values of the stability derivatives C_{m_α} and C_{n_β} under steady rolling conditions.

NACA TN 2988

TEMPERATURES, THERMAL STRESS, AND SHOCK IN HEAT-GENERATING PLATES OF CONSTANT CONDUCTIVITY AND OF CONDUCTIVITY THAT VARIES LINEARLY WITH TEMPERATURE. S. V. Manson. July 1953. 62p. diagrs. (NACA TN 2988)

Working formulas are presented for the steady-state temperatures and thermal stress in heat-generating infinite plates of constant conductivity, and of conductivity that decreases linearly with temperature as the temperature increases, for the case in which the heat is generated uniformly throughout the plate thickness and both faces of the plate are equally cooled. A criterion is indicated for determining the surface cooling conditions under which the thermal shocks at the surface and midplane will be smaller than, equal to, or greater than the steady-state thermal stresses at those planes. The dimensionless parameters governing the transient temperatures and thermal stresses in materials of linearly varying conductivity are derived by a similarity study of the conduction equation and boundary conditions of the transient state. A numerical technique for solving the transient-state equations is indicated in detail.

NACA TN 2989

COMPARISON OF SECONDARY FLOWS AND BOUNDARY-LAYER ACCUMULATIONS IN SEVERAL TURBINE NOZZLES. Milton G. Kofskey, Hubert W. Allen and Howard Z. Herzig. August 1953. 58p. diagrs., photos., 3 tabs. (NACA TN 2989)

An investigation was made of losses and secondary flows in three different turbine nozzle configurations in annular cascades. Appreciable outer shroud loss cores (passage vortices) were found to exist at the discharge of blades which had thickened suction surface boundary layers near the outer shroud. Blade designs having thinner boundary layers did not show such outer shroud loss cores, but indicated greater inward radial flow of low momentum air in the blade wake which resulted in greater contribution to inner shroud loss regions. The blade wake was a combination of profile loss and low momentum air from the outer shroud, and the magnitude of the wake loss is to this extent an indication of the presence or absence of radial flow. At a higher Mach number, shock-boundary-layer thickening on the blade suction surfaces provided an additional radial flow path for low momentum air, which resulted in large inner shroud loss regions accompanied by large deviations from design values of discharge angle.

NACA TN 2992

APPLICATION OF A CHARACTERISTIC BLADE-TO-BLADE SOLUTION TO FLOW IN A SUPERSONIC ROTOR WITH VARYING STREAM-FILAMENT THICKNESS. Eleanor L. Costilow. August 1953. 36p. diagrs., 5 tabs. (NACA TN 2992)

An analysis of the circumferential blade-to-blade flow properties in a supersonic impeller has been made using the method of characteristics on an arbitrary stream surface of revolution. The method takes into account variable stream-filament thickness and curvature along the flow surface. The results of an example considering stream-filament-thickness variation alone indicate an appreciable difference between the flow properties calculated with the plane-flow characteristic equations and those determined with the characteristics method demonstrated here. The effect of a stream-filament-thickness reduction from blade-passage inlet to exit was to reduce the relative velocity and the absolute value of the flow angle in the blade passage.

NACA TN 2993

CALIBRATION OF STRAIN-GAGE INSTALLATIONS IN AIRCRAFT STRUCTURES FOR THE MEASUREMENT OF FLIGHT LOADS. T. H. Skopinski, William S. Aiken, Jr. and Wilber B. Huston. August 1953. 70p. diagrs., 10 tabs. NACA TN 2993. Formerly RM L52G31)

A general procedure is developed for calibrating strain-gage installations in aircraft structures for application to flight measurements of loads. The basic procedure can be modified as necessary to suit the requirements of any particular structure. The application of the procedure is illustrated by results for two typical structures.

NACA RM E53E28

EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF SUPPORT INTERFERENCE ON THE PRESSURE DISTRIBUTION OF A BODY OF REVOLUTION AT A MACH NUMBER OF 3.12 AND REYNOLDS NUMBERS FROM 2×10^6 to 14×10^6. L. Eugene Baughman and John R. Jack. August 1953. 18p. diagrs., photo., tab. (NACA RM E53E28)

An experimental investigation was performed to determine the effect on base and forebody pressures of using a sting modified with varying length splitter plates and fins instead of a conventional sting to support a cone-cylinder body of revolution. The investigation was conducted at a Mach number of 3.12 for a Reynolds number range of 2×10^6 to 14×10^6 and for an angle of attack range of 0° to 9°. For Reynolds numbers of 8×10^6 and 14×10^6 there was a negligible effect of the splitter plate modification on the base pressure, and at a Reynolds number of 2×10^6 there was a small effect. Positioning the leading edge of the splitter plate at or ahead of the base made no appreciable change in the influence of the modifications on base pressure at a Reynolds number of 14×10^6. With the fin-type modification there was a small increase in base pressure.

NACA RM E53F02

PRELIMINARY RESULTS OF HEAT TRANSFER FROM A STATIONARY AND ROTATING ELLIPSOIDAL SPINNER. U. von Glahn. August 1953. 35p. diagrs., photo., 2 tabs. (NACA RM E53F02)

The convective heat-transfer coefficients were determined for an ellipsoidal spinner of 30-inch maximum diameter for both stationary and rotating operation. The range of conditions studied included airspeeds up to 275 miles per hour, rotational speeds up to 1200 rpm, and angles of attack of zero and 4°. The results indicate that a higher heat transfer occurred with rotation of the spinner. Transition from laminar to turbulent flow occurred over a large range of Reynolds numbers primarily because of surface roughness of the spinner.

BRITISH REPORTS

N-23901*

Royal Aircraft Establishment (Gt. Brit.)
FUNCTION GENERATORS BASED ON LINEAR INTERPOLATION, WITH APPLICATIONS TO ANALOGUE COMPUTING. E. G. C. Burt and O. H. Lange. April 1953. 27p. diagrs. (RAE Tech. Note GW 244)

The use of function generators in electronic analogue computing and simulation greatly extends the range of problems which can be solved by these methods. This paper presents a technique in which diode units are used to approximate to the functions by linear interpolation. It is shown that the method can be extended to deal with a wide class of functions, including multivariate functions. Analogue multiplication and division are discussed as particular cases of function generators, and formulas for the general function are developed. The results are presented of an experimental generator for $\sin x$ in the range $-\pi \leq x \pi \leq$, in which the error is about 1 percent of the maximum output.

N-23902*

Royal Aircraft Establishment (Gt. Brit.)
MOVING PARTIAL RANGE SMOOTHING WITH CENTRAL-DIFFERENCES USING A NATIONAL ACCOUNTING MACHINE. J. D. Downes. April 1953. 33p. diagrs., 12 tabs. (RAE Tech. Note GW 250)

Based on a suggestion by Dr. Th. W. Schmidt of G. W. Trials Division, a method of partial range smoothing of experimental data by central-differences which greatly reduces the normal amount of labor and permits simple checking, is described. The method is particularly suited for use where a National Accounting Machine as well as a desk calculator is available. The observed quantities are converted to linear combinations of their differences and used in an adaptation of the "least-squares" method of curve-fitting. Additional, relevant applications of the National Machine are included in numerical example.

N-23929*

Aeronautical Research Council (Gt. Brit.)
THE APPLICATION OF THE POLYGON METHOD TO THE CALCULATION OF THE COMPRESSIBLE SUBSONIC FLOW ROUND TWO-DIMENSIONAL PROFILES. L. C. Woods. 1953. 31p. diagrs., 7 tabs. (ARC CP 115)

This paper describes the method now used by the author of applying the polygon method to the calculation of the compressible subsonic flow round two-dimensional airfoils. Tables have been constructed which can be used for all airfoil shapes, putting the polygon method on the same footing numerically with Goldstein's "Approximation III" for incompressible flow. A method of calculating lift and moment coefficients, and their rates of change with incidence is also given in the paper.

N-23930*

Aeronautical Research Council (Gt. Brit.)
WAKE SURVEY AND STRAIN-GAUGE MEASUREMENTS ON AN INCLINED PROPELLER IN THE R. A. E. 24-FT. TUNNEL. PART I. WAKE SURVEY. J. G. Russell. 1953. 61p. diagrs., photos., 4 tabs. (ARC CP 117)

This report describes tests carried out in the RAE 24-foot wind tunnel with a 16 foot diameter, 4 bladed propeller, during October and November 1949. Wake survey and blade strain-gage measurements were made at tunnel speeds of 100 and 170 fps with the propeller axis inclined at angles of 0°, 5°, 10°, and 15° to the air flow. The blade angles and propeller rotational speeds were also varied within the limits imposed by the 1,500 hp electric motor. The lift grading curves at the points of maximum and minimum loading, derived from total head measurements made in the slipstream by means of a pilot comb, have been compared with estimated values, and estimated power absorption figures compared with measured values.

N-23931*

Aeronautical Research Council (Gt. Brit.)
A COMPARISON OF CALCULATED AND MEASURED BASE PRESSURES OF CYLINDRICALLY BASED PROJECTILES. W. F. Cope. Appendix: CALCULATION OF REYNOLDS NUMBER EFFECT ON PROJECTILES AT SUPERSONIC SPEEDS. W. F. Cope. 1953. 12p. diagrs., photo. (ARC CP 118)

In 1946 at the VI International Congress for Applied Mechanics a paper was read on a method of calculating the base pressure of a cylindrically based projectile. At that time there were few written base pressure determinations and therefore it was not possible to check completely the theory put forward. Since that time measurements have been made. In this report these measurements are compared with results of calculations according to the theory. The original report, "Calculation of Reynolds Number Effect on Projectiles at Supersonic Speeds," is included as an appendix.

N-23932*

Aeronautical Research Council (Gt. Brit.)
EFFECT OF MEAN STRESS ON THE FATIGUE STRENGTH OF D.T.D. 364 ROUND BARS WITH AND WITHOUT TRANSVERSE HOLES. G. M. Norris. 1953. 15p. photos., diagrs., 3 tabs. (ARC CP 120)

Endurance curves for zero mean stress and for tensile mean stresses of 5 tons/in^2 and 10 tons/in^2 were determined for round specimens machined from extruded D.T.D. 364 bar. Endurance curves were determined also for similar specimens with a transverse hole. Variations in surface roughness caused some scatter in results and an attempt is made to correlate degree of surface finish with fatigue strength.

N-23933*

Aeronautical Research Council (Gt. Brit.)
THE LOW SPEED PERFORMANCE OF A HELICOPTER. A. L. Oliver. 1953. 12p. diagrs. (ARC CP 122)

The analysis and estimation of helicopter performance is dependent upon the accurate assessment of rotor induced velocity. An empirical curve relating the flow through the rotor to the flight speed is used for vertical flight and the momentum theory is sufficiently accurate for a tip speed ratio greater than about 0.1, but no simple method has been generally available for the intermediary speed range. Sets of empirical curves covering this speed range and based on the analysis of low-speed flight performance are given in this report. The charts give values of the rotor induced velocity varying smoothly from the vertical flight state to the forward flight region in which the momentum theory becomes accurate. The charts are presented in forms suitable for determining steady flight performance and also for estimating rotor thrust during accelerated motion in, for example, take-off flight.

N-23934*

Aeronautical Research Council (Gt. Brit.)
THE USE OF INFLUENCE FACTORS IN PROBLEMS OF FLUID FLOW. K. H. V. Britten. 1952. 13p. diagrs., 2 tabs. (ARC R & M 2441. Formerly ARC 10,500; FM 1094)

A vigorous mathematical analysis has been applied to some empirical results, obtained by Thom, on the use of the "squares method" in problems of fluid flow. The problem considered is that of determining the incompressible and compressible flow past an arbitrarily shaped body placed in a wind tunnel.

N-23935*

Aeronautical Research Council (Gt. Brit.)
TUNNEL WALL EFFECT FROM MASS FLOW CONSIDERATIONS. A. Thom. 1953. 10p. diagrs., 2 tabs. (ARC R & M 2442. Formerly ARC 11,004; FM 1173, TP 211)

This is an attempt to extend the usual blockage formulas to high subsonic speeds. It is based on an assumption which perhaps can only be fully justified by results. The conclusion reached seems sufficiently reasonable to suggest that the method might be worth taking further either analytically or experimentally.

N-23936*

Aeronautical Research Council (Gt. Brit.)
TABLES OF COMPLETE DOWNWASH DUE TO A RECTANGULAR VORTEX. Staff of the Mathematics Division. 1953. 18p. (ARC R & M 2461. Formerly ARC 10,754; Perf. 334; S & C 2138)

Critical tables are given from which the complete downwash due to a unit rectangular vortex can be read to three places of decimals, on selected lines coplanar with the vortex. These lines are at specified integral multiples of the semiwidth of the vortex from the center line of the vortex, and are of importance in the solution of wing loading problems by vortex lattice theory.

N-23937*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF CURVATURE OF SURFACE AND THICKNESS OF TRAILING EDGE ON AILERON HINGE MOMENTS. Part I. MODIFICATION TO AILERON ON UPPER SURFACE. A. S. Batson, C. H. Burge and J. R. Greening. Part II. MODIFICATION TO AILERON ON LOWER SURFACE. A. S. Batson, C. H. Burge and W. C. Skelton. Part III. MODIFICATION TO AILERON ON BOTH SURFACES. A. S. Batson, C. H. Burge and W. C. Skelton. 1953. 48p. diagrs., photo., 13 tabs. (ARC R & M 2506. Formerly ARC 5310; S & C 1257; ARC 5490; S & C 1290; ARC 6188; S & C 1426)

This investigation was made to provide additional data on the effect on hinge moment of rounding the upper surface and of thickening the trailing edge of an aileron. Hinge moments were measured on an aileron (24.6 percent balance), and on an aileron (27-1/2 percent balance) with various modifications to the upper surface, lower surface, and both surfaces. Strips (approximately 1 percent of aileron chord) were also fitted for a few cases near the trailing edges.

N-23938*

Aeronautical Research Council (Gt. Brit.)
THE THEORETICAL ESTIMATION OF POWER REQUIREMENTS FOR SLOT-SUCTION AEROFOILS, WITH NUMERICAL RESULTS FOR TWO THICK GRIFFITH TYPE SECTIONS. J. H. Preston, N. Gregory and A. G. Rawcliffe. 1953. 27p. diagrs. (ARC R & M 2577. Formerly ARC 10,280; Perf. 276; FM 1052; ARC 11,610; Perf. 466; FM 1263)

This report describes a method for assessing the performance of slot-suction airfoils in terms of an effective drag coefficient, which takes into account the power requirements of the suction pump neglecting slot entry and duct losses. When the suction-slot is located at a velocity discontinuity the suction flow

required to prevent separation can be calculated, using the elementary theory suggested by Sir Geoffrey Taylor. The method is applied to two Griffith type airfoils and the drags are compared with those of normal thin airfoils 20 percent thick.

N-23939*

Aeronautical Research Council (Gt. Brit.)
ELECTRONICS APPLIED TO THE MEASUREMENT OF PHYSICAL QUANTITIES. G. E. Bennett, G. R. Richards and E. C. Voss. 1952. 124p. diagrs., photos. (ARC R & M 2627. Formerly RAE Instn. 1)

The report describes the application of electro-mechanical and electronic principles to the design of instruments for the measurement of physical quantities such as movement, strain, pressure, acceleration, and vibratory motion, with particular reference to the special requirements of aeronautical engineering. The dynamic characteristics of pick-ups are considered, and subdivided on an electrical basis into electromagnetic, capacitance and resistance types, a detailed description of each type being given. An account is given of the circuits used for the conversion of the electrical variation produced in each type of pick-up into a corresponding voltage or current, particular mention being made of bridge circuits and resonance circuit methods. The special requirements of amplifiers, and the best basic circuits for satisfying them, are considered and illustrated by detailed reference to a number of particular amplifier designs; in particular, direct-coupled and carrier amplifiers are considered. The requirements of recording equipment and the various recording methods are discussed, and a detailed account given of photographic recording and various oscillograph cameras, their optical arrangements, components and timing devices.

N-23940*

Aeronautical Research Council (Gt. Brit.)
TOWING TANK TESTS ON A LARGE SIX-ENGINE FLYING BOAT SEAPLANE, TO SPECIFICATION 10/46 PRINCESS. PART I. GENERAL PORPOISING STABILITY, TRIM AND SPRAY CLEARANCE. A. G. Smith, G. L. Fletcher, T. B. Owen and D. F. Wright. 1953. 29p. diagrs., photos., 6 tabs. (ARC R & M 2641; 11,462. Formerly RAE Aero 2240)

This report gives the results of the first series of towing tank tests made at the Royal Aircraft Establishment Towing Tank (up to May 1947) on a powered dynamic model of a six-engine transport flying boat,' later named the Princess class, and designed to specification 10/46, on the basis of which full-scale hull construction was started; later tests have been made to further improve the hull step and afterbody and test the effect of modifications to the aerodynamic superstructure and power units.

N-26032*

National Gas Turbine Establishment (Gt. Brit.)
THE THERMODYNAMICS OF FRICTIONAL RESISTED ADIABATIC FLOW OF GASES THROUGH DUCTS OF CONSTANT AND VARYING CROSS SECTION. W. R. Thomson. September 1952. 45p. diagrs. (NGTE R.119)

The report presents an analytical study dealing with the adiabatic flow of gases with frictional losses through ducts of constant and varying cross section. The thermodynamic treatment is along lines published by other workers such as Bailey and Fabri and is essentially one-dimensional in character insofar that frictional effects are assumed to be uniformly distributed over the total cross-sectional area of flow. With this simplifying assumption, relationships are deduced connecting the pressure, temperature, velocity and flow area of the gas at any one plane with those at any other plane in a duct. The main relationships are unusable for quantitative estimation except through graphs and the main value of the report lies in the presentation of these graphs, the use of which should facilitate the solution of duct flow problems.

N-26067*

Aeronautical Research Council (Gt. Brit.)
ON BOUNDARY LAYERS AND UPSTREAM INFLUENCE. I. A COMPARISON BETWEEN SUBSONIC AND SUPERSONIC FLOWS. M. J. Lighthill. October 23, 1952. 17p. diagrs., 3 tabs. (ARC 15,297; FM 1805)

It is pointed out that there are two separate mechanisms for upstream influence through the boundary layer in supersonic flow, and that one of these (that involving separation) operates also in subsonic flow. A quantitative theory of subsonic flow up a step is given to illustrate this. The main differences between the subsonic and supersonic flows are as follows. (1) The boundaries of dead air regions are nearly straight in supersonic flow but are usually highly curved in subsonic flow. (2) Separation (whether of the laminar or turbulent layer) occurs at a much lower pressure coefficient in supersonic flow; this is only slightly due to the fact that the fluid nearest the wall is then lighter and so more easily brought to rest; it is due much more to the relative suddenness of the pressue rise ahead of the dead air region. (3) However, for a given pressure coefficient in the dead air region, the distance of upstream influence is somewhat greater in the subsonic flow, except at the higher pressures.

N-26085*

National Gas Turbine Establishment (Gt. Brit.)
A METHOD FOR MEASURING THE REACTION FORCE OF A HIGH PRESSURE GAS STREAM. P. J. Fletcher. March 1953. 9p. diagrs. (NGTE Memo. M. 184)

A method has been developed for measuring the reaction force produced by a high pressure gas stream. Briefly the method is to utilize the jet reaction to produce a bending moment in the gas supply pipe by arranging for the jet to discharge in a direction at right angles to that of the entering air. The strain due to bending is indicated by resistance strain gages and the reaction force deduced from direct calibration. The method thus obviates the need for flexible joints and hence eliminates the problem of ensuring flexibility and sensitivity at high pressure. A detailed description of the method of installing the gages is given as well as the precautions necessary

to separate the required bending strain from that due to pressure forces. With the particular apparatus described a thrust of up to 150 lb produced by a gas stream at 10 atm pressure can be measured to within $\pm$ 0.2 lb.

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National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA TN 2965

AN ANALYSIS OF NORMAL-ACCELERATION AND AIRSPEED DATA FROM A FOUR-ENGINE TYPE OF TRANSPORT AIRPLANE IN COMMERCIAL OPERATION ON AN EASTERN UNITED STATES ROUTE FROM NOVEMBER 1947 TO FEBRUARY 1950. Thomas L. Coleman and Paul W. J. Schumacher. August 1953. 27p. diagrs., 5 tabs. (NACA TN 2965)

Normal acceleration and airspeed data covering about 50,000 hours of flight of one type of four-engine transport airplane flown in commercial operations at altitudes to 20,000 feet on a north-south route in the eastern United States are analyzed to determine the gusts encountered and the accelerations experienced. Comparisons are made between the present results and the results previously obtained from other operations. Effects of airpseed and of seasons on the gusts and accelerations are indicated.

NACA TN 2984

STUDIES OF THE LATERAL-DIRECTIONAL FLYING QUALITIES OF A TANDEM HELICOPTER IN FORWARD FLIGHT. Kenneth B. Amer and Robert J. Tapscott. August 1953. 42p. diagrs., photos., tab. (NACA TN 2984)

Results of flight measurements and pilots' opinions of the forward-flight lateral-directional flying qualities of a tandem helicopter in several different configurations are compared and analyzed. The conclusions are presented in the form of desirable flying-qualities goals applicable to all types of helicopters. Comparison between theoretical analyses and experimental results indicates theory to be a useful tool for studying means of achieving these goals. On the basis of theoretical analyses, possible practical methods of achieving these goals in the tandem helicopter are suggested.

NACA TN 2986

EFFECT OF BLADE-THICKNESS TAPER ON AXIAL-VELOCITY DISTRIBUTION AT THE LEADING EDGE OF AN ENTRANCE ROTOR-BLADE ROW WITH AXIAL INLET, AND THE INFLUENCE OF THIS DISTRIBUTION ON ALINEMENT OF THE ROTOR BLADE FOR ZERO ANGLE OF ATTACK. John D. Stanitz. August 1953. 33p. diagrs. (NACA TN 2986)

A method is developed for estimating the effect of blade-thickness taper on the inlet axial-velocity distribution of an entrance rotor-blade row with axial inlet, and the influence of this velocity distribution on the alinement of the rotor blade for zero effective angle of attack (that is, zero blade loading at the nose). This alinement of the blade requires a deviation between the angle of the blade camber line direction at the inlet and the upstream relative flow direction. The method is developed for compressible and incompressible nonviscous fluids, and results are presented for incompressible flow into a plane, two-dimensional cascade and for compressible flow into an entrance rotor-blade row with tapered blades. It is concluded that, for the entrance rotor-blade row investigated, blade taper has a large effect on the inlet deviation angle; whereas compressibility has a small effect, except perhaps at the hub, and the upstream relative flow direction also has a small effect.

NACA TN 2987

CHARTS RELATING THE COMPRESSIVE BUCKLING STRESS OF LONGITUDINALLY SUPPORTED PLATES TO THE EFFECTIVE DEFLECTIONAL AND ROTATIONAL STIFFNESS OF THE SUPPORTS. Roger A. Anderson and Joseph W. Semonian. August 1953. 53p. diagrs., 4 tabs. (NACA TN 2987)

The stability of a plate under edge compressive stress is analyzed in terms of the deflectional and rotational stiffnesses of one or more longitudinal lines of support between the plate side edges. The results are presented in the form of charts which make possible the determination of the compressive buckling stress of plates supported by members whose stiffness may or may not be defined by elementary beam bending and twisting theory but yet whose effective restraint is amenable to evaluation. The deflectional and rotational restraint provided by longitudinal stiffeners and full-depth webs is discussed, and numerical examples illustrate the application of the charts to the design of wing structures.

NACA TN 2990

FLIGHT MEASUREMENTS AND ANALYSIS OF HELICOPTER NORMAL LOAD FACTORS IN MANEUVERS. F. B. Gustafson and Almer D. Crim. August 1953. 29p. diagrs., photos., 2 tabs. (NACA TN 2990)

Flight tests have been conducted in two single-rotor helicopters to determine the load factors due to various maneuvers. A simple theoretical method of estimating for new designs the maximum load factor that can be attained for any given flight condition is also presented, and the results compared with those obtained from the flight tests.

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NACA TN 2991

ACCELERATIONS AND PASSENGER HARNESS LOADS MEASURED IN FULL-SCALE LIGHT-AIRPLANE CRASHES. A. Martin Eiband, Scott H. Simpkinson and Dugald O. Black. August 1953. 67p. diagrs., photos. (NACA TN 2991)

Full-scale light-airplane crashes simulating stall-spin accidents were conducted to determine the decelerations to which occupants are exposed and the resulting harness forces encountered in this type of accident. Crashes at impact speeds from 42 to 60 miles per hour were studied. The airplanes used were of the familiar steel-tube, fabric-covered, tandem, two-seat type. In crashes up to an impact speed of 60 miles per hour, crumpling of the forward fuselage structure prevented the maximum deceleration at the rear-seat location from exceeding 26 to 33g. This maximum g value appeared independent of the impact speed. Restraining forces in the seat-belt - shoulder-harness combination reached 5800 pounds. The rear-seat occupant can survive crashes of the type studied at impact speeds up to 60 miles per hour, if body movement is restrained by an adequate seat-belt - shoulder-harness combination, so as to prevent injurious contact with obstacles normally present in the cabin. Inwardly collapsing cabin structure, however, is a potential hazard in the higher-speed crashes.

NACA TN 3000

STUDIES OF THE USE OF FREON-12 AS A WIND-TUNNEL TESTING MEDIUM. Albert E. von Doenhoff, Albert L. Braslow and Milton A. Schwartzberg. August 1953. 57p. diagrs. (NACA TN 3000)

A number of studies relating to the use of Freon-12 as a substitute medium for air in aerodynamic testing have been made. The use of Freon-12 instead of air makes possible large savings in wind-tunnel drive power. Because of the fact that the ratio of specific heats is approximately 1.13 for Freon-12 as compared with 1.4 for air, some differences exist between data obtained in Freon-12 and in air. Methods for predicting aerodynamic characteristics of bodies in air from data obtained in Freon-12, however, have been developed, which provide substantial agreement in all cases for which comparative data are available. The Freon charging and recovery system used for the Langley low-turbulence pressure tunnel is described.

NACA RM E53F19

MEASUREMENT AND ANALYSIS OF TURBULENT FLOW CONTAINING PERIODIC FLOW FLUCTUATIONS. William R. Mickelsen and James C. Laurence. August 1953. 45p. diagrs. (NACA RM E53F19)

Techniques are presented for the measurement of the energy spectrum of flow fluctuations in both axial and lateral flow directions. A simple spectrum analysis is presented by which quantitative distinction may be made between turbulence and the flow disturbances associated with sound waves in ducts. Experimental data are presented which indicate that the energy spectrum of the turbulence is not affected by periodic and random sound disturbances outside the frequency ranges containing the disturbances. Preliminary measurements are presented that illustrate the effect of combustion on the approach-stream velocity-fluctuation spectra in a ram-jet combustor.

NACA RM L53F16

SOME INFORMATION ON THE STRENGTH OF THICK-SKIN WINGS WITH MULTIWEB AND MULTIPOST STABILIZATION. Roger A. Anderson, Richard A. Pride and Aldie E. Johnson, Jr. August 1953. 19p. diagrs., 3 tabs. (NACA RM L53F16)

The preliminary results of strength tests on thick-skin wing structures are described. Some of the factors which have a major influence on the buckling behavior and strength of multiweb and multipost stiffened construction are illustrated by the data presented, and the conditions under which a combination of multiweb and multipost construction may be used are discussed. Also given are the results of bending tests on hollow circular-arc airfoils.

NACA TM 1335

MOTION OF A CYLINDER UNDER THE SURFACE OF A HEAVY FLUID. (Dvizhenie tsilindra pod poverkhnostyu tyazheloi zhidkosti). L. N. Sretensky. August 1953. 36p. (NACA TM 1335. Trans. from Central Aero-Hydrodynamical Institute, Transactions, Rept. 346, 1938, p. 3-27).

General equations are derived for the approximate solution of the flow of a heavy infinite depth about a submerged circular cylinder where the center of the cylinder is submerged 1.5 diameter or greater. Then by replacing the cylinder by a dipole of a certain strength an equation is derived for the wave resistance of a circular cylinder moving in a fluid of finite depth.

BRITISH REPORTS

N-26059*

Aeronautical Research Council (Gt. Brit.) THEORETICAL CONSIDERATIONS ON FREE CONVECTION IN TUBES. M. J. Lighthill. July 21, 1952. 44p. diagrs. (ARC 15,074; FM 1758)

Methods are developed for predicting the flow and heat transfer due to free convection in heated vertical tubes, closed at the bottom and opening into a reservoir of cool fluid at the top. These include methods of predicting whether the flow is laminar or turbulent, and whether the boundary layer of heated fluid fills or does not fill the tube, or fills it with a stagnant region near the closed end. The theory is extended to apply to a tube closed at both ends, part heated and part cooled. There is some discussion of a mechanical engineering application in which the external force is not gravity but centrifugal.

N-26063*

Aeronautical Research Council (Gt. Brit.)
THE DESIGN OF THIN FINITE WINGS IN INCOMPRESSIBLE FLOW. G. J. Hancock. September 2, 1952. 17p. diagrs. (ARC 15,185; FM 1788)

A method is developed for designing thin finite wings with prescribed lift distributions. Particular attention is given to wings which, at a certain optimum angle of incidence, have zero loading along the whole leading edge. It is suggested that such a wing will have greater range of lift coefficeint for low drag than other wings with the same plan form. On the basis of the linearized theory a formula, relating the wing surface to the pressure distribution over the surface, is deduced which differs from the usual potential relationship by avoiding the difficulty of the nonuniform convergence with respect to the normal distance away from the wing surface singularities. The surface integral which is developed includes a regular singularity and a definite limiting process. Three examples have been worked out in which the condition of smooth flow at the leading edge is satisfied.

N-26068*

Aeronautical Research Council (Gt. Brit.)
ON BOUNDARY LAYERS AND UPSTREAM INFLUENCE. II. SUPERSONIC FLOW WITHOUT SEPARATION. M. J. Lighthill. October 23, 1952. 38p. diagrs., tab. (ARC 15,298; FM 1805a)

This report is concerned with interactions between a boundary layer and a supersonic main stream which take place without separation. These arise either from expansive disturbances, or from relatively weak compressive disturbances to a turbulent layer. The analysis may also have value for the study of the flow upstream of separation in interactions with laminar separation.

N-26070*

Aeronautical Research Council (Gt. Brit.)
ON EDGE TONES AND ASSOCIATED PHENOMENA. Alan Powell. October 7, 1952. 17p. diagr., photos., tab. (ARC 15,333; FM 1809)

The edge-tone phenomena occurring at high jet speeds have been photographed by the Schlieren method and the sound waves produced are clearly visible. They are of opposite phase on each side of the stream, and microphone traverses have shown this to be the case at low speeds also. This observation makes possible an explanation of the mechanism by virtue of the "sensitivity" of the jet, which is particularly susceptible to this form of acoustic disturbance whereby the sound waves give rise to stream disturbances at the jet orifice. Two basic relationships are given, one connecting the relative phases of the motion and the other dealing with the effective efficiencies of each of the component processes.

N-26300*

Royal Aircraft Establishment (Gt. Brit.)
SOME REMARKS ON THE CHOICE AND PRESENTATION OF FORMULAE FOR TURBULENT SKIN FRICTION IN COMPRESSIBLE FLOW. R. J. Monaghan. May 1953. 13p. (RAE Tech. Note Aero 2246)

A review of the various formulas which have been developed for estimating turbulent skin friction in compressible flow has already been given and is mainly concerned with the theoretical aspects of the problem. The object of the present note is to examine briefly the practical application of the results obtained. It is suggested that there is now sufficient evidence to justify changing the compressibility parameter from Mach number to the ratio (surface temperature)/(local ambient temperature). The merits of various formulas are discussed and some brief remarks are made on the effects of pressure gradients and on the present state of knowledge concerning transition.

N-26301*

Royal Aircraft Establishment (Gt. Brit.)
AN ELECTRO-HYDRAULIC POWERED FLYING CONTROL SYSTEM WITH AUTOMATIC SAFEGUARDS AND VARIABLE CONTROL CHARACTERISTICS. C. D. Watson. March 1953. 17p. photos., diagrs. (RAE Tech. Note Mech. Eng. 77)

A standard Lincoln aircraft was fitted with an autopilot and powered flying controls to investigate the stability conditions of two series connected servomechanisms in an aircraft control system. This note describes the design and installation of the electrohydraulic power control units, and the various automatic and safety provisions. In addition, details are given of a variable rate spring feel system, semiautomatic feel trimming and variable servocontrol characteristics. To introduce powerful threshold damping should sustained oscillations arise in flight, a divided reset mechanism is incorporated, which is also described. Stability curves show the effect of tuning this mechanism.

N-26302*

National Gas Turbine Establishment (Gt. Brit.)
THE MEASUREMENT OF TRUE MEAN PRESSURES AND MACH NUMBERS IN OSCILLATORY FLOW. M. V. Nesbitt. March 1953. 37p. diagrs. (NGTE Memo. M. 180)

In this paper, the problem of measuring mean pressures and Mach numbers under regular oscillating flow conditions is considered. Firstly, a parameter is developed which enables the damping orifice and instrument volume to be designed to give any required variation in pressure in the measuring section. Next the relationship between the measured mean pressure and true mean pressure is determined for rectangular, sine, and sawtooth wave forms and finally the relation between true mean Mach numbers and Mach numbers as computed from true mean pressures is determined for rectangular, sine and sawtooth waves traveling up and downstream.

N-26303*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) THE FORWARD TAKE-OFF OF A HELICOPTER. F. O'Hara. June 26, 1953. 21p. diagrs. (AAEE/Res/276)

A theoretical analysis is given of the accelerated motion of a single rotor helicopter for estimation of the forward take-off performance. The motion is considered in stages during which either the disk attitude to the horizontal or the flight speed is constant. Equations are derived for the motion along and normal to the flight path and solutions are given assuming constant mean values for the aerodynamic forces on the rotor and fuselage. The equations of motion for constant disk attitude have a simple solution for motion from rest (and for special initial conditions) giving a straight flight path, and a general solution giving a curved flight path. The performance at constant speed is considered for a general climb away case and also for climb away approaching steady flight conditions with the thrust approximately equal to the aircraft weight. For application of the theory, charts of the various solutions are given covering a representative range of the variables.

N-26335 *

Royal Aircraft Establishment (Gt. Brit.) DESIGN CRITERION FOR FATIGUE OF WINGS. P. B. Walker. May 1953. 16p. diagr., tab. (RAE Structures 146)

Design criteria for wings are postulated from a study of past and present knowledge of aircraft structural fatigue. Earlier criteria are considered first, and are then followed by new criteria that are believed to be more appropriated to modern conditions. The main general conclusions are, first, that design must be based on a fatigue test of critical components and, secondly, that the conditions for this test must be derived from a typical gust case specially devised for fatigue life, followed by suggested adjustments when statistical information is available concerning the particular operational conditions.

MISCELLANEOUS

NACA TM 1317

Errata No. 2 on "A SIMPLE NUMERICAL METHOD FOR THE CALCULATION OF THE LAMINAR BOUNDARY LAYER." K. Schröder. April 1952.

UNPUBLISHED PAPERS

N-19474*

Cornell U. Graduate School of Aeronautical Engineering. ON THE LONGITUDINAL STRESS PROPAGATION IN THE PLASTIC RANGE. Kuang-Tao Hsu, Cornell University. September 1950. vi, 67p. diagrs., photos. (Cornell U. Graduate School of Aeronautical Engineering)

This report presents a graphical method to solve the problem of longitudinal wave propagation in the plastic range and a short summary of the theories developed by others. The problem of a semi-infinite plastic bar struck by a rigid mass and that of a constant force impact on the bar with the mass attached at its end are investigated. A short investigation of the experimental method of photoelasticity applied to impact test is given.

N-24814

Gas Turbine Lab., Mass. Inst. of Tech. LAMINAR AND TURBULENT BOUNDARY LAYERS IN A ROTATING PIPE. A PRELIMINARY THEORETICAL AND EXPERIMENTAL INVESTIGATION. Joel S. Isenberg and Alan H. Stenning. June 1952. vi, 67p. diagrs., photos. (Gas Turbine Lab., Mass. Inst. of Tech.)

An analysis is made of the boundary layer which forms in a straight rotating pipe through which a uniform incompressible stream of fluid is flowing in the cases when this layer is entirely laminar or entirely turbulent. The analogous problem of a rotating flow entering a fixed pipe is also analyzed.

NACA-Langley - 9-8-53 - 4000

National Advisory Committee for Aeronautics

Research Abstracts

NO.49 SEPTEMBER 18, 1953

CURRENT NACA REPORTS

NACA Rept. 1091

EFFECT OF ASPECT RATIO ON THE LOW-SPEED LATERAL CONTROL CHARACTERISTICS OF UNTAPERED LOW-ASPECT-RATIO WINGS EQUIPPED WITH FLAP AND WITH RETRACTABLE AILERONS. Jack Fischel, Rodger L. Naeseth, John R. Hagerman and William M. O'Hare. 1952. ii, 47p. diagrs., 3 tabs. (NACA Rept. 1091. Formerly TN 2347; TN 2348)

A low-speed wind-tunnel investigation was made to determine the lateral control characteristics of a series of untapered low-aspect-ratio wings. Sealed flap ailerons of various spans and spanwise locations were investigated on unswept wings of aspect ratios 1.13, 2.13, 4.13, and 6.13; and various projections of 0.60-semispan retractable ailerons were investigated on the unswept wings of aspect ratios 1.13, 2.13, and 4.13 and on a 45° sweptback wing. The retractable ailerons investigated on the unswept wings spanned the outboard stations of each wing; whereas the plain and stepped retractable ailerons investigated on the sweptback wing were located at various spanwise stations. Design charts based on experimental results are presented for estimating the flap aileron effectiveness for low-aspect-ratio, untapered, unswept wings.

NACA TN 2994

COLUMN STRENGTH OF H-SECTIONS AND SQUARE TUBES IN POSTBUCKLING RANGE OF COMPONENT PLATES. P. P. Bijlaard and G. P. Fisher. August 1953. 106p. diagrs., photos., 6 tabs. (NACA TN 2994)

The column buckling stress in the range where the component plates have buckled is calculated by the method of split rigidities. For the elastic range simple formulas are derived which express the column buckling stress in terms of the Euler buckling stress of the column, the plate or local buckling stress, and the local buckling stress for a higher mode of buckling. For the plastic range a Johnson parabola is proposed which in the buckling-stress - slenderness diagram is tangent to the curve for the elastic column buckling stress in the post-buckling range. Also the case of initially crooked columns is considered. Tests were carried out for a considerable range of slenderness ratios on three H-sections and two square tube sections. The experimental ultimate buckling stresses are in excellent agreement with those predicted by the theory.

NACA TN 2995

NEW EXPERIMENTS ON IMPACT-PRESSURE INTERPRETATION IN SUPERSONIC AND SUBSONIC RAREFIED AIR STREAMS. F. S. Sherman. University of California. September 1953. 73p. diagrs., photos., 2 tabs. (NACA TN 2995)

Results are presented of an experimental investigation of impact-pressure interpretation in supersonic and subsonic rarefied air streams at Mach numbers from 0.1 to 0.7 and 1.7 to 3.4 and in the Reynolds number range from 2 to 800. A study of the effects of impact-probe size on the accuracy of pressure measurements indicated that corrections for viscous effects are less than 1 percent for probes in supersonic flows at Reynolds numbers above 200, where the Reynolds number is based on the velocity, density, and viscosity of the free stream, the reference dimension being the outer diameter of the probe. Viscous-effect corrections are presented for interpretation of pressure measurements at lower Reynolds numbers.

NACA TN 2996

APPRAISAL OF HAZARDS TO HUMAN SURVIVAL IN AIRPLANE CRASH FIRES. Gerard J. Pesman. September 1953. 98p. diagrs., photos., 4 tabs. (NACA TN 2996)

The factors which affect the survival of human beings in airplane accidents followed by fire were studied by conducting full-scale crashes of transport- and cargo-type airplanes. Studies of burning airplane hulks supplemented the information obtained from the crash fires. The time interval during which occupants could escape from a burning airplane was determined by using the time histories of cabin temperatures and toxic gas concentrations in conjunction with data that define the environmental conditions which can be tolerated by human beings. Other hazardous factors, such as flying detached airplane parts, explosions, and crushing of the airplane structure, were also studied.

NACA TN 2998

THE EFFECTS OF CAMBER ON THE VARIATION WITH MACH NUMBER OF THE AERODYNAMIC CHARACTERISTICS OF A 10-PERCENT-THICK MODIFIED NACA FOUR-DIGIT-SERIES AIRFOIL SECTION. Albert D. Hemenover. September 1953. 34p. diagrs., tab. (NACA TN 2998)

The effects of camber on the variation with Mach number of the aerodynamic characteristics of a 10-percent-chord-thick modified NACA four-digit-series airfoil section are determined from tests in the Ames 1- by 3-1/2-foot high-speed wind tunnel

at Mach numbers from 0.3 to 0.9 and corresponding Reynolds numbers from 1×10^6 to 2×10^6. Lift, drag, and pitching-moment characteristics of airfoils cambered for design lift coefficients of 0.2 and 0.4 on an NACA a = 0.8 mean line are compared with those of the corresponding uncambered profile.

NACA TN 3001

COMPARISON OF OPERATING CHARACTERISTICS OF FOUR EXPERIMENTAL AND TWO CONVENTIONAL 75-MILLIMETER-BORE CYLINDRICAL-ROLLER BEARINGS AT HIGH SPEEDS. William J. Anderson, E. Fred Macks and Zolton N. Nemeth. September 1953. 27p. diagrs., 4 tabs. (NACA TN 3001)

Studies of four experimental outer-race-riding cage-type bearings with inner-race-guided rollers, a conventional inner-race-riding cage-type bearing, and a conventional outer-race-riding cage-type bearing with outer-race-guided rollers are reported. All cages were made of nodular iron. The experimental bearings operated at lower temperatures and to higher limiting DN values than did the conventional bearings. The conventional inner-race-riding cage-type bearing had the lowest heat dissipation to the oil, but only at the expense of higher operating temperatures. The conventional outer-race-riding cage-type bearing operated at high temperatures at high oil flows and high speeds because of its tendency to trap oil and create churning losses.

NACA TN 3002

EFFECT OF BRONZE AND NODULAR IRON CAGE MATERIALS ON CAGE SLIP AND OTHER PERFORMANCE CHARACTERISTICS OF 75-MILLIMETER-BORE CYLINDRICAL-ROLLER BEARINGS AT DN VALUES TO 2×10^6. William J. Anderson, E. Fred Macks and Zolton N. Nemeth. September 1953. 24p. diagrs., 6 tabs. (NACA TN 3002)

In an investigation of four outer-race-riding cage-type bearings (two with bronze and two with nodular iron cages) heavy wear was found to accompany cage slip. Nodular iron seemed to promote cage slip at DN values in excess of 1.2×10^6; consequently, bearings with bronze cages showed less wear than did bearings with nodular iron cages at very high speeds. There was little difference in performance between the bronze and nodular iron at DN values to 1.2×10^6

NACA TN 3003

INVESTIGATION OF 75-MILLIMETER-BORE DEEP-GROOVE BALL BEARINGS UNDER RADIAL LOAD AT HIGH SPEEDS. II - OIL INLET TEMPERATURE, VISCOSITY, AND GENERALIZED COOLING CORRELATION. Zolton N. Nemeth, E. Fred Macks and William J. Anderson. September 1953. 33p. diagrs., photos., 2 tabs. (NACA TN 3003)

The extent of the effects of oil inlet temperature and viscosity on bearing inner- and outer-race temperatures is shown. In this investigation, 75-millimeter-bore ball bearings were operated at DN values (bore times speed) from 0.3×10^6 to 2.4×10^6, radial loads from 7 to 1113 pounds, and oil flows from 1.6 to 8 pounds per minute. The cooling correlation previously developed for cylindrical-roller-bearing temperatures was extended and applied to ball bearing temperatures and to the power rejected to the oil by the test bearing. It is possible to predict either the inner- or outer-race bearing temperature or the power rejected to the oil from single curves regardless of whether speed, load, oil flow, oil inlet temperature, oil inlet viscosity or any combination of these parameters is varied. Bearing failure due to breakage of the cage occurred at a DN of 2.4×10^6 (32,000 rpm) when the bearing was lubricated with a medium viscosity oil at an oil inlet temperature of 100° F.

NACA TN 3004

THEORETICAL PERFORMANCE CHARACTERISTICS OF SHARP-LIP INLETS AT SUBSONIC SPEEDS. Evan A. Fradenburgh and DeMarquis D. Wyatt. September 1953. 21p. diagrs. (NACA TN 3004)

A method is presented for the estimation of the subsonic-flight-speed characteristics of sharp-lip inlets applicable to supersonic aircraft. The analysis, based on a simple momentum balance consideration, permits the computation of inlet pressure recovery - mass-flow relations and additive-drag coefficients for forward velocities from zero to the speed of sound. Operation of a sharp-lip inlet at velocity ratios less than 1.0 results in an additive drag that is not cancelled by lip suction, while at velocity ratios greater than 1.0, losses in inlet total pressures result. In particular, at the take-off condition, the total pressure and the mass flow for a choked inlet are only 79 percent of the values ideally attainable with a rounded lip.

NACA TN 3006

CORRELATION OF CALCULATION AND FLIGHT STUDIES OF THE EFFECT OF WING FLEXIBILITY ON STRUCTURAL RESPONSE DUE TO GUSTS. John C. Houbolt. August 1953. 14p. diagrs., tab. (NACA TN 3006)

Flight and calculation studies of two twin-engine transports and one four-engine bomber are presented to show how wing bending flexibility influences the structural response due to gusts. It is shown that an analysis approach based upon single-gust encounter reveals the general nature of the flexibility effects and leads to qualitative correlation with flight results. It is shown further, however, that quantitative correlation can be obtained with an approach that considers continuous-turbulence encounter and is based on generalized harmonic analysis. This approach allows for a greater degree of resolution of the flexibility effects and appears to now provide a suitable means for evaluating these effects.

NACA RM A53G09

TESTS OF THE NACA 0010-1.50 40/1.051 AIRFOIL SECTION AT HIGH SUBSONIC MACH NUMBERS. Albert D. Hemenover. September 1953. 18p. diagrs., tab. (NACA RM A53G09)

Aerodynamic characteristics of the NACA 0010-1.50 40/1.051 airfoil section are compared with those for the same basic airfoil section with leading-edge radii of 1.10, 0.70, and 0.27 percent of the chord at Mach numbers from 0.3 to 0.9. The corresponding Reynolds number variation is from 1×10^6 to 2×10^6.

NACA RM E53F29

PRELIMINARY INVESTIGATION OF THE EFFECTS OF CASCADING ON THE OSCILLATING LIFT FORCE OF AN AIRFOIL VIBRATED IN BENDING. Donald F. Johnson and Alexander Mendelson. September 1953. 15p. diagrs., photos. (NACA RM E53F29)

Measurements were made of the oscillatory lift force acting on an airfoil vibrated in bending. Results were obtained for an isolated airfoil and for the same airfoil oscillated in a cascade, at low and high angles of attack. It was found that at high angles of attack and at low values of the reduced frequency, the damping for the isolated airfoil can become negative. The oscillating lift force changes little, for the case considered, by placing this blade in a stationary cascade. It is indicated that for this case the effect of the cascade is generally to increase the damping by a slight amount.

MISCELLANEOUS

NACA TN 2494

Errata No. 1 on "LIFT AND MOMENT ON OSCILLATING TRIANGULAR AND RELATED WINGS WITH SUPERSONIC EDGES." Herbert C. Nelson. September 1951.

National Advisory Committee for Aeronautics

Research Abstracts

NO.50 OCTOBER 9, 1953

CURRENT NACA REPORTS

NACA Rept. 1073

AN ITERATIVE TRANSFORMATION PROCEDURE FOR NUMERICAL SOLUTION OF FLUTTER AND SIMILAR CHARACTERISTIC-VALUE PROBLEMS. Myron L. Gossard. 1952. ii, 45p. diagrs., 9 tabs. (NACA Rept. 1073. Formerly TN 2346)

The idea of the iterative transformation procedure suggested by H. Wielandt is explained. Application of the procedure to ordinary natural-vibration problems and to flutter problems is shown in numerical examples. Comparisons of computed results with experimental values and with results obtained by other methods of analysis are made.

NACA Rept. 1077

TWO- AND THREE-DIMENSIONAL UNSTEADY LIFT PROBLEMS IN HIGH-SPEED FLIGHT. Harvard Lomax, Max A. Heaslet, Franklyn B. Fuller and Loma Sluder. 1952. ii, 55p. diagrs., 3 tabs. (NACA Rept. 1077. Formerly TN 2403; TN 2387)

The problem of transient lift on two- and three-dimensional wings flying at high speeds is discussed as a boundary-value problem for the classical wave equation. Kirchhoff's formula is applied so that the analysis is reduced, just as in the steady state, to an investigation of sources and doublets. The applications include the evaluation of indicial lift and pitching-moment curves for two-dimensional sinking and pitching wings flying at Mach numbers equal to 0, 0.8, 1.0, 1.2, and 2.0. Results for the sinking case are also given for a Mach number of 0.5. In addition, the indicial functions for supersonic-edged triangular wings in both forward and reversed flow are presented and compared with the two-dimensional values.

NACA Rept. 1080

A THEORETICAL ANALYSIS OF THE EFFECTS OF FUEL MOTION ON AIRPLANE DYNAMICS. Albert A. Schy. 1952. ii, 22p. diagrs., 2 tabs. (NACA Rept. 1080. Formerly TN 2280)

The general equations of motion for an airplane with a number of spherical fuel tanks are derived. These equations are applied to two cases with two fuel tanks located in the plane of symmetry. The calculated motions show that the airplane motion may be greatly changed by considering the motion of the fuel and, in particular, that small-amplitude residual oscillations may result. The same type of analysis may be applied to arbitrarily shaped tanks; therefore, the most general conclusions as to the effects of the fuel motion on airplane dynamics also apply for arbitrarily shaped tanks.

NACA Rept. 1090

METHOD FOR CALCULATING LIFT DISTRIBUTIONS FOR UNSWEPT WINGS WITH FLAPS OR AILERONS BY USE OF NONLINEAR SECTION LIFT DATA. James C. Sivells and Gertrude C. Westrick. 1952. ii, 25p. diagrs., 13 tabs. (NACA Rept. 1090. Formerly TN 2283)

A method is presented for calculating lift distributions for unswept wings with flaps or ailerons using nonlinear section lift data. This method is based upon lifting-line theory and is an extension to the method described in NACA Rep. 865. Simplified computing forms containing detailed examples are given for both symmetrical and asymmetrical lift distributions. A few comparisons of experimental and calculated characteristics are also presented.

NACA Rept. 1101

FLIGHT INVESTIGATION OF A MECHANICAL FEEL DEVICE IN AN IRREVERSIBLE ELEVATOR CONTROL SYSTEM OF A LARGE AIRPLANE. B. Porter Brown, Robert G. Chilton and James B. Whitten. 1952. ii, 14p. diagrs. (NACA Rept. 1101. Formerly TN 2496)

Data are presented showing the flight characteristics of a large airplane having a control-surface booster and mechanical feel device in the elevator-control system. The tests were made with various force gradients provided by the adjustable feel device. The booster was set to operate at a very high boost ratio throughout the tests so that the measured or apparent stick-free stability would be influenced only slightly by the aerodynamic hinge moments. The results show the effect of the feel device on the handling qualities of the test airplane and also the design features which should be incorporated in such feel devices.

NACA Rept. 1105

CHORDWISE AND COMPRESSIBILITY CORRECTIONS TO SLENDER-WING THEORY. Harvard Lomax and Loma Sluder. 1952. ii, 19p. diagrs., 4 tabs. (NACA Rept. 1105. Formerly TN 2295)

Corrections to slender-wing theory are obtained by assuming a spanwise distribution of loading and determining the chordwise variation which satisfies the appropriate integral equation. Such integral equations are set up in terms of the given vertical induced velocity on the center line or, depending on the

type of wing plan form, its average value across the span at a given chord station. The chordwise distribution is then obtained by solving these integral equations. Results are shown for flat-plate, rectangular, and triangular wings.

NACA Rept. 1107

AN EMPIRICALLY DERIVED BASIS FOR CALCULATING THE AREA, RATE, AND DISTRIBUTION OF WATER-DROP IMPINGEMENT ON AIRFOILS. Norman R. Bergrun. 1952. ii, 21p. diagrs., 6 tabs. (NACA Rept. 1107)

An empirically derived basis for predicting the area, rate, and distribution of water-drop impingement on airfoils of arbitrary section is presented. The concepts involved represent an initial step toward the development of a calculation technique which is generally applicable in the design of thermal ice-prevention equipment for airplane wing and tail surfaces. The calculation technique presented is based on results of extensive water-drop trajectory computations for five airfoil cases which consisted of 15-percent-thick airfoils encompassing a moderate lift-coefficient range. The differential equations pertaining to the paths of the drops were solved by a differential analyzer.

NACA Rept. 1109

EXPERIMENTAL INVESTIGATION OF BASE PRESSURE ON BLUNT-TRAILING-EDGE WINGS AT SUPERSONIC VELOCITIES. Dean R. Chapman, William R. Wimbrow and Robert H. Kester. 1952. ii, 19p. diagrs., photos., tab. (NACA Rept. 1109. Formerly TN 2611)

The pressures acting on the base of blunt-trailing-edge airfoils have been measured at Mach numbers of 1.25, 1.5, 2.0, and 3.1 and at Reynolds numbers from 0.2 to 3.8 million. Data are presented for 29 profiles both with laminar and with turbulent boundary layers approaching the trailing edges of the wings. The base pressure is found to be a function primarily of Mach number and the ratio of the boundary layer thickness at the trailing edge to the trailing-edge thickness.

NACA Rept. 1111

AN ANALYSIS OF LAMINAR FREE-CONVECTION FLOW AND HEAT TRANSFER ABOUT A FLAT PLATE PARALLEL TO THE DIRECTION OF THE GENERATING BODY FORCE. Simon Ostrach. APPENDIX B: NUMERICAL SOLUTION OF SIMPLIFIED BOUNDARY-VALUE PROBLEM. Lynn U. Albers. 1953. ii, 17p. diagrs., tab. (NACA Rept. 1111. Formerly TN 2635)

A formal and general analysis of the free-convection flow about a flat plate parallel to the direction of the generating body force is made, and velocity and temperature distributions for Prandtl numbers of 0.01, 0.72, 0.733, 1, 2, 10, 100, 1000, and large Grashof numbers are computed. The distributions for Prandtl number of 0.72 compare favorably with experimental values. It is shown that velocities and Nusselt numbers of the same order of magnitude as those associated with forced-convection flows can be obtained under free-convection conditions. A flow and a heat-transfer parameter are derived from which the important physical quantities can be computed. Reasonable agreement is obtained among values of the heat-transfer parameter obtained from an approximate theoretical development, experiments, and the present development.

NACA TN 2979

EFFECTS OF SYMMETRIC AND ASYMMETRIC THRUST REVERSAL ON THE AERODYNAMIC CHARACTERISTICS OF A MODEL OF A TWIN-ENGINE AIRPLANE. Kenneth W. Goodson and John W. Draper. September 1953. 67p. diagrs., photo., tab. (NACA TN 2979)

An investigation was made to determine the magnitude and degree of changes in static forces and moments caused by variations of symmetric and asymmetric thrust reversal on a twin-engine airplane. The effects of both positive and negative thrust coefficients were investigated on the individual propellers and covered a thrust-coefficient range of 0.167 to -0.150.

NACA TN 2983

LINEARIZED POTENTIAL THEORY OF PROPELLER INDUCTION IN A COMPRESSIBLE FLOW. Robert E. Davidson. September 1953. 47p. diagrs., 5 tabs. (NACA TN 2983)

This paper gives the potential-theory representation of the wave-equation flow about a lifting-line propeller of finite number of blades and arbitrary circulation distribution. From the velocity potential, the compressible inflow velocities at the blade became known. The induced velocities are known also at any point in the flow because the velocity potential is determined for the whole field.

NACA TN 2997

APPLICATION OF SEVERAL METHODS FOR DETERMINING TRANSFER FUNCTIONS AND FREQUENCY RESPONSE OF AIRCRAFT FROM FLIGHT DATA. John M. Eggleston and Charles W. Mathews. September 1953. 74p. diagrs., 2 tabs. (NACA TN 2997)

A study is presented of several methods for determining the transfer functions and frequency response of aircraft from flight tests. Results obtained from experience in the use of these methods are compared as to time required for application, comparative accuracy, and means for facilitating their use. The studies cover three categories of methods: sinusoidal response, Fourier analysis of transients, and curve-fitting analysis of transients. Three general types of aircraft are used to illustrate the application of these methods.

NACA TN 2999

IMPINGEMENT OF DROPLETS IN 90° ELBOWS WITH POTENTIAL FLOW. Paul T. Hacker, Rinaldo J. Brun and Bemrose Boyd. September 1953. 58p. diagrs., 2 tabs. (NACA TN 2999)

Trajectories were determined for droplets in air flowing through 90° elbows especially designed for two-dimensional potential motion with low pressure losses. The elbows were established by selecting as walls of each elbow two streamlines of the flow field produced by a complex potential function that establishes a two-dimensional flow around a 90° bend. An unlimited number of elbows with slightly different shapes can be established by selecting different pairs of streamlines as walls. The elbows produced by the complex potential function selected are suitable for use in aircraft air-intake ducts. The droplet impingement data derived from the trajectories are presented along with equations in such a manner that the collection efficiency, the area, the rate, and the distribution of droplet impingement can be determined for any elbow defined by any pair of streamlines within a portion of the flow field established by the complex potential function. Coordinates for some typical streamlines of the flow field and velocity components for several points along these streamlines are presented in tabular form.

NACA TN 3005

HEAT TRANSFER AND SKIN FRICTION BY AN INTEGRAL METHOD IN THE COMPRESSIBLE LAMINAR BOUNDARY LAYER WITH A STREAMWISE PRESSURE GRADIENT. Ivan E. Beckwith. September 1953. 55p. diagrs., tab. (NACA TN 3005)

A simplified method has been developed for the calculation of heat transfer and skin friction in the compressible laminar boundary layer with an arbitrary Prandtl number near unity and an arbitrary streamwise pressure gradient and wall temperature distribution. The use of a fifth-degree polynomial for the stagnation enthalpy profile gives results of good accuracy for the case of boundary-layer cooling. The method has been extended to the calculation of heat transfer under conditions of equilibrium dissociation in the boundary layer. By means of a suitable transformation the method is also applied to a body of revolution with a boundary-layer thickness of the order of the body radius.

NACA TN 3007

LIFT AND PITCHING MOMENT AT LOW SPEEDS OF THE NACA 64A010 AIRFOIL SECTION EQUIPPED WITH VARIOUS COMBINATIONS OF A LEADING-EDGE SLAT, LEADING-EDGE FLAP, SPLIT FLAP, AND DOUBLE-SLOTTED FLAP. John A. Kelly and Nora-Lee F. Hayter. September 1953. 45p. diagrs., photos., 2 tabs. (NACA TN 3007)

Results of a two-dimensional wind-tunnel investigation of an NACA 64A010 airfoil equipped with a leading-edge flap, a leading-edge slat, a split flap, and a double-slotted flap are presented. The results include determination of optimum slat positions and effects of varying Reynolds number on the lift and pitching-moment characteristics of the model with the various high-lift devices.

NACA TN 3008

EFFECTS OF FINITE SPAN ON THE SECTION CHARACTERISTICS OF TWO 45° SWEPTBACK WINGS OF ASPECT RATIO 6. Lynn W. Hunton. September 1953. 32p. diagrs. (NACA TN 3008. Formerly RM A52A10)

A study has been made of the finite-span effects on the local loading characteristics of two sweptback wings at low speed with a view toward providing some insight into the usefulness of two-dimensional section data and span-loading theory for determining the section characteristics of a swept wing. The two wings considered were identical in plan form having 45° of sweepback of the quarter-chord line, an aspect ratio of 6, and a taper ratio of 0.5 but differed in twist and in sections, the latter being the NACA 64A010 and NACA 64A810. The analysis is based on comparisons of local pressure distributions and local lift characteristics on the wings with comparable two-dimensional section data, all of which were available at large scale.

NACA TN 3009

VELOCITY POTENTIAL AND AIR FORCES ASSOCIATED WITH A TRIANGULAR WING IN SUPERSONIC FLOW, WITH SUBSONIC LEADING EDGES, AND DEFORMING HARMONICALLY ACCORDING TO A GENERAL QUADRATIC EQUATION. Charles E. Watkins and Julian H. Berman. September 1953. 61p. diagrs., tab. (NACA TN 3009)

The velocity potential for a triangular wing with subsonic leading edges experiencing harmonic deformations in supersonic flow is treated herein. The oscillations considered are such that the amplitude of distortion of the wing can be represented by a general quadratic equation. The velocity potential is derived in the form of a power series in terms of the frequency of oscillation. Although only the first four terms of the series expansion are presented, additional terms may be obtained if desired. The material constitutes an extension of the work given in NACA Report 1099.

NACA TN 3011

COEFFICIENT OF FRICTION AND DAMAGE TO CONTACT AREA DURING THE EARLY STAGES OF FRETTING. I - GLASS, COPPER, OR STEEL AGAINST COPPER. Douglas Godfrey and John M. Bailey. September 1953. 23p. diagrs., photos., 2 tabs. (NACA TN 3011)

Experiments were conducted to measure the coefficient of friction μ and to determine the damage to the contact area during early stages of fretting of copper at a frequency of 5 cycles per minute. Specimen combinations of copper against glass, copper against copper, and copper against steel, as well as various copper oxide films and powder compacts, were used. The results lead to the conclusion that fretting of copper starts with the same mechanical damage that occurs during unidirectional sliding. Fretting of copper against glass, copper against copper, and copper against steel starts with adhesion and metal transfer (galling) with accompanying high μ values (>1.0) the same as those obtained during unidirectional sliding. After the ini-

tial high values of μ, a reduction in μ was observed, associated with reduced plowing and an increasing concentration of debris in and around the contact area. After approximately 100 cycles of fretting, μ reached a constant value (0.5-0.6) approximately the same as that obtained with compacts of either cuprous or cupric oxide. The presence of preformed cuprous or cupric oxide films on copper does not delay the occurrence of fretting but only lowers the initial coefficient of friction.

NACA TN 3012

AN ANALYSIS OF TURBOJET-ENGINE-INLET MATCHING. DeMarquis D. Wyatt. September 1953. 19p. diagrs. (NACA TN 3012)

A method of presenting turbojet-engine air-flow requirements and inlet-system air-flow capacities in identical though independent parametric terms is developed. The application of the air-flow representation technique to the analysis of engine-inlet matching conditions is demonstrated. Several examples are presented to illustrate the application of the method to the explicit determination of inlet geometric variations required to improve the powerplant performance of supersonic airplanes.

NACA TN 3014

CALCULATED SPANWISE LIFT DISTRIBUTIONS AND AERODYNAMIC INFLUENCE COEFFICIENTS FOR UNSWEPT WINGS IN SUBSONIC FLOW. Franklin W. Diederich and Martin Zlotnick. September 1953. 120p. diagrs., 11 tabs. (Tables of F matrices to be used with TN 3014 are published separately) (NACA TN 3014)

Spanwise lift distributions have been calculated for nineteen unswept wings with various aspect ratios and taper ratios and with a variety of angle-of-attack or twist distributions, including flap and aileron deflections, by means of the Weissinger method with eight control points on the semispan. Also calculated were aerodynamic influence coefficients which pertain to a certain definite set of stations along the span, and several methods are presented for calculating aerodynamic influence coefficients for stations other than those stipulated.

NACA TN 3015

AN EXPERIMENTAL INVESTIGATION OF SECONDARY FLOW IN AN ACCELERATING, RECTANGULAR ELBOW WITH 90° OF TURNING. John D. Stanitz, Walter M. Osborn and John Mizisin. October 1953. 60p. diagrs., photos., 2 tabs. (NACA TN 3015)

Secondary flow tests were conducted on an accelerating elbow with 90° of turning designed for prescribed velocities that eliminate boundary-layer separation by avoiding local decelerations along the walls. Secondary flows were investigated for six boundary-layer thicknesses generated on the plane walls of the elbow by spoilers upstream of the elbow inlet. The passage vortex associated with secondary flows appears to be near the suction surface and away from the plane wall of the elbow at the exit and does not have appreciable spanwise motion as it moves downstream from the elbow exit. As the spoiler size increases, the boundary-layer form changes and a rather sudden difference in the secondary flow occurs, perhaps associated with the reduced importance of viscous effects in thick boundary layers. It is suggested that the strength of the secondary vortices is small and that the energy of secondary flows is small.

NACA TN 3016

ANALYSIS OF TURBULENT HEAT TRANSFER AND FLOW IN THE ENTRANCE REGIONS OF SMOOTH PASSAGES. Robert G. Deissler. October 1953. 88p. diagrs. (NACA TN 3016)

A previous analysis for fully developed turbulent heat transfer and flow with variable fluid properties is extended and applied to the entrance regions of smooth tubes and parallel flat plates. Integral heat-transfer and momentum equations are used for calculating the thicknesses of the thermal and flow boundary layers. The effect of variable properties is determined for the case of uniform heat flux, uniform initial temperature distribution, and fully developed velocity distribution. A number of other cases in which the fluid properties are constant are analyzed. The predicted Nusselt numbers for air with a uniform wall temperature and uniform initial temperature and velocity distributions agree closely with experimentally determined values.

NACA TN 3017

AXIAL-LOAD FATIGUE TESTS ON NOTCHED AND UNNOTCHED SHEET SPECIMENS OF 61S-T6 ALUMINUM ALLOY, ANNEALED 347 STAINLESS STEEL, AND HEAT-TREATED 403 STAINLESS STEEL. Herbert F. Hardrath, Charles B. Landers and Elmer C. Utley, Jr. October 1953. 28p. diagrs., 4 tabs. (NACA TN 3017)

Axial-load fatigue tests at a stress ratio of zero were performed on notched and unnotched sheet specimens of 61S-T6 aluminum alloy and 347 and 403 stainless steels. Special emphasis was placed on tests at high stress levels producing failures in small numbers of cycles. It was found that the stress-concentration factors effective in fatigue of notched specimens were somewhat less than the theoretical elastic values at low stresses and were approximately equal to one at the ultimate strength. The mimimum life to failure at stresses near the ultimate strength was drastically reduced with increasing stress-concentration factor.

NACA TN 3019

INVESTIGATION OF THE STATISTICAL NATURE OF THE FATIGUE OF METALS. G. E. Dieter and R. F. Mehl. Carnegie Institute of Technology. September 1953. 25p. diagrs., 5 tabs. (NACA TN 3019)

Results are presented of an investigation of the statistical nature of the fatigue of metals utilizing statistical methods developed previously. The investigation included a study of the fatigue properties and their statistical variation of a plain carbon eutectoid steel heat-treated to coarse pearlitic and spheroidized structures of the same tensile strength and of commercially pure aluminum (2S) and 24S alloy heat-treated to two different structures. Calcula-

tion of data from the literature provided statistics for 75S aluminum alloy for comparison with the data of the present investigation.

NACA RM E53E05

EFFECT OF PRESSURE ON THE SMOKING TENDENCY OF DIFFUSION FLAMES. Rose L. Schalla and Glen E. McDonald. September 1953. 13p. diagrs., 2 tabs. (NACA RM E53E05)

The effect of pressure on smoke formation was investigated by burning nine hydrocarbon fuels as diffusion flames from a modified wick lamp in an enclosed chamber. The maximum relative rate at which each fuel could be burned without smoking was determined over a pressure range of about 1/2 to 4 atmospheres, and up to 12 atmospheres in the case of one fuel. The results indicate that over this pressure range the maximum smoke-free fuel flow was inversely proportional to the pressure. The relative variation in smoking tendency among the different fuel types was approximately constant at all pressures. From an analysis of the data it has been tentatively proposed that the variations in smoke formation with pressure result from changes in the rate of diffusion and mixing of the fuel and air.

NACA RM E53G08

VAPOR PRESSURES OF CONCENTRATED NITRIC ACID SOLUTIONS IN THE COMPOSITION RANGE 83 TO 97 PERCENT NITRIC ACID, 0 TO 6 PERCENT NITROGEN DIOXIDE, 0 TO 15 PERCENT WATER, AND IN THE TEMPERATURE RANGE 20° TO 80° C. A. B. McKeown and Frank E. Belles. September 1953. 22p. diagrs., tab. (NACA RM E53G08)

Total vapor pressures were measured for 28 acid mixtures of the ternary system nitric acid, nitrogen dioxide, and water within the temperature range 20° to 80° C and within the composition range 83 to 97 percent nitric acid, 0 to 6 percent nitrogen dioxide, and 0 to 15 percent water. The ullage of the apparatus used for the measurements was 0.65. Ternary diagrams showing isobars as a function of composition of the system NO_2-H_2O-HNO_3 were constructed from experimental and interpolated data for the temperatures 25°, 40°, and 60° C and are presented herein.

NACA RM L53G24a

MODEL DITCHING INVESTIGATIONS OF THREE AIRPLANES EQUIPPED WITH HYDRO-SKIS. (Revised) Lloyd J. Fisher. September 1953. 8p. photos. (NACA RM L53G24a)

Calm-water tests were made to determine possible arrangements of hydro-ski ditching gear on typical multiengine airplanes. The tests showed that hydro-skis would afford very satisfactory water landings as compared with landings without skis. The best landings were made in a near-level (slightly nose-up) landing attitude although any normal landing attitude was satisfactory. It is possible that critical damage could be eliminated from ditchings by using a hydro-ski landing gear.

BRITISH REPORTS

N-11456*

Aeronautical Research Council (Gt. Brit.)
THE DISTURBED MOTION OF ARTICULATED BLADES. H. Roberts. October 1949. 77p. diagrs. (ARC 12,688; H. 127)

The general theory of motion for articulated helicopter blades is presented and allowance is made for for: (a) arbitrary motion of the hub, (b) offset blade hinges, (c) inclined flapping hinges, and (d) cambered blades. The method employed is the simple one of giving the hub prescribed horizontal, vertical, and angular velocities, the motion being two-dimensional. It is shown that the flapping stability equation arises when considering disturbed motion or response phenomena. It is also shown that disturbances in the pitching plane lead in general to a lateral tilt of the rotor disk, thereby inducing a coupling between the longitudinal and lateral stability equations.

N-26520*

Aeronautical Research Council (Gt. Brit.)
THE DETERMINATION OF SKIN TEMPERATURES ATTAINED IN HIGH SPEED FLIGHT. F. V. Davies and R. J. Monaghan. 1953. 65p. diagrs., 8 tabs. (ARC CP 123)

This report discussed the factors affecting skin temperatures attained by high-speed missiles and presents some methods of solution. These have been reduced to graphical or tabular form and are set out in order of complexity. Graphical or algebraic solutions may be quickly obtained if steady conditions are assumed, and for some flight cases these are reasonable approximations to corresponding transient solutions. If the temperature time variation is required, then longer numerical integration processes have to be performed. Account may be taken of external radiation and heat loss to the interior if their effects are considered significant.

N-26521*

Aeronautical Research Council (Gt. Brit.)
THE DEFINITIONS OF THE ANGLES OF INCIDENCE AND OF SIDESLIP. C. H. E. Warren. 1953. 11p. diagrs. (ARC CP 124)

The use of large angles of incidence and of sideslip in missile work, and recent changes in wind-tunnel testing techniques, have shown the need for clear and precise definitions of the angles of incidence and of sideslip. The suitability of different definitions for both experimental and theoretical work in both the aircraft and missile field is considered, and it is concluded that, as no single definition is universally acceptable, care should be taken in theoretical and experimental reports to define precisely the angles used.

N-26522*

Aeronautical Research Council (Gt. Brit.)
PRESSURE ERROR MEASUREMENT USING THE FORMATION METHOD. K. C. Levon. 1953. 15p. diagrs. (ARC CP 126)

Measurements of pressure error at altitude have been made by flying several aircraft in formation with a reference aircraft whose airspeed system had previously been calibrated by radar. Tests made show that analysis by comparison of indicated airspeeds (comparison of differences between static and total head pressures) gives more consistent and reliable results than pressure altitude comparison (comparison of direct measurement of static pressure).

N-26523*

Aeronautical Research Council (Gt. Brit.)
SURFACE SLOPES AND CURVATURES OF THE RAE 100 - 104 AND OTHER ROOFTOP-TYPE AEROFOIL SECTIONS. J. Williams and Edna M. Love. 1952. 11p. 3 tabs. (ARC CP 129)

Formulas and tables have been obtained for the accurate and rapid calculation of the surface slopes and curvatures of the RAE 100-104 airfoil sections, and of more general "rooftop-type" sections. In particular, the surface slopes of the RAE 102 and 104 shapes have been evaluated for application with a "tangent-plane" method of model construction.

N-26535*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF COMPRESSIBILITY ON THE PERFORMANCE OF A GRIFFITH AEROFOIL. H. H. Pearcey and E. W. E. Rogers. 1953. 30p. diagrs., photos., 4 tabs. (ARC R & M 2511. Formerly ARC 10,096; FM 1017; Perf. 250)

Experiments were made in the 20-inch by 8-inch high-speed tunnel at the NPL on a 9-inch chord, 22 percent thick, symmetrical Griffith section at 0° incidence. Drag was determined by the pitot traverse method. Information on the flow was obtained from the pitot tube traverses, from direct shadow photographs, and from normal pressure measurements. Three Mach numbers of the undisturbed stream were covered, namely 0.4, 0.6, and 0.7. Estimates of the power absorbed by the compressor, ignoring duct losses are made from measurements of the mass of air sucked and the static pressure in the slots. Additional information was obtained on the adverse effect of a large radius of the forward lip of the slot, on the effect at $M_o = 0.4$ of an increase in slot width, and on the choke quantities for the slots.

N-26536 *

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF SLIPSTREAM ON THE LONGITUDINAL STABILITY OF MULTI-ENGINED AIRCRAFT. D. E. Morris and J. C. Morrall. 1953. 9p. diagrs., tab. (ARC R & M 2701; ARC 12,136. Formerly RAE Aero 2304)

Flight measurements of longitudinal stability power-off and power-on made on numerous aircraft have been analyzed and a generalized curve for estimating the contribution of slipstream to longitudinal stability, applicable to both flaps-up and flaps-down cases, has been derived. Using this curve, the change in stability due to slipstream at a given value of C_L can be estimated with a probable error of less than $\pm$ 0.02 in the position of the neutral point.

N-26537 *

Aeronautical Research Council (Gt. Brit.)
LOW-SPEED WIND-TUNNEL TESTS ON TWO 45 DEG SWEPTBACK WINGS OF ASPECT RATIOS 4.5 AND 3.0 (MODELS A AND B). J. Trouncer and G. F. Moss. 1953. 43p. diagrs., 13 tabs. (ARC R & M 2710; ARC 10,904. Formerly RAE Aero 2210)

Low-speed stability tests were made on two wings of aspect ratio 4.5 and 3.0. Both wings were of 45° sweepback, 4:1 taper ratio, and 14 percent thickness ratio. Tests included stability tests on the two wings without body or tail unit, tests with a body, fin and tailplane fitted and tests made with two types of nose flaps on the aspect ratio 4.5 wing.

N-26538*

Aeronautical Research Council (Gt. Brit.)
THE MEASUREMENT OF THE OVERALL DRAG OF AN AIRCRAFT AT HIGH MACH NUMBERS. D. J. Higton, R. H. Plascott and D. A. Clarke. 1953. 22p. diagrs., photo., tab. (ARC R & M 2748; ARC 11,429; ARC 12,237. Formerly RAE Aero 2241; RAE Aero 2309)

This report describes the technique which has been developed to measure the over-all drag of an aircraft at high Mach numbers in both level flight and dives. It shows how improvements have been made both in flight and tunnel technique so that comparisons between full-scale and model tests have now become possible. Flight results from Meteor IV aircraft show close agreement between drag measured in level flight and in dives and later tests compare well with high-speed wind-tunnel measurements on a 1/12th scale model.

N-26540*

Aeronautical Research Council (Gt. Brit.)
THE THEORETICAL PRESSURE DISTRIBUTIONS AROUND SOME CONVENTIONAL TURBINE BLADES IN CASCADE. T. J. Hargest. 1953. 10p. diagrs. (ARC R & M 2765; ARC 13,360. Formerly NGTE R. 67)

By means of Relf's analogy between aerodynamic streamline flow and electric potential flow, the theoretical pressure distributions around a series of conventional turbine blades in cascade have been determined over a range of incidence covered in some previously reported aerodynamic tests. The theoretical pressure distributions and their variation with incidence provide the basis of an explanation of the observed aerodynamic performance.

N-26541*

Aeronautical Research Council (Gt. Brit.)
A CALCULATION OF THE COMPLETE DOWNWASH IN THREE DIMENSIONS DUE TO A RECTANGULAR VORTEX. Doris E. Lehrian. 1953. 45p. diagrs., 15 tabs. (ARC R & M 2771. Formerly ARC 11,786; S & C 2252; Perf. 487; ARC 12,221; S & C 2294; Perf. 537)

A calculation of the complete downwash in three dimensions due to a rectangular vortex, is given for the limited range $Z = \pm 4$. The downwash is computed at selected positions, in planes normal to the plane of the vortex; these planes are spaced at even integral multiples of the semiwidth of the vortex, measured from the line of symmetry. Values are tabulated for Z in the range (0, 4) and a set of graphs is also included for $0 \leqslant Z \leqslant 2$; they are to be used in conjunction with the "Tables of Complete Downwash due to a Rectangular Vortex" (R. & M. 2461).

MISCELLANEOUS

NACA TN 2991

Errata No. 1 on "ACCELERATIONS AND PASSENGER HARNESS LOADS MEASURED IN FULL-SCALE LIGHT-AIRPLANE CRASHES." A. Martin Eiband, Scott H. Simpkinson and Dugald O. Black. August 1953.

UNPUBLISHED PAPERS

N-20019A*

REVIEW OF PUBLISHED DATA ON THE EFFECT OF ROUGHNESS ON TRANSITION FROM LAMINAR TO TURBULENT FLOW. Hugh L. Dryden. 6p. diagrs. (Reprint from Journal of the Aeronautical Sciences, v. 20, no. 7, July 1953, p. 477-482).

A review is presented of the published data on the effect of roughness, especially single roughness elements, on transition from laminar to turbulent flow, in which an attempt is made to reanalyze and correlate the available information. The paper also discusses available data on the effect of distributed roughness on transition on a flat plate, as well as some of the published data on roughness effects on transition on airfoils.

N-25045*

SOME FACTORS CONTRIBUTING TO SCALE EFFECT AT SUPERSONIC SPEEDS. Ira H. Abbott. 34p. diagrs., photos. (Presented at the fourth meeting of the Advisory Group for Aeronautical Research and Development, Wind Tunnel and Model Testing Panel, London, September 3-11, 1953)

This paper presents information on the Reynolds number effects at supersonic speeds on skin friction, transition and separation. A brief consideration is also given to some of the effects of airstream turbulence, weak shock waves from the walls, and heat transfer.

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1108

EXPERIMENTAL AERODYNAMIC DERIVATIVES OF A SINUSOIDALLY OSCILLATING AIRFOIL IN TWO-DIMENSIONAL FLOW. Robert L. Halfman, Massachusetts Institute of Technology. 1952. ii, 44p. diagrs., photo., 19 tabs. (NACA Rept. 1108. Formerly TN 2465)

Experimental measurements of the aerodynamic reactions on a symmetrical airfoil oscillating harmonically in a two-dimensional flow are presented and analyzed. Harmonic motions include pure pitch and pure translation, for several amplitudes and superimposed on an initial angle of attack, as well as combined pitch and translation. Considerable consistent data for pure pitch were obtained from a search of available reference material, and several definite Reynolds number effects are evident.

NACA Rept. 1120

RELATIVE IMPORTANCE OF VARIOUS SOURCES OF DEFECT-PRODUCING HYDROGEN INTRODUCED INTO STEEL DURING APPLICATION OF VITREOUS COATINGS. Dwight G. Moore, Mary A. Mason and William N. Harrison. 1953. 12p. photos., diagrs., 5 tabs. (NACA Rept. 1120. Formerly TN 2617)

The purpose of this investigation was to study and to determine experimentally the relative importance of various sources of defect-producing hydrogen introduced into steel during the application of vitreous-type ceramic coatings. Under the conditions investigated, the principal source of defect-producing hydrogen was the dissolved water present in the enamel frit of the coating. Acid pickling, milling water, chemically combined water in the clay, and quenching water were all minor sources. Test results indicate that fishscaling, reboil, and possibly primary boil may be eliminated by using a coating prepared with a water-free frit.

NACA TN 2978

AN APPROXIMATE METHOD OF CALCULATING THE DEFORMATIONS OF WINGS HAVING SWEPT, M OR W, Λ, AND SWEPT-TIP PLAN FORMS. George W. Zender and William A. Brooks, Jr. October 1953. 28p. diagrs., photo. (NACA TN 2978)

An approximate method of calculating the deformations of wings of uniform thickness having swept, M or W, Λ, and swept-tip plan forms is presented. The method employs an adjustment to the elementary beam theory to account for the effect of the triangular root portion of a swept wing on the deformation of the outboard section of the wing. It is shown that, for calculating angles of attack due to loading, the unmodified elementary theory alone suffices.

NACA TN 3010

COMPARISON OF EFFECTIVENESS OF CONVECTION-, TRANSPIRATION-, AND FILM-COOLING METHODS WITH AIR AS COOLANT. E. R. G. Eckert and John N. B. Livingood. October 1953. 52p. diagrs. (NACA TN 3010)

Material necessary for a comparison of the cooling requirements of film and transpiration cooling with conventional convection cooling is presented. Both laminar and turbulent flow, with and without radiation, are considered for a flat plate. The superiority of transpiration cooling is clearly shown for both laminar and turbulent flow.

NACA TN 3013

A NOTE ON SECONDARY FLOW IN ROTATING RADIAL CHANNELS. James J. Kramer and John D. Stanitz. October 1953. 33p. diagrs. (NACA TN 3013)

A general vector differential equation for the vorticity component parallel to a streamline is derived for steady, nonviscous and incompressible flow in a rotating system. This equation is then simplified by restricting it to rotating radial channels and by making further simplifying assumptions. This simplified equation is used to solve for the secondary vorticity, the vorticity component parallel to the streamline, in three special cases involving different streamtube geometries; the results are presented in a series of figures. The secondary vorticity is shown to decrease with decreased absolute angular velocity of the fluid, decreased inlet total-pressure gradient, decreased length of relative flow path, and increased relative velocity.

NACA TN 3018

A THEORETICAL STUDY OF THE EFFECT OF FORWARD SPEED ON THE FREE-SPACE SOUND-PRESSURE FIELD AROUND PROPELLERS. I. E. Garrick and C. E. Watkins. October 1953. 39p. diagrs., tab. (NACA TN 3018)

The sound-pressure field due to thrust and torque of a propeller in flight at uniform subsonic speed is analyzed by use of a distribution of acoustic doublets located at the propeller disk. The results can be regarded as an extension of the work for the static

propeller given by Gutin (NACA TM 1195) for the far pressure field and given by Hubbard and Regier (NACA Rep. 996) for the field near the tips of the rotating propeller. The extended formulas are used to calculate the sound field for a specific two-blade propeller operating at constant torque for various forward-speed Mach numbers.

NACA TN 3020

DETERMINATION OF BOUNDARY-LAYER TRANSITION REYNOLDS NUMBERS BY SURFACE-TEMPERATURE MEASUREMENT OF A 10° CONE IN VARIOUS NACA SUPERSONIC WIND TUNNELS. Albert O. Ross. October 1953. 26p. diagrs., tab. (NACA TN 3020)

An investigation was conducted in the Ames and Lewis supersonic tunnels to determine transition Reynolds numbers on a 10° cone at zero angle of attack. Measurements of surface temperature at known increments along the cone were made for the case of negligible heat transfer and negligible wind-tunnel pressure gradients. The trends of transition Reynolds number with stream Reynolds number and with Mach number are not consistent for the various tunnels. The inconsistencies are attributed to effects of free-stream turbulence, flow irregularities introduced by the compressor systems, and other air-stream disturbances.

NACA TN 3021

A METHOD OF DERIVING FREQUENCY-RESPONSE DATA FOR MOTION OF THE CENTER OF GRAVITY FROM DATA MEASURED ON AN AIRCRAFT AT LOCATIONS OTHER THAN THE CENTER OF GRAVITY. John M. Eggleston. October 1953. 25p. diagrs. (NACA TN 3021)

A method is given for deriving time-response and frequency-response data for angle of attack and normal acceleration of the center of gravity of an aircraft when these data are measured at locations on the aircraft other than the center of gravity and when the pitching velocity is not recorded. The method may be applied to aircraft in which limited recording channels and space limitations restrict the number and location of recording instruments. The application of this method is illustrated with data obtained from drop tests of a freely falling model.

NACA TN 3024

MAXIMUM EVAPORATION RATES OF WATER DROPLETS APPROACHING OBSTACLES IN THE ATMOSPHERE UNDER ICING CONDITIONS. Herman H. Lowell. October 1953. 56p. diagrs., 3 tabs. (NACA TN 3024)

Maximum possible evaporation rates of water droplets approaching obstacles in the atmosphere along stagnation lines or moving within intake ducts of airplanes under icing conditions were calculated for a wide variety of ambient conditions, flight Mach numbers, degrees of stagnation of the incident relative air stream, and droplet diameters. Droplet diameter, body size, and flight Mach number effects were found to predominate, whereas wide variation in ambient conditions had little effect on evaporative losses. It was concluded that little or no evaporative loss occurs from droplets approaching small obstacles such as liquid-water-content measurement cylinders, whereas losses may be as high as several percent in the case of larger obstacles such as wings, or 50 percent in the case of ducts at high ram pressure. Losses in ducts in general, however, will usually be about 10 to 20 percent.

NACA TN 3025

AN INVESTIGATION UTILIZING AN ELECTRICAL ANALOGUE OF CYCLIC DE-ICING OF HOLLOW STEEL PROPELLERS WITH INTERNAL ELECTRIC HEATERS. Carr B. Neel, Jr. October 1953. 31p. diagrs., photo., 3 tabs. (NACA TN 3025)

An analytical study, utilizing an electrical analogue, of the heat requirements for cyclic de-icing of hollow steel propellers fitted with two types of internal electric heaters showed the impracticability of using an internal tubular heater, and illustrated the advantages of employing an internal shoe-type heater to distribute the heat more evenly to the blade surface. The importance of minimizing the thermal inertia of the system was demonstrated, and the magnitude of reductions in the total energy requirement made possible through reductions in heating period was indicated.

NACA TN 3031

PRELIMINARY EXPERIMENTAL INVESTIGATION OF LOW-SPEED TURBULENT BOUNDARY LAYERS IN ADVERSE PRESSURE GRADIENTS. Virgil A. Sandborn. October 1953. 37p. diagrs., photos. (NACA TN 3031)

Measurements of velocity profiles and skin friction in subsonic turbulent boundary layers with adverse pressure gradients are presented. The skin friction was measured by using a local heat-transfer instrument and employing a calibrated relation between heat transfer and skin friction. The skin friction in an adverse pressure gradient was found to decrease steadily with distance to a value approaching zero for the region of separation. The measured values of skin friction were related to the form factor and momentum thickness of the measured velocity profiles substantially in accordance with the equation of Ludwieg and Tillmann. Momentum thickness θ and mean velocity-profile-form parameters H computed according to the semiempirical method of Maskell have been compared with the measured quantities. From the agreement it is concluded that the method (which exploits the Ludwieg-Tillman formula for skin friction) gives results, for the flows investigated, well within a range of engineering accuracy for the predictions of profile parameters, local skin friction, and the point of flow separation; required data for the calculation are the profile parameters at a starting point and the pressure distribution.

NACA TN 3033

APPLICATION OF AN ELECTRO-OPTICAL TWO-COLOR PYROMETER TO MEASUREMENT OF FLAME TEMPERATURE FOR LIQUID OXYGEN - HYDROCARBON PROPELLANT COMBINATION. M. F. Heidmann and R. J. Priem. October 1953. 39p. diagrs., photos. (NACA TN 3033)

The development of an electro-optical two-color pyrometer and its application to the measurement of temperature and emissivity in the exhaust gases of an open-tube combustor during normal and oscillatory combustion are described. Temperature variations up to 1000° R and emissivity variations of 10 to 1 were measured; the variations were sporadic and periodic during normal and oscillatory operation, respectively. The results of simultaneous measurements of sound intensity and temperature by the two-color method and by a microwave absorption technique are also presented.

NACA RM L53G20a

CHARTS FOR ESTIMATION OF THE PROFILE DRAG-LIFT RATIO OF A HELICOPTER ROTOR HAVING RECTANGULAR BLADES WITH -8° TWIST. F. B. Gustafson. October 1953. 18p. diagrs. (NACA RM L53G20a)

Theoretically derived charts are presented for prediction of profile drag-lift ratios of helicopter rotors having rectangular blades with -8° twist. Conditions for onset of blade-section stalling are shown in the charts.

NACA TM 1361

CONCERNING THE FLOW ON RING-SHAPED COWLINGS. PART XIII. THE INFLUENCE OF A PROJECTING HUB. (Ueber die Strömung an ringförmigen Verkleidungen. XIII. Mitteilung: Der Einfluss einer vorgezogenen Nabe). D. Küchemann. October 1953. 19p. diagrs. (NACA TM 1361. Trans. from Zentrale fur wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin. UM 3144)

The influence of thickness and length of a hub projecting from an inlet opening was investigated on one of the two new classes of circular cowls reported in NACA TM 1360.

BRITISH REPORTS

N-25316C*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE EFFECT OF VARIABLE WALL TEMPERATURE ON HEAT TRANSFER. H. B. Squire. (Addendum to ARC R &M 1986). 1953. 2p. tab. (ARC R & M 2753; ARC 13,475)

This report records the extension of the method given in R & M 1986 on the heat-transfer calculation for airfoils to the case of variable surface temperature.

N-26539*

Aeronautical Research Council (Gt. Brit.)
EXPERIMENTS ON CONICAL DIFFUSERS. H. B. Squire. 1953. 18p. diagrs., tab. (ARC R & M 2751; ARC 12,838. Formerly RAE Aero 2216; ARC 13,499; TP 320)

Measurements of the characteristics of conical diffusers of area ratio 4 between entry and exit and of total cone angle 4°, 5°, 6°, 8°, and 10° were made to determine the effect of Reynolds number on efficiency for uniform entry flow. A range of entry Reynolds number between 5×10^4 and 10^6 was covered. The pressure distributions along the walls and the velocity distributions at the end of the conical sections were measured. Further measurements of velocity distribution were made with conical diffusers of area ratio 16 between entry and exit and with pipe flow at the entry, to determine the velocity distributions which finally develop.

N-26566*

Forest Products Research Lab. (Gt. Brit.)
TRAILS OF TIMBERS FOR PLYWOOD MANUFACTURE. SAPELE (ENTANDROPHRAGMA CYLINDRICUM-SPRAGUE) GOLD COAST. (40 POUNDS PER CUBIC FOOT AT 15 PER CENT MOISTURE CONTENT) PROGRESS REPORT TWENTY. July 1953. 13p. 6 tabs. (Forest Products Research Lab.)

Four logs of Sapele that had been stored under water from December 1951 - March 1953 were treated with steam and peeled into veneer. Characteristics of the green veneer are given. The veneer was dried and cut into squares and glued together. Different treatment was given several lots. Results for each are given.

N-26651*

Royal Aircraft Establishment (Gt. Brit.)
TENSOR TRANSFORMATIONS FOR DESCRIBING SUCCESSIVE CHANGES IN THE ATTITUDE OF AN AIRCRAFT. E. H. Bateman. July 1953. 11p. (RAE Tech. Note Structures 121)

The methods of elementary vector and tensor analysis are applied to the problem of finding the attitude of an aircraft after successive applications of roll, pitch or yaw, or of rotations about any axes. General transformations are tabulated for the six second order combinations of roll, pitch, and yaw; and examples are given of a third order and a fifth order combination.

N-26653*

Royal Aircraft Establishment (Gt. Brit.)
SOME NOTES ON IRREVERSIBLE MACHINES. D. Rendel and J. Rudman. May 1953. 27p. diagrs., photo., tab. (RAE Tech. Note Mech. Eng. 144)

A mathematical analysis has been made of the simple type of irreversible machine without lost motion in which the internal frictional forces can be expressed in terms of the external loading. The analysis emphasises that the most efficient type of machine would be one in which, when operating against an opposing load, the input force gradually releases a brake which holds the output load. A model machine of this type, which can theoretically be made over 50-percent efficient, has been tested and found to be usable and irreversible up to an efficiency of 80 percent. A description of this machine and the tests

made on it is given in the appendix which may be read without reference to the main text. Other forms of irreversible machines are more generally surveyed and their probable defects pointed out.

N-26654*

Royal Aircraft Establishment (Gt. Brit.)
ESTIMATION OF THE FATIGUE LIFE OF A TRANSPORT AIRCRAFT. P. B. Walker. July 1953. 9p. (RAE Structures 149)

A simple formula is presented for the safe life of an aircraft under reasonably good operating conditions from the standpoint of wing fatigue. Gusts are treated as the main factor in determination of fatigue life, though other factors are allowed for as being secondary. Before the formula can be used a simple fatigue test is required on critical components, and repeated several times to establish variation of nominally identical specimens. The loading cycle for this test corresponds to a sequence of up and down gusts of 8 ft/sec equivalent velocity. The life obtained is termed the "Standard Life" and corresponds to normal operating conditions on European Air Lines. Reservations in the use of the formula and correction for other operating conditions are discussed in general terms.

N-26656*

Royal Aircraft Establishment (Gt. Brit.)
A REVIEW OF HEAT RESISTANCE OF LAMINATED PLASTICS. W. W. Wright. June 1953. 10p. (RAE Tech. Note Chem. 1200)

The results of recent investigations of the heat resistance of laminated plastics are reviewed. Structural factors which influence thermal stability are listed and possible research developments indicated.

N-26657*

Royal Aircraft Establishment (Gt. Brit.)
LEAKAGE TESTS ON SOLID AND INFLATABLE RUBBER SEALS DESIGNED FOR USE IN WIND TUNNELS. D. I. T. P. Llewelyn-Davies and M. T. Caiger. January 1953. 24p. diagrs., tab. (RAE Tech. Note Aero 2219)

Tests have been made on two types of rubber seals designed for use in a variable pressure wind tunnel. A solid seal was designed which would satisfactorily seal gaps of up to 0.04 inch against pressure differences of $\pm$1 atmosphere from atmospheric pressure and which required a minimum sealing force of 5 lb/inch run of seal. It is essential to keep to a minimum the number of joints in the seal and also it is important that the seal should be a loose fit in its groove. A minimum inflation pressure of 30 lb/sq in. gage was required to ensure satisfactory sealing when an inflatable seal was used to seal gaps of up to 0.128 inch against the same range of pressure differences. When sealing against pressures higher than atmospheric, the performance deteriorated rapidly due to the decrease of the effective seal pressure. Care was necessary to ensure that the seal did not roll out of its groove when the joint surfaces were slid apart.

UNPUBLISHED PAPERS

N-9275*

Polytechnic Inst. of Brooklyn.
THE CALCULATION OF BOUNDARY LAYER STABILITY ON A FLAT SURFACE WITH HEAT TRANSFER USING AN INTEGRAL SOLUTION FOR THE MEAN FLOW. Martin Bloom. June 1951. 35p. diagrs., 2 tabs. (Polytechnic Inst. of Brooklyn. PIBAL Rept. 179)

The compressible laminar boundary layer over a flat surface with heat transfer at the surface, a unit Prandtl number, and a linear temperature viscosity relation, is considered. The one-parameter Karman Pohlhausen integral method is applied with a sixth-degree polynomial assumed for the velocity profile. The method is shown to predict accurately the velocity profile slopes and curvatures. It is also shown to give good stability estimates as compared with mathematically exact solutions. The procedure for estimating the minimum critical Reynolds number for instability is modified to extend its applicability somewhat for extreme amounts of heat transfer and high Mach numbers.

N-25342*

TEST APPARATUS FOR PRODUCTION OF THICK LAMINAR BOUNDARY LAYERS. (Versuchseinrichtung zur erzeugung dicker laminarschichten). K. Wieghardt. April 1953. 9p. diagrs. (Trans. from Zentrale fur wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin. UM 6610)

According to a suggestion by Professor Betz, very thick laminar layers may be produced for test purposes by blowing air out of a wing-nose model in an air flow as continuously as possible, for instance through a perforated sheet. Preliminary measurements on such a test apparatus resulted, for an approach flow of 20 m/s air velocity and 0.4 m starting distance, already in boundary layers several cm thick. Therewith one has a test arrangement with which the behavior of laminar boundary layers may be investigated experimentally in all details, without great expense.

N-25353*

BEHAVIOR OF THE AIRPLANE TIRE IN A LANDING WITH LARGE ANGLE OF SIDESLIP. (Das verhalten des flugzeugreifens bei der landung mit grossem schiebewinkel). E. Maier and W. Rheinwald. September 1953. 9p. photos. (Trans. from Aerodynamische Versuchsanstalt Gottingen E. V. Technische Berichte, v. 11, no. 8, 1944, p. 275-277.)

Landings with large angles of sideslip were simulated on the road on airplane wheels rigidly mounted in a test trailer. These landings show that the airplane tire is capable of withstanding these loads without being pulled off the wheel rim.

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1094

AN EXPERIMENTAL INVESTIGATION OF TRANSONIC FLOW PAST TWO-DIMENSIONAL WEDGE AND CIRCULAR-ARC SECTIONS USING A MACH-ZEHNDER INTERFEROMETER. Arthur Earl Bryson, Jr., California Institute of Technology. 1952. ii, 33p. diagrs., photos. (NACA Rept. 1094. Formerly TN 2560)

Interferometer measurements are given of the flow fields near two-dimensional wedge and circular-arc sections at zero angle of attack. Pressure distributions and drag coefficients as functions of Mach number were obtained and the wedge data are compared with theory. It is shown that the local Mach number at any point on the surface of a finite three dimensional body or an unswept two-dimensional body, moving through an infinite fluid, has a stationary value at Mach number 1 and, in fact, remains nearly constant for a range of speeds below and above Mach number 1. On the basis of this concept and the experimental data, pressure distributions and drag coefficients for the wedge and circular-arc sections are presented throughout the entire transonic range of velocities.

NACA Rept. 1097

STRESSES IN A TWO-BAY NONCIRCULAR CYLINDER UNDER TRANSVERSE LOADS. George E. Griffith. 1952. ii, 12p. diagrs., 3 tabs. (NACA Rept. 1097. Formerly TN 2512)

A method, taking into account the effects of flexibility and based on a general eighth-order differential equation, is presented for finding the stresses in a two-bay, noncircular cylinder the cross section of which can be composed of circular arcs. Numerical examples are given for two cases of ring flexibility for a cylinder of doubly symmetrical (essentially elliptic) cross section, subjected to concentrated radial, moment, and tangential loads. The results parallel those already obtained for shells with circular rings.

NACA Rept. 1112

HYDROCARBON AND NONHYDROCARBON DERIVATIVES OF CYCLOPROPANE. Vernon A. Slabey, Paul H. Wise and Louis C. Gibbons. 1953. ii, 18p. diagrs., 4 tabs. (NACA Rept. 1112)

The methods used to prepare and purify 19 hydrocarbon derivatives of cyclopropane are discussed. Of these hydrocarbons, 13 were synthesized for the first time. In addition to the hydrocarbons, six cyclopropylcarbinols, five alkyl cyclopropyl ketones, three cyclopropyl chlorides, and one cyclopropanedicarboxylate were prepared as synthesis intermediates. The melting points, boiling points, refractive indices, densities, and, in some instances, heats of combustion of both the hydrocarbon and nonhydrocarbon derivatives of cyclopropane were determined. These data and the infrared spectrum of each of the 34 cyclopropane compounds are presented herein. The infrared absorption bands characteristic of the cyclopropyl ring are discussed, and some observations are made on the contribution of the cyclopropyl ring to the molecular refractions of cyclopropane compounds.

NACA Rept. 1113

SPECTRUM OF TURBULENCE IN A CONTRACTING STREAM. H. S. Ribner and M. Tucker. 1953. ii, 17p. diagrs., tab. (NACA Rept. 1113. Formerly TN 2606)

Spectrum concepts are employed to study the selective effect of a stream contraction on longitudinal and lateral turbulent velocity fluctuations. By consideration of the effect of stream contraction on a single plane wave, the effect on spectrum and correlation tensors of the turbulence is determined. Weak turbulence and an inviscid fluid are postulated; compressibility of mean flow only is taken into account. For axisymmetric contraction and isotropic initial turbulence, explicit results are obtained. The one dimensional longitudinal spectrum is found to be markedly distorted. The selective effect of contraction on longitudinal and lateral components of turbulence is found to be given uniquely, regardless of details of the isotropic spectrum; comparison with experiment is made.

NACA TN 3022

METHOD FOR STUDYING HELICOPTER LONGITUDINAL MANEUVER STABILITY. Kenneth B. Amer. October 1953. ii, 52p. diagrs., photos., 2 tabs. (NACA TN 3022)

A theoretical analysis of helicopter maneuver stability is made and the results are compared with experimental results for both a single- and a tandem-rotor helicopter. Techniques are described for measuring in flight the significant stability derivatives for use with the theory to aid in design studies of means for achieving marginal maneuver stability for a prototype helicopter.

NACA TN 3026

ELECTROSTATIC SPARK IGNITION-SOURCE HAZARD IN AIRPLANE CRASHES. Arthur M. Busch. October 1953. 28p. diagrs., photos., tab. (NACA TN 3026)

The hazard of igniting airplane crash fires by elec-

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trostatic sparks, generated when detached airplane parts fly through clouds of dust and fuel mist, was investigated. Within the limits of variables studied, the rates with which airplane wreckage collected a charge were directly proportional to the rate that clay dust or fuel mist was intercepted. Maximum rates of experimental electrification were used to relate energy accumulation to wreckage sizes and trajectories and to estimate minimum hazardous wreckage sizes and trajectories. Comparison of sizes and trajectories of wreckage shown in motion pictures of airplane crashes with these estimated sizes and trajectories indicated that the hazard is small. Of the remedial measures considered, polyethylene coatings were found to offer promise of protection against electrostatic spark ignition.

NACA TN 3027

INFLUENCE OF ROTOR-ENGINE TORSIONAL OSCILLATION ON CONTROL OF GAS-TURBINE ENGINE GEARED TO HELICOPTER ROTORS. John C. Sanders. October 1953. 40p. diagrs., photos., 2 tabs. (NACA TN 3027)

Equations were developed for the torsional motion of a gas-turbine engine geared to a helicopter rotor in which the rotor blades were hinged to the rotor shaft. The rotor system was simplified to yield simple third-order equations that can be used in the analysis of engine control. Comparison of the system response calculated from these equations with the experimentally observed frequency response of a rotor from a 2500-pound helicopter showed satisfactory agreement. Calculations showed that the torsional motion arising from the hinged construction of the blades contributed to instability of the engine-speed and engine-torque controls. Trends in stability and response of controls with increasing weight of helicopters were investigated.

NACA TN 3028

THE COMPRESSIBLE LAMINAR BOUNDARY LAYER WITH HEAT TRANSFER AND SMALL PRESSURE GRADIENT. George M. Low. APPENDIX B. NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS. Lynn U. Albers. October 1953. 68p. diagrs., 7 tabs. (NACA TN 3028)

A perturbation method for the calculation of velocity and temperature profiles, skin-friction and heat-transfer characteristics for two-dimensional compressible laminar boundary layers with heat transfer and small arbitrary gradient is presented. The permissible pressure gradients include those of a form and magnitude usually encountered over slender aerodynamic shapes in supersonic flight. The combined effects of heat transfer and pressure gradient on boundary-layer characteristics are demonstrated by applying the results of the analysis to two representative wings.

NACA TN 3032

AN ANALYTICAL STUDY OF THE EFFECT OF AIRPLANE WAKE ON THE LATERAL DISPERSION OF AERIAL SPRAYS. Wilmer H. Reed, III. October 1953. 46p. diagrs., 3 tabs. (NACA TN 3032)

An analysis is made to determine the trajectories and deposit of aerial spray droplets which are issued into the air disturbances generated by an agricultural airplane. Various nozzle arrangements and droplet-size spectra are considered with a view to improving the uniformity and effective width of the deposit.

NACA TN 3034

GRAPHICAL SOLUTION OF SOME AUTOMATIC-CONTROL PROBLEMS INVOLVING SATURATION EFFECTS WITH APPLICATION TO YAW DAMPERS FOR AIRCRAFT. William H. Phillips. October 1953. 41p. diagrs. (NACA TN 3034)

A graphical method is presented for determining the motion of a freely oscillating system of one degree of freedom stabilized by a controlling device which applies control force in proportion to the displacement of the system, to its rate of change of displacement, or both. The controlling member is assumed to have limitations on its maximum deflection and on its maximum rate of movement. Several examples concerned with the application of yaw dampers to aircraft are presented to illustrate the method, and some conclusions regarding the variation of the stability of the motion with amplitude are obtained.

NACA TN 3035

A PRELIMINARY STUDY OF THE PROBLEM OF DESIGNING HIGH-SPEED AIRPLANES WITH SATISFACTORY INHERENT DAMPING OF THE DUTCH ROLL OSCILLATION. John P. Campbell and Marion O. McKinney, Jr. October 1953. 40p. diagrs., 4 tabs. (NACA TN 3035)

This paper presents some preliminary results of a theoretical investigation to determine what design features appear most important in designing modern high-performance airplanes to have the greatest possible inherent stability of the Dutch roll oscillation in order that the need for artificial stabilizing devices can be minimized. These preliminary results cover the case of fighter airplanes at subsonic speeds.

NACA TN 3036

THE FLOW ABOUT A SECTION OF A FINITE-ASPECT-RATIO NACA 0015 AIRFOIL ON A TRANSONIC BUMP. Jack A. Mellenthin. October 1953. 30p. diagrs., photos., tab. (NACA TN 3036)

Pressure distributions were measured at one spanwise station on a semispan rectangular wing model having an NACA 0015 airfoil section and a moderate aspect ratio. The tests were conducted on a transonic bump at Mach numbers from 0.4 to 1.06. Pressure-distribution plots were integrated to obtain the section lift, drag, and pitching-moment coefficients. At a fixed angle, a region developed over the airfoil surface wherein the local Mach number remained nearly constant as the free-stream Mach number was increased above the critical value. This region covered essentially the whole chord of the airfoil at free-stream Mach numbers near unity.

NACA TN 3037

COUNTING METHODS AND EQUIPMENT FOR MEAN-VALUE MEASUREMENTS IN TURBULENCE RESEARCH. H. W. Liepmann and M. S. Robinson, California Institute of Technology. October 1953. 49p. diagrs., photos. (NACA TN 3037)

Methods of measuring the probability distributions and mean values of random functions as encountered in turbulence research were studied. Applications to the measurement of probability distributions of the axial velocity fluctuation u(t) and its derivative du/dt in isotropic turbulence are shown. The assumption of independent probabilities of u(t) and du/dt was investigated and the results indicate that the assumption is satisfied within a few percent and that there is no evidence that the systematic difference between the microscale of turbulence measured from zero counts and measured independently can be traced entirely to the statistical dependence of u and du/dt. The chronological development of apparatus is described, concluding with the 10-channel statistical analyzer.

NACA TN 3042

HIGH-FREQUENCY PRESSURE INDICATORS FOR AERODYNAMIC PROBLEMS. Y. T. Li, Massachusetts Institute of Technology. November 1953. 52p. diagrs., photos., 4 tabs. (NACA TN 3042)

Three different types of pressure indicators are discussed. Each of these indicators has a unique feature, but all are designed with an attempt to combine both high-frequency response and high resolving power into one instrument. Of the mechanical-electrical-transducer type of pressure indicator, the wire strain gage leads in simplicity. The capacitance type is more versatile because it permits the use of very high frequency carrier systems and thereby cuts down the effective interference in the electronic system. The system utilizing the stretching of a barium-titanate disk produces large signals and results in compact design, but it can only be used for dynamic measurements when temperature variations are slight. Five different types of pressure receivers were tested. The flat-diaphragm type leads the others in simplicity, the spherical-diaphragm type exceeds in dynamic performance, and the catenary-diaphragm type is the one least affected by temperature change.

NACA TN 3045

ANALOGY BETWEEN MASS AND HEAT TRANSFER WITH TURBULENT FLOW. Edmund E. Callaghan. October 1953. 19p. diagrs. (NACA TN 3045)

An analysis of combined heat and mass transfer from a flat plate has been made in terms of Prandtl's simplified physical concept of the turbulent boundary layer. The results of the analysis show that for conditions of reasonably small heat and mass transfer, the ratio of the mass- and heat-transfer coefficients is dependent on the Reynolds number of the boundary layer, the Prandtl number of the medium of diffusion, and the Schmidt number of the diffusing fluid in the medium of diffusion. For the particular case of water evaporating into air, the ratio of mass-transfer coefficient to heat-transfer coefficient is found to be slightly greater than unity.

NACA TM 1360

CONCERNING THE FLOW ABOUT RING-SHAPED COWLINGS. PART XII. TWO NEW CLASSES OF CIRCULAR COWLS. (Uber die Stromung an ringförmigen Verkleidungen. XII Mitteilung: Zwei neue Klassen von Ringhauben). Dietrich Küchemann and Johanna Weber. October 1953. 72p. diagrs., 3 tabs. (NACA TM 1360. Trans. from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin. UM 3111)

For application in practice for annular radiator fairings and similar arrangements, two new classes of circular cowls are developed by theoretical method, and investigated in a systematic test series regarding their behavior under various working conditions.

NACA RM E53G03

EFFECTIVE THERMAL CONDUCTIVITIES OF MAGNESIUM OXIDE, STAINLESS STEEL, AND URANIUM OXIDE POWDERS IN VARIOUS GASES. C. S. Eian and R. G. Deissler. October 1953. 18p. diagrs., photos., tab. (NACA RM E53G03)

As a part of a general investigation of the effective thermal conductivities of powders, tests were conducted to determine the conductivity of magnesium oxide, stainless steel, and uranium oxide powders in various gases at temperatures between 120° and 1455° F. Fair agreement was obtained between conductivities calculated from experimental data for fine magnesium oxide and stainless steel powders and those calculated from a simplified analysis from a previous investigation, although the experimental values are somewhat higher. Runs were also made to determine the effect of gas pressure on effective thermal conductivity.

NACA RM E53H31

MINIMUM SPARK-IGNITION ENERGIES OF 12 PURE FUELS AT ATMOSPHERIC AND REDUCED PRESSURE. Allen J. Metzler. October 1953. 28p. diagrs., 5 tabs. (NACA RM E53H31)

Minimum spark-ignition energies for 12 pure fuels were measured at reduced pressure, and the data obtained were extrapolated to 1 atmosphere. The fuels investigated included normal and cycloparaffins, olefins, carbon disulfide, and oxygenated compounds such as an alcohol, ether, propylene oxide, and tetrahydropyran; these fuels were ignited at reduced pressures by capacitance sparks of controlled duration. The minimum ignition energies obtained are related to the pressure, the quenching distance, and the maximum fundamental flame velocity of the fuel-air mixture. Also, the experimental data obtained are applied to two correlations of spark-ignition energies to check the data of this investigation with that of others.

NACA RM L53I18a

FACTORS AFFECTING TRANSITION AT SUPERSONIC SPEEDS. K. R. Czarnecki and Archibald R. Sinclair. November 1953. 13p. diagrs. (NACA RM L53I18a)

The paper surveys the available material and summarizes what is known to date about boundary-layer transition at supersonic speeds. Variables studied include Mach number, Reynolds number, pressure gradients, heat transfer, surface roughness, and

angle of attack. The discussion is limited to bodies of revolution because similar reliable data for wings is lacking.

BRITISH REPORTS

N-25356*

Aeronautical Research Council (Gt. Brit.)
WING-FUSELAGE FLUTTER OF LARGE AEROPLANES. W. P. Jones. 1953. 46p. diagrs., 7 tabs. (ARC R & M 2656. Formerly ARC 11,024; 0.688)

A general theoretical method is described which takes into account a large number of degrees of freedom and is based on the design data for the airplane. The problem specifically investigated is the symmetrical flutter of a particular aircraft. Twelve degrees of freedom are assumed to cover pitching and translational motion of the whole airplane, flexure and torsion of the wings, and fuselage vertical bending. The tailplane is regarded as rigid. In the case considered, estimates indicate that the lowest critical speed is well above the maximum design speed of the airplane. The influence of the additional degrees of freedom associated with movements of the control surfaces is not considered.

N-26658*

Royal Aircraft Establishment (Gt. Brit.)
CALCULATIONS OF THE PRESSURE DISTRIBUTIONS AND BOUNDARY LAYER DEVELOPMENT ON A BODY OF REVOLUTION WITH VARIOUS PARABOLIC AFTERBODIES AT SUPERSONIC SPEEDS. L. E. Fraenkel. February 1953. 56p. diagrs., 4 tabs. (RAE Aero 2482)

Detailed calculations are made of the flow over a series of bodies at Mach numbers of 1.2, 1.4, and 1.6 and Reynolds numbers of 48 to 72 millions. The bodies consist of a basic forebody and parallel portion to which are added truncated parabolic afterbodies of three different thickness ratios. Calculation of the flow over the bodies is done by the method of characteristics. The method of Squire and Young is used to calculate the boundary layer properties. Calculation of the pressure distribution on the "modified" afterbodies is by Ferri's method of linearized characteristics.

N-26687*

National Gas Turbine Establishment (Gt. Brit.)
REFLECTION OF A SMALL PRESSURE PULSE BY DISTRIBUTED FRICTION IN ONE-DIMENSIONAL GAS FLOW. P. W. H. Howe. July 1953. 23p. diagrs. (NGTE Memo. M. 168)

This work is part of an investigation into the combustion excited oscillations in a ram jet or reheat system. The main interest here is how much of a pressure pulse produced in the combustion zone succeeds in travelling upstream past the flame stabilizing baffle. The method used is effectively a differentiation from the steady state-conditions and is of general application.

N-26694*

National Gas Turbine Establishment (Gt. Brit.)
AN IMPROVED DESIGN OF SONIC SUCTION PYROMETER. L. Fuller and B. Marlow. June 1953. 24p. diagrs. (NGTE Memo. M. 189)

Designs of sonic suction pyrometers for the measurement of the temperature of low density, high velocity, hot gases have been exmained and tested in a rig that permits the comparison of two pyrometers, one in a gas stream at approximately ground level, atmospheric pressure and the second in the same stream but at a pressure controllable to below 3 inches mercury absolute. Various modifications were made and the pyrometers now advocated agree on mean temperatures to within 5° C when one is at 24 inches mercury absolute and the other is at 3 inches mercury absolute.

N-26842*

Aeronautical Research Council (Gt. Brit.)
NOTES ON THE TECHNIQUE EMPLOYED AT THE R. A. E. IN LOW-SPEED WIND-TUNNEL TESTS IN THE PERIOD 1939-1945. Edited by F. B. Bradfield. 1952. 71p. photos., diagrs., tab. (ARC R & M 2556; 11,164. Formerly RAE Aero 2222)

Very little has been recorded during the war years as to the details of technique used in low-speed wind-tunnel tests. The size and type of tunnel used during this period will remain in use at firms and colleges for some time after newer equipment is available at research establishments, so it has been decided to issue some record of the technique in use at the Royal Aircraft Establihsment during the war years, both with a view to establishing a standard technique where it is satisfactory, and to consider weaknesses where it has failed.

N-26843*

Aeronautical Research Council (Gt. Brit.)
THE SOLUTION OF LIFTING-PLANE PROBLEMS BY VORTEX-LATTICE THEORY. V. M. Falkner. 1953. 30p. diagrs., 46 tabs. (ARC R & M 2591. Formerly ARC 10,895; S & C 2153; Perf. 354)

The report describes in detail the methods by which the principles of vortex-lattice theory, introduced in a previous report R & M 1910, are applied to the calculation of the aerodynamic loading of wings by lifting plane theory. The scope of the paper is limited to the application of these principles to symmetrical incidence solutions and symmetrical and antisymmetrical wing twist solutions, for which standard solutions can be treated by comparatively simple loading functions. The effect of discontinuity of direction of leading or trailing edge cannot be avoided even in the simplest solutions, and it has been found necessary to include an investigation of this problem in order to cover the prescribed usage of the method. Special standard functions tabulated in another report are used to allow for the rounding off effects due to change of direction of leading or trailing edge. The general problem of discontinuities is under investigation and will be dealt with in a later report. A comprehensive set of solutions for a delta wing is included in the report in order to show the convergence

N-26843*

of and relation between solutions of varying complexity, and to indicate which solution should be used in order to satisfy the accuracy prescribed for any given problem. The case of the delta wing is not completely general, and the exposition in respect to induced drag and yawing moment will be completed in a later report.

N-26847*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF SPANWISE RIB-BOOM STIFFNESS ON THE STRESS DISTRIBUTION NEAR A WING CUT-OUT. E. H. Mansfield. 1952. 21p. diagrs. (ARC R & M 2663; ARC 11,291. Formerly RAE Structures 13)

A theoretical investigation is made into the effect of spanwise rib-boom stiffness on the stress distribution at a cut-out in the interspar skin of a stressed skin wing in bending. Both shear and bending stiffness of the rib-boom are taken into account, and attention is concentrated on the case in which the rib-boom is built-in to the spar flanges. Curves are included which determine, for any particular case, the magnitude of the peak shear stress adjacent to the flange, the approximate spanwise variation of this shear stress, the proportion of load transferred by the rib-boom to the skin and stringers, and the bending moment in the rib-boom at its points of attachment to the spar flanges. By suitable design of the rib-boom, it is possible to lower the shear stresses adjacent to the flange with little or no increase in structure weight.

N-26848*

Aeronautical Research Council (Gt. Brit.)
WIND-TUNNEL TESTS OF THE STALLING PROPERTIES OF AN 8 PER CENT THICK SYMMETRICAL SECTION WITH NOSE SUCTION THROUGH A POROUS SURFACE. R. C. Pankhurst, W. G. Raymer and A. N. Devereux. 1953. 14p. diagrs., tab. (ARC R & M 2666. Formerly ARC 11,496; Perf. 441; FM 1247)

The stalling properties of an 8-percent-thick symmetrical airfoil with large leading-edge radius of curvature and continuous (distributed) suction over the nose have been tested in the 4-foot No. 2 wind tunnel of the National Physical Laboratory. It was found that suction postponed the stall to higher angles of incidence by suppressing separation at the leading edge. The suction also produced beneficial effects in delaying transition. Moreover, it prevented the development of boundary-layer turbulence behind a single excresence or spanwise corrugation, provided the suction was applied over a sufficient chordwise extent of the airfoil surface. The quantity requirements are remarkably small. For example, even at the low Reynolds number of 0.3×10^6 a quantity coefficient $C_Q(Q/Uc)$ of only 0.0036 is sufficient to increase the lift coefficient at 15° increase by 0.6 (from 0.7 to 1.3), and it is to be expected that C_Q will become even less as the Reynolds number is increased. It is not yet possible to estimate the probable power requirements, because the potentialities of the best methods of porous construction are not known.

N-26849*

Aeronautical Research Council (Gt. Brit.)
THE DETERMINATION OF THE NATURAL FREQUENCIES OF A FULL-SCALE AIRFRAME-ENGINE SYSTEM BY THE ADMITTANCE METHOD. J. R. Forshaw and F. T. Mountford. 1953. 24p. diagrs., 3 tabs. (ARC R & M 2667; ARC 11,826. Formerly RAE Tech. Note Structures 20)

The development of the method of the measurement of admittances and the solution of the frequency equation for a complex full-scale airframe-engine system is given, dividing the dynamical system at the attachment of the engine to the airframe, and using a force system of equal and opposite bending moments and shearing forces. The values of the resonance frequencies obtained from the graphical solution of the frequency equation and from the resonance test are compared and found to be in good agreement. The method is applicable to the matching of an engine to an airframe by adjusting the flexibility of the mounting units.

N-26853*

Aeronautical Research Council (Gt. Brit.)
HIGH-SPEED TUNNEL TESTS OF A 5 PER CENT. CHORD DIVE-RECOVERY FLAP ON A NACA 0015 AEROFOIL. D. A. Clarke. 1953. 19p. diagrs., 9 tabs. (ARC R & M 2689; ARC 11,743. Formerly RAE Aero 2269)

Pressure plotting tests were made in the Royal Aircraft Establishment high-speed tunnel on a parallel wooden NACA 0015 wing with dive-recovery flap. The Mach number was varied between 0.30 and 0.80, and the Reynolds number was kept constant at 1.4×10^6. All combinations of the following were tested: flap position 0.2c, 0.3c, 0.4c; flap angle 20°, 40°; incidence 0°, 4°. The flap-chord/wing-chord ratio was 0.05. The report presents a general picture of the action of a dive-recovery flap on a wing. The data are, however, too limited to permit the formulation of general design recommendations.

N-26854*

Aeronautical Research Council (Gt. Brit.)
THE ROYAL AIRCRAFT ESTABLISHMENT 4 FT x 3 FT EXPERIMENTAL LOW TURBULENCE WIND TUNNEL. PART I - GENERAL FLOW CHARACTERISTICS. H. B. Squire and K. G. Winter. 1953. 28p. diagrs., photos., 4 tabs. (ARC R & M 2690; ARC 10,695; ARC 11,410. Formerly RAE Aero 2182; RAE Tech. Note Aero 1937)

The 4- by 3-foot wind tunnel was erected as a model of larger tunnels to investigate unconventional design features directed towards obtaining a high standard of flow. Diffusers of 5° cone angle are used, except for the rapid expansion through three wire-gauze screens up to the maximum section. The contraction ratio is 31.2:1 and nine screens are fitted in the maximum section. A speed control is used operating independently of the fan by means of a bypass duct. The velocity distribution across the working-section is constant to $\pm 1/4$ percent. The standard deviation of the velocity with time measured over a period of 50 sec is 0.03 percent. The flow in the diffusers shows no tendency to separate and the velocity distribution approaching the first screen is very satis-

factory. The installation of cascades with gap/chord ratio of 1/4 gives uniform outlet flow without appreciseparation in the rapid expansion of the bulge, but the flow in the contraction cone is not satisfactory. A longer contraction would have been advantageous. The power factor has been measured as 0.27 with all screens fitted but could be imporved slightly if all the leaks were sealed. The speed control is satisfactory in operation.

N-26858*

Aeronautical Research Council (Gt. Brit.)
THE DIFFUSION OF LOAD INTO A PANEL BOUNDED BY CONSTANT STRESS BOOMS AND A TRANSVERSE BEAM. E. H. Mansfield. 1953. 12p. diagrs. (ARC R & M 2729; ARC 11,885. Formerly RAE Structures 31)

A theoretical investigation is made into the diffusion of symmetrical, concentrated loads into a long stiffened panel having constant stress edge members and a transverse loading beam. Both pin-jointed and clamped end conditions for the beam are considered. Curves are given for determining the peak shear stress near the boom, the variation of this shear stress along the length of the panel, the proportion of load transferred by the beam, and the bending moment at the ends of the beam.

N-26859*

Aeronautical Research Council (Gt. Brit.)
AN INVESTIGATION OF THE USE OF AN AUXILIARY SLOT TO RE-ESTABLISH LAMINAR FLOW ON LOW-DRAG AEROFOILS. R. W. Cumming, N. Gregory and W. S. Walker. 1953. 14p. diagrs., photos., tab. (ARC R & M 2742. Formerly ARC 13,003; Perf. 645; FM 1424)

The use of an auxiliary slot on a laminar-flow airfoil has been investigated to check whether laminar flow can be reestablished by suction at the rear of the region of deposited dirt, flies, etc. Results indicate that in the absence of unfavorable pressure gradients, it is possible to reestablish a laminar boundary layer by removing a little more than the whole turbulent layer reaching the slot, and preliminary estimates suggest that with efficient ducting it should be possible to achieve a reduction in over-all effective drag coefficient by this means.

N-26861*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF COMPRESSIBILITY ON THE ATTITUDE OF AIRCRAFT IN RECTILINEAR FLIGHT. K. J. Lush. 1953. 7p. diagrs., tab. (ARC R & M 2776; ARC 11,500. Formerly AAEE/Res/234)

The attitude of aircraft (that is, the angle between the aircraft datum and the flight path) is of considerable importance in the aiming of certain airborne armament. An investigation was therefore made of the effect of compressibility on the attitude of aircraft in flight in a straight path. The application of the results of linear perturbation theory to the problem was examined and the deductions made compared with the results of attitude measurements on a Spitfire IX over a wide range of altitude and airspeed.

N-26862*

Aeronautical Research Council (Gt. Brit.)
THE TOEPLER SCHLIEREN APPARATUS. D. W. Holder and R. J. North. 1953. 13p. diagrs., photos., 3 tabs. (ARC R & M 2780. Formerly ARC 13,068; FM 1433)

For wind-tunnel observations it is usually necessary that a Toepler schlieren apparatus shall have roughly uniform sensitivity to density gradients within a certain range determined by the nature of the flow. It is also desirable that the illumination in the image of the flow shall be as high as possible if visual observations are to be made under the best conditions and if photographs are to be taken with very short exposures. Methods for satisfying these two requirements are discussed and experimental results are included to illustrate their importance.

N-26863*

Aeronautical Research Council (Gt. Brit.)
EVAPORATION OF DROPS OF LIQUID. J. K. Hardy. 1953. 9p. (ARC R & M 2805; ARC 10,675. Formerly RAE Mech. Eng. 1)

An analysis has been made of the processes which follow when a drop of liquid is subjected to a sudden change in the condition of the air in which it is suspended. Equations are given from which either the temperature of the drop, or the rate at which it will evaporate, can be calculated.

N-26886*

Royal Aircraft Establishment (Gt. Brit.)
TORSIONAL STRENGTH OF BARS IN STEEL, AND ALUMINIUM, MAGNESIUM AND COPPER ALLOYS. E. L. Ripley, A. J. Beard and B. A. J. McCarthy. July 1953. 40p. diagrs., 5 tabs. (RAE Tech. Note Structures 119)

Simple empirical relationships between the torsional strength and tensile strength of solid and hollow bars are derived from tests on steel, aluminum alloy, magnesium alloy, and copper alloy bars. Both proof and ultimate conditions of failure are considered. The relationships are used to present design data on the torsional strength of solid and hollow bars.

N-26887*

Royal Aircraft Establishment (Gt. Brit.)
SHEAR STRENGTH OF PINS IN STEEL, AND ALUMINIUM, MAGNESIUM AND COPPER ALLOYS. E. L. Ripley and A. J. Beard. July 1953. 28p. diagrs., 5 tabs. (RAE Tech. Note Structures 120)

Simple empirical relationships between the ultimate shear strength and ultimate tensile strength of cylindrical pins are derived from tests on steel, aluminum alloy, magnesium alloy, and copper alloy bars. The relationships are used to present design data on the shear strength of pins.

N-26888*

Royal Aircraft Establishment (Gt. Brit.)
LOW SPEED WIND TUNNEL MEASUREMENTS OF THE LIFT ON A 45° SWEPT BACK HALF WING AND CYLINDRICAL BODY. J. A. Lawford. July 1953. 40p. diagrs., 12 tabs. (RAE Tech. Note Aero 2243)

Measurements have been made of the lift, drag, and pitching moment on a 45° sweptback half wing mounted on a cylindrical body. Four wing aspect ratios between 0.5 and 1.5 and two body diameters have been tested. For the larger body the lift due to the wing has been analyzed by pressure plotting into contributions due to lift on the wing and to the lift induced by the wing on the body. The measured lift slopes are compared with values calculated by the method of J. Weber (R.A.E. Report No. Aero 2467). The calculation overestimates the lift slope of the wing-body combination by approximately 10 percent. The tests are part of an investigation to establish a method of estimating the lift slope of this configuration, which occurs when a swept fin is carried on a body of circular section (for example, a jetpipe) and when a single store is carried on a wing tip.

N-26889*

Aeronautical Research Council (Gt. Brit.)
INVESTIGATION OF THE INSTABILITY OF A MOVING LIQUID FILM. H. B. Squire. January 25, 1952. 10p. photos., diagrs., tab. (ARC 14,586; CF 213)

The stability of a thin layer of liquid moving in still air is studied theoretically with the object of throwing light on the break-up of films during atomization. It is found that instability occurs if $W = T/\rho_1 U^2 h < 1$ and that the wave length for maximum growth factor, for $W \ll 1$, is $\lambda = 4\pi T/\rho_2 U^2$ where ρ_1 is the liquid density, ρ_2 is the air density, U is the film velocity, 2h is the film thickness, and T is the surface tension of the liquid. Comparison with experimental data shows fair agreement with the observed wave lengths.

N-26958*

Royal Aircraft Establishment (Gt. Brit.)
A TECHNIQUE FOR STUDYING THE BEHAVIOUR OF CINE CAMERA MECHANISMS UNDER DYNAMIC CONDITIONS. G. L. Davies. July 1953. 10p. diagrs., photos. (RAE Tech. Note GW 261)

In the design of high-speed cine camera mechanisms, it is not always possible to predict the behavior of the film under dynamic conditions. A simple technique has been developed for measuring running speed, register, film acceleration, shutter timing, and other parameters. The camera under test has its normal shutter replaced by a "negative" shutter, and it is then used to photograph a cathode ray oscilloscope which has a linear saw tooth wave form applied to its X deflection plates. The wave shape of the resulting traces on the film can easily be interpreted to give the required information.

UNPUBLISHED PAPERS

N-25367*

THE MODERN DEVELOPMENT OF THE THEORY OF PROPELLERS. (Le developpement moderne de la theorie de l'helice). Raymond Siestrunck. September 1953. ii, 137p. diagrs. (Trans. from Institut de Mecanique de la Faculte des Sciences de Paris, 1947)

The empirical basis of propeller vortex theory is examined; theories already known are arranged and summarized. The general form of the vortex surfaces with respect to the propeller is specified and evaluation of the field of velocities induced by these vortices is undertaken. The idea is given that the functioning of the propeller depends on the state of the velocities of the surrounding fluid. The problem of determining the distribution of the circulations which induce the velocities along a blade is studied in detail as are the problems of its adaptations for practical use.

MISCELLANEOUS

NACA TN 2135

Errata No. 1 on "THE CALCULATION OF DOWNWASH BEHIND WINGS OF ARBITRARY PLAN FORM AT SUPERSONIC SPEEDS. John C. Martin. July 1950.

NACA TN 2590

Errata No. 1 on "CALCULATIONS ON THE FORCES AND MOMENTS FOR AN OSCILLATING WING-AILERON COMBINATION IN TWO-DIMENSIONAL POTENTIAL FLOW AT SONIC SPEED." Herbert C. Nelson and Julian H. Berman. January 1952.

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1106

THE LANGLEY ANNULAR TRANSONIC TUNNEL. Louis W. Habel, James H. Henderson and Mason F. Miller. 1952. ii, 10p. diagrs., photos. (NACA Rept. 1106. Formerly RM L8A23; RM L50E18)

The development of the Langley annular transonic tunnel, a facility in which test Mach numbers from 0.6 to slightly over 1.0 are achieved by rotating the test model in an annular passage between two concentric cylinders, is described. Data obtained for two-dimensional airfoil models in the Langley annular transonic tunnel at subsonic and sonic speeds are shown to be in reasonable agreement with experimental data from other sources and with theory when comparisons are made for nonlifting conditions or for equal normal-force coefficients rather than for equal angles of attack. The trends of pressure distributions obtained from measurements in the Langley annular transonic tunnel are consistent with distributions calculated for Prandtl-Meyer flow.

NACA Rept. 1110

SOME FEATURES OF ARTIFICIALLY THICKENED FULLY DEVELOPED TURBULENT BOUNDARY LAYERS WITH ZERO PRESSURE GRADIENT. P. S. Klebanoff and Z. W. Diehl, National Bureau of Standards. 1952. 27p. diagrs., photos. (NACA Rept. 1110. Formerly TN 2475)

Results are presented of tests to determine the feasibility of artifically thickening a turbulent boundary layer on a flat plate. It is shown that it is possible to do substantial thickening and obtain a fully developed turbulent boundary layer which is free from any distortions introduced by the thickening process. Measurements of mean velocity, spectrum of u-fluctuation, and intensity of u-fluctuation are presented. Some features of the fully developed turbulent boundary layer with zero pressure gradient are discussed. The mean flow in the boundary layer is compared with the logarithmic laws of mean-velocity distribution derived for pipes and channels, and the existing theories dealing with the shape of the spectrum in isotropic turbulence are applied to the spectrum measured in the outer portion of the boundary layer.

NACA TN 3038

LOW-SPEED DRAG OF CYLINDERS OF VARIOUS SHAPES. Noel K. Delany and Norman E. Sorensen. November 1953. 22p. diagrs., photos., tab. (NACA TN 3038)

An investigation has been conducted to find the approximate variation of the drag coefficient with Reynolds number of cylinders. Data were obtained for circular cylinders, elliptical cylinders of two fineness ratios, rectangular and diamond cylinders of three fineness ratios, and two isosceles triangular cylinders (apex forward and base forward). Three different corner radii were tested. Data were obtained for Reynolds numbers as low as 11,000 and high as 2,300,000. Frequencies of pressure fluctuations in the wake were measured for some of the cylinders.

NACA TN 3039

EXPERIMENTAL STRESS ANALYSIS OF STIFFENED CYLINDERS WITH CUTOUTS. PURE TORSION. Floyd R. Schlechte and Richard Rosecrans. November 1953. 41p. diagrs., 7 tabs. (NACA TN 3039)

Torsion tests were made on a cylindrical semi-monocoque shell of circular cross section. The cylinder was first tested without a cutout, and then with a rectangular cutout which was successively enlarged through six sizes varying from 30° to 130° in circumference and from 1 to 2 bays in length. Strain measurements were made with resistance-type wire strain gages near the cutout on the stringers, the skin, and the rings for each size of cutout, and the stresses obtained are presented in tables.

NACA TN 3040

USE OF TWO-DIMENSIONAL DATA IN ESTIMATING LOADS ON A 45° SWEPTBACK WING WITH SLATS AND PARTIAL-SPAN FLAPS. Lynn W. Hunton and Harry A. James. November 1953. 40p. diagrs., photo., tab. (NACA TN 3040)

A study has been made of the application of two-dimensional data and span-loading theory for estimating the local loading characteristics on a swept wing with flaps. Estimated results, including local pressure distributions, span loadings, and the nonlinear local lift characteristics, are compared with similar results measured at a Reynolds number of 8 million on a 45° sweptback wing of aspect ratio 6 having a 0.4 span double-slotted flap both with and without a full-span slat. Two-dimensional pressure distributions when corrected for sweep were found to agree closely with the wing pressures for most local sections either on or off the flap, this agreement continuing to lift coefficients approaching those for stall.

*AVAILABLE ON LOAN ONLY.

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NACA TN 3041

SUMMARY OF REVISED GUST-VELOCITY DATA OBTAINED FROM V-G RECORDS TAKEN ON CIVIL TRANSPORT AIRPLANES FROM 1933 TO 1950. Walter G. Walker. November 1953. 16p. diagrs., 4 tabs. (NACA TN 3041)

This paper summarizes gust-velocity data obtained by reevaluating the normal accelerations and airspeeds from V-G records taken on civil transport airplanes from 1933 to 1950. The reevaluation was made on the basis of a "derived" gust velocity U_{de}, which is related to the "effective" gust velocity U_e by a conversion factor that is a function of the type of airplane and operating altitude. Although the value of the conversion factor varies from about 1.6 to 2.0 for the data presented, the conclusions drawn from the previously presented data based on U_e (in particular the relative levels of turbulence indicated between different routes) remain essentially unchanged.

NACA TN 3043

APPLICATION OF SILVER CHLORIDE IN INVESTIGATIONS OF ELASTO-PLASTIC STATES OF STRESS. L. E. Goodman and J. G. Sutherland, University of Illinois. November 1953. 55p. diagrs., photos., 4 tabs. (NACA TN 3043)

Quantitative relationships between the state of elastic or plastic stress in a specimen and the observed relative retardation and extinction angle were developed from a general theory of stress birefringence, according to a stress-dependent hypothesis. The relationships were verified experimentally by measurements on single-crystal specimens of silver chloride tested in simple tension in the elastic and plastic stress ranges. Studies were also made of stress states in bicrystal tension specimens, in simple polycrystalline tension specimens, and in single-crystal and polycrystal tension specimens with holes and notches. Silver chloride appears to be a suitable medium for photoelastic studies of effects of plastic yielding on the state of stress in a crystalline specimen.

NACA TN 3044

EFFECT OF A RAPID BLADE-PITCH INCREASE ON THE THRUST AND INDUCED-VELOCITY RESPONSE OF A FULL-SCALE HELICOPTER ROTOR. Paul J. Carpenter and Bernard Fridovich. November 1953. 26p. diagrs., photos. (NACA TN 3044)

A method is developed for calculating the response of a helicopter rotor and its induced velocity buildup following a rapid blade-pitch increase. The calculated and experimental results are in good agreement for various rates of pitch increase of 6° to 200° per second.

NACA TN 3046

THEORETICAL CALCULATIONS OF THE EFFECTS OF FINITE SIDESLIP AT SUPERSONIC SPEEDS ON THE SPAN LOADING AND ROLLING MOMENT FOR FAMILIES OF THIN SWEPTBACK TAPERED WINGS AT AN ANGLE OF ATTACK. Windsor L. Sherman and Kenneth Margolis. November 1953. 53p. diagrs., tab. (NACA TN 3046)

By means of the expressions derived in NACA Technical Note 2898, the span load distributions for families of thin sweptback wings sideslipping at an angle of attack have been calculated. Variations of the rolling-moment coefficient C_l with sideslip angle and of the corresponding stability derivative C_{l_β} with Mach number are also presented. The results are applicable to plan forms for which the wing tips are parallel to the wing axis of symmetry and, in general, at supersonic speeds for which the trailing edge is supersonic.

NACA TN 3048

EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF COOLING ON FRICTION AND ON BOUNDARY-LAYER TRANSITION FOR LOW-SPEED GAS FLOW AT THE ENTRY OF A TUBE. Stephen J. Kline and Ascher H. Shapiro, Massachusetts Institute of Technology. November 1953. 65p. diagrs., tab. (NACA TN 3048)

The effect of cooling on boundary-layer transition in the steady flow of air in the entrance of a smooth round tube was investigated experimentally. Runs were made at diameter Reynolds numbers varying from 50,000 to 106,000. The levels of disturbance were such as to yield adiabatic length Reynolds numbers, based on the length to the start of transition, ranging from 500,000 to 1,800,000. Temperature differences between the wall and the free stream up to 270° F were applied, but no significant effect of cooling on the point of transition was found. Precise data for local and mean apparent friction factors are presented for the adiabatic and cooled cases. For the laminar portion of the flow, the apparent friction factors are correlated and compared with simple theories.

NACA TN 3051

GUST LOADS AND OPERATING AIRSPEEDS OF ONE TYPE OF FOUR-ENGINE TRANSPORT AIRPLANE ON THREE ROUTES FROM 1949 TO 1953. Walter G. Walker. November 1953. 34p. diagrs., 4 tabs. (NACA TN 3051)

V-G data obtained from a four-engine civil transport airplane are analyzed to determine the magnitude and frequency of occurrence of gust loads and gusts. The influence of the gusts and operating speeds in rough air on the gust loads experienced is shown. Variations in roughness on the different routes due to changes in seasonal weather conditions are indicated. The results of the analysis are in general agreement with those from similar operations of other civil transports recently investigated.

NACA TN 3052

THE EFFECT OF VERTICAL CHINE STRIPS ON THE PLANING CHARACTERISTICS OF V-SHAPED PRISMATIC SURFACES HAVING ANGLES OF DEAD RISE OF 20° AND 40°. Walter J. Kapryan and George M. Boyd, Jr. November 1953. 38p. diagrs., photo., 2 tabs. (NACA TN 3052)

The effect of vertical chine strips on the planing characteristics of two prismatic surfaces having angles of dead rise of 20° and 40° has been determined as part of a general research investigation on planing surfaces. Wetted lengths, resistance, and

center-of-pressure location were determined at speed coefficients up to 25.0, load coefficients up to approximately 80.0, and trims up to 30°. In addition, comparisons of the more important planing characteristics are made with those for related surfaces having angles of dead rise of 0°, 20°, and 40°, and for surfaces having angles of dead rise of 20° and 40° with horizontal chine flare. These comparisons show that vertical chine strips are a more effective means of increasing the lift of a given surface than horizontal chine flare is. This increase in lift, however, is accompanied by a substantial increase in drag so that the lifting efficiency of the vertically flared surface is comparable to one having horizontal chine flare.

NACA RM E51F21

RESISTANCE OF VARIOUS MATERIALS TO ATTACK BY MOLTEN BISMUTH-LEAD EUTECTIC AT ELEVATED TEMPERATURES. James J. Gangler and Walter J. Engel. September 1951. 14p. diagrs., photos., 2 tabs. (NACA RM E51F21)

The resistance of 40 materials including alloys, ceramics, ceramals, and pure metals to attack by bismuth-lead eutectic at temperatures between 1500° and 2000° F was investigated. A velocity of 15 feet per second was maintained between the material surface and the bismuth-lead eutectic. Those materials found to be resistant to this attack included 17 of the ceramals and ceramics, graphite, and arc-cast molybdenum. All other materials investigated were appreciably attacked by the eutectic in the form of uniform attack, cavitation, or pitting, as indicated by metallographic analysis. No evidence of intergranular corrosion was observed in any of the materials studied in this investigation. Disintegration rates were estimated in mils per year from linear measurements taken before and after the specimens were subjected to attack by the molten eutectic.

NACA RM E53I14

EVAPORATION AND SPREADING OF ISOOCTANE SPRAYS IN HIGH-VELOCITY AIR STREAMS. Donald W. Bahr. November 1953. 35p. diagrs., tab. (NACA RM E53I14)

The evaporation and spreading in isooctane sprays were investigated over a range of air-flow and fuel-injection conditions common in ram-jet engines. The fuel was injected contrastream from a simple-orifice fuel injector into air flowing through a duct 8 inches in diameter. The measurements were made over the following ranges: air temperatures, 80° to 390° R; air velocities, 100 to 350 feet per second; air static pressures, 18 to 35 inches of mercury absolute; fuel-injection pressure drops, 25 to 85 pounds per square inch; diameters of fuel injector orifice, 0.024 to 0.041 inch; and axial distances from fuel injector, 5 to 18 inches. Over these ranges, expressions were obtained which related the evaporation and spreading of the sprays to the experimental variables.

NACA TM 1363

A NEW SIMPLE INTERFEROMETER FOR OBTAINING QUANTITATIVELY EVALUABLE FLOW PATTERNS. (Ein Neues, Sehr Einfaches Interferometer zum Erhalt Quantitativ Auswertbarer Strömungsbilder). S. F. Erdmann. November 1953. 62p. diagrs., photos. (NACA TM 1363. Trans. from Applied Scientific Research, v. B2)

The method described in this report makes it possible to obtain interferometer records with the aid of available schlieren optics by the addition of very simple expedients. Under certain conditions, the interferograms need not be inferior to those obtained by other methods. (However, one fundamental drawback of the method compared to the Mach-Zehnder interferometer lies in a relatively very poor light output.) The method is based on the fundamental concept of the phase-contrast process developed by Zernike but which has been enlarged to such an extent that it practically represents an independent interference method. The two light beams causing the interferences are not separated until immediately before photographing and up to that point are subject to the same effects. The theory is explained on a purely physical basis and illustrated and proved by experimental data. A number of typical cases are cited and some quantitative results reported.

NACA TM 1368

SUPERSATURATION IN THE SPONTANEOUS FORMATION OF NUCLEI IN WATER VAPOR. (Übersättigung bei der spontanen Keimbildung in Wasserdampf). Adolf Sander and Gerhard Damköhler. November 1953. 19p. diagrs. (NACA TM 1368. Trans. from Naturwissenschaften, v. 31, no. 39/40, September 24, 1943. p. 460-465).

The supersaturation of water vapor required for spontaneous formation of nuclei was measured in the temperature range between +35° and -75° C. The influence of the presence of ions on the condensation process was found to disappear and a break in the critical supersaturation as a function of temperature curve was found at -62° C. In addition, the condensate particles were observed to scintillate at -62° C or lower. A modified form of the Volmer and the Becker-Döring equations for rate of nucleus formation is presented and compared with the experimental data. The temperature range of droplet-nucleus formation and crystal-nucleus formation are considered as two distinct (not overlapping) temperature regions separated by the melting point (-62° C) of a two-dimensional surface phase.

BRITISH REPORTS

N-26750*

Forest Products Research Lab. (Gt. Brit.) TRIALS OF TIMBER FOR PLYWOOD MANUFACTURE. SMALL SCALE TESTS ON: SCOTS PINE - PINUS SYLVESTRIS L - HOME GROWN. (33 POUNDS PER CUBIC FOOT AT 15 PER CENT MOISTURE CONTENT); SITKA SPRUCE - PICEA SITCHENSIS CARR - HOME GROWN (25 POUNDS PER CUBIC FOOT AT 15 PER CENT MOISTURE CONTENT) PROGRESS REPORT TWENTY-ONE. July 1953. 11p. 3 tabs. (Forest Products Research Lab.)

Two varieties of home grown timber were tested for use as plywood. The Scots Pine was considered unsuitable owing to many loose knots. The Sitka Spruce was also unsuitable because large numbers

of knot holes and encased knots, together with slight roughness and woolliness of the surface, reduced the finished boards to a low grade.

N-26844*

Aeronautical Research Council (Gt. Brit.)
THE AERODYNAMIC CHARACTERISTICS OF FLAPS. A. D. Young. 1953. 55p. diagrs., 2 tabs. (ARC R &M 2622; ARC 10,766. Formerly RAE Aero 2185)

This report collects and summarizes the results of work that has been done both in this and other countries on the aerodynamic characteristics of flaps prior to and during the period of the war. The report presents charts and tables which will enable designers to predict with acceptable accuracy the characteristics of any particular flap arrangement. In section 2, a brief description of the various flaps considered is given. Section 3 is devoted to a discussion of the definitions of the lift, drag, and pitching-moment increments, based on the normal and on the effective (extended or reduced) wing chords. Section 4 deals in some detail with split and plain flaps, while section 5 is devoted to the simple slotted flaps of the Handley Page and NACA types. A large variety of flaps classified as high-lift flaps are considered in section 6. These include Fowler flaps, double Fowler flaps, NACA single and double-slotted flaps, single and double Blackburn flaps, Blackburn flaps with flap leading-edge slots, Blackburn flaps with inset slots, Blackburn flaps with deflected shrouds, and Venition-blind flaps. The effect of wing-body interference on the drag and lift increments of split and slotted flaps is discussed in section 7, while section 8 summarizes the aerodynamic effects of wing leading-edge slots. The effect of flaps on induced drag is dealt with in section 9. A discussion of the characteristics of nose flaps, with particular reference to the type developed and tested by Kruger in Germany is given in section 10. A brief discussion on brake flaps is given in section 11, while the allied subject of dive recovery flaps is examined in section 12. Such information as is available on the characteristics of flaps on sweptback wings is summarized in section 13. Section 14 is devoted to a summary of the main formulas and conclusions developed in the report.

N-26846*

Aeronautical Research Council (Gt. Brit.)
BOUNDARY-LAYER FLOW ALONG A FLAT PLATE WITH UNIFORM SUCTION. J. M. Kay. 1953. 28p. diagrs. (ARC R & M 2628. Formerly ARC 11,476; AC 137; FM 1244; Perf. 474; ARC 12,193; FM 1244a; Perf. 474a)

Experiments have been made to determine the effectiveness of distributed suction as a means of controlling and stabilizing the flow in a boundary layer. Good agreement has been obtained between the measured velocity profiles and the theoretical exponential form. The variation with rate of suction of the total effective drag of a flat plate has been investigated. In turbulent flow distributed suction provides an effective method of thinning a turbulent boundary layer.

N-26850*

Aeronautical Research Council (Gt. Brit.)
THE DIFFUSION OF LOAD INTO A SEMI-INFINITE SHEET. PARTS I AND II. E. H. Mansfield. 1953. 61p. diagrs. (ARC R & M 2670; ARC 11,268; ARC 11,747. Formerly RAE Structures 11; RAE Structures 27)

In Part I, the rigorous and the "stringer-sheet" stress solutions are given for a point load applied in the plane of a semi-infinite sheet and at a finite distance from the boundary which is assumed to be free. From these are derived, by integration, some of the stresses produced by distributed loads applied along lines normal to the free boundary; attention is concentrated on the stresses along the line of action of the applied loads. The problem of finding the shear stresses adjacent to a load-carrying boom attached to the sheet and normal to the free edge is also investigated and integral equations for the shear stresses are derived. In Part II, a theoretical investigation is made into the problem of stiffening a sheet to relieve the high stresses near the free edge and adjacent to a direct load-carrying boom attached to the sheet. For booms of constant cross-section the stress distribution depends, with certain assumptions on two nondimensional parameters, and curves are included for determining the peak stresses in the sheet and the loads in the stiffening structure over the practical range of these parameters.

N-26851*

Aeronautical Research Council (Gt. Brit.)
MEASUREMENTS OF MAXIMUM LIFT ON 26 AEROFOIL SECTIONS AT HIGH MACH NUMBER. Part I. TESTS ON 19 AEROFOILS. J. A. Beavan, R. Sargent, R. J. North and P. M. Burrows. Part II. TESTS ON A FURTHER 7 AEROFOILS. R. J. North and P. M. Burrows. 1953. 31p. diagrs., 2 tabs. (ARC R & M 2678. Formerly ARC 11,084; Perf. 386; S & C 2174; ARC 11,191; Perf. 386a; S & C 2174a)

The lift on a number of airfoil sections mostly of 2-inch chord has been determined over a wide range of angle of attack and Mach number by measuring the pressures on the walls of the 20-by 8-inch high-speed tunnel.

N-26852*

Aeronautical Research Council (Gt. Brit.)
A COMPARISON OF TWO METHODS OF CALCULATING WING LOADING WITH ALLOWANCE FOR COMPRESSIBILITY. V. M. Falkner. With appendix: NOTE ON FALKNER'S METHOD FOR CALCULATING COMPRESSIBILITY EFFECTS OF WING LOADING. W. P. Jones. 1953. 53p. diagrs., 41 tabs. (ARC R &M 2685. Formerly ARC 11,944; S & C 2266; Perf. 507; FM 1312; ARC 12,650; ARC 12,147; Perf. 530; FM 1335; S & C 2302)

The report gives the results of a comparison by two different methods of the aerodynamic loading of a tapered V wing of aspect ratio 5.8 and 45° sweepback at $M = 0.8$ based on the Prandtl-Glauert factor or linear perturbation theory; the first method, associated particularly with vortex-lattice theory, deals with changes in Mach number by preserving the

plan of the wing and using special tables of downwash, while the second used the solution for Mach number 0 on a wing with the lateral dimensions reduced by a specified factor. Examples of the application of the theory are also given for a delta wing, for a straight tapered wing without sweep, and for a tapered wing with 28.4° sweepback. It is possible to give a general and reasonable explanation of the nature of the variations of load grading and local aerodynamic center which occur with increasing Mach number, and with the information given, there should be no difficulty in the prediction of Mach number effects on a wide range of plan forms.

N-26855*

Aeronautical Research Council (Gt. Brit.)
SOME TESTS ON COMPRESSOR CASCADES OF RELATED AEROFOILS HAVING DIFFERENT POSITIONS OF MAXIMUM CAMBER. A. D. S. Carter. 1953. 17p. diagrs., photos., 2 tabs. (ARC R & M 2694; ARC 12,324. Formerly NGTE R. 47)

One of the major variables defining the shape of any blade is its position of maximum camber, and there are several indications that its choice considerably effects the performance of the cascade. Tests have therefore been carried out on a series of aerodynamically equivalent cascades in which the position of maximum camber was varied systematically. The tests covered a full incidence range up to choking.

N-26856*

Aeronautical Research Council (Gt. Brit.)
THE CALCULATION OF WHIRLING SPEEDS OF A SYSTEM OF ROTORS KEYED TO CO-AXIAL SHAFTS. T. S. Wilson. 1953. 24p. diagrs. (ARC R & M 2709; ARC 12,266)

The calculation of whirling speeds of a "semirigid" system is brought within the scope of the iterative technique of Duncan and Collar. It is demonstrated by theory and example that problems involving large numbers of degrees of freedom may thereby be efficiently dealt with. An additional refinement of procedure allows two or more modes to be extracted more or less simultaneously from an iteration which is converging slowly. Only rotors having axial symmetry as regards mass are dealt with.

N-26857*

Aeronautical Research Council (Gt. Brit.)
THE CALCULATION OF LIFT TAKING ACCOUNT OF THE BOUNDARY LAYER. J. H. Preston. 1953. 40p. diagrs., 2 tabs. (ARC R & M 2725. Formerly ARC 12,747; FM 1397; Perf. 609; S & C 2351)

The purpose of this paper is to find a sound approach to the problem of the theoretical prediction of sectional characteristics taking account of the boundary layer. Attention is mainly concentrated on the lift, since it is on the accuracy of this calculation that the accuracy of calculations for other characteristics such as pressure distribution and moments must depend. Calculations of the lift and of the velocity at the edge of the boundary layer near the trailing edge have been made for two dissimilar symmetrical airfoils at an incidence of 6°, using boundary-layer data taken from experiment. The method of calculation satisfies the fundamental theorem that no net vorticity is discharged into the wake at the trailing edge and in contrast to the earlier calculations of R & M 1996, full account is now taken of the effect of the boundary layer on the velocity field outside the boundary layer, so that the empiricism of that report is avoided. The present calculations harmonize the two different methods of approach which have been used in the past, namely, the one in which the loss of lift below the Joukowski value was attributed entirely to the incidence and camber effects of the boundary layer, and the other in which the vorticity theorem was satisfied, but boundary-layer camber effects were ignored.

N-26860*

Aeronautical Research Council (Gt. Brit.)
AERODYNAMIC FORCES ON BICONVEX AEROFOILS OSCILLATING IN A SUPERSONIC AIRSTREAM. W. P. Jones and Sylvia W. Skan.
EFFECT OF THICKNESS ON THE AERODYNAMIC FORCES ON BICONVEX AEROFOILS OSCILLATING IN A SUPERSONIC AIRSTREAM, AND CALCULATION OF FORCES FOR AEROFOIL WITH FLAP. Sylvia W. Skan. 1953. 34p. diagrs., 5 tabs. (ARC R & M 2749. Formerly ARC 13,162; FM 1443; 0.873; S & C 2401; ARC 14,217; 0.954)

In the first part of this report, a method for the calculation of the aerodynamic forces on an oscillating airfoil which allows for the effect of thickness is developed. Aerodynamic lift and pitching-moment derivatives for a 5-percent-thick, symmetrical, circular-arc airfoil at Mach numbers of 1.4, 1.5 and 2.0 are given for a range of frequencies and compared with values obtained on the basis of the flat plate theory. In the second part, the lift distribution and the aerodynamic force coefficients are calculated for a 7.5-percent-thick symmetrical circular-arc airfoil at Mach numbers of 2.0, 1.7 and 1.5 for a range of frequencies. These results are compared with those given in the first part for a 5-percent-thick airfoil, and with the values derived on the basis of flat plate theory.

N-26864*

Aeronautical Research Council (Gt. Brit.)
EXPERIMENTS WITH STATIC TUBES IN A SUPERSONIC AIRSTREAM. PARTS I AND II. D. W. Holder, R. J. North and A. Chinneck. 1953. 14p. diagrs., photos., 2 tabs. (ARC R & M 2782. Formerly ARC 13,268; TP 309; FM 1463; ARC 13,269; TP 310; FM 1464)

Part I presents results of systematic tests made at a Mach number of 1.6 on a family of static tubes. The variables which were investigated are the shape of the nose, the distance of the holes downstream, and the inclination of the tube to the flow. Pressure measurements were also made in the vicinity of a shock wave and close to a wall. Part II presents the results of tests made of a family of flat-nosed pitot tubes at Mach numbers of 1.6 and 1.8. At both Mach numbers it was found that no change of reading could be detected when the ratio of the external diameter to the bore was varied from 2 to 16.

N-26956*

Ministry of Supply (Gt. Brit.)
DEVELOPMENT OF TECHNIQUE FOR METALLIC INERT ARC WELDING. (Final report) March 1953. 19p. diagrs., photos. (MOS S & TM 2/53; Bristol Aeroplane Co., Ltd.)

The purpose of this investigation was to ascertain if there is any advantage in the use of a consumable metallic inert arc automatic welding machine for welding magnesium-zirconium alloys compared with a fixed tungsten electrode for the same purpose, the arc in the latter case being struck between the fixed electrode and the workpiece, the filler rod being automatically fed to the weld pool.

N-26957*

National Gas Turbine Establishment (Gt. Brit.)
SOME TESTS ON A HIGH EFFICIENCY AIR CLEANER. D. R. Whittet. July 1953. 22p. diagrs. (NGTE R. 139)

Some tests have been conducted on a special form of Cottrell precipitator in which a moving film of water forms the receiving electrode. The performance of the cleaner at differing conditions of air velocity, applied voltage, wire diameter, tube diameter, and tube length was examined. The tests were made in an effort to find a cleaner for use in reducing the rate of blade fouling in axial compressors where they operate in industrial atmospheres.

N-27000*

National Gas Turbine Establishment (Gt. Brit.)
THE RELATIONSHIP BETWEEN THE CREEP AND TENSILE PROPERTIES AT ELEVATED TEMPERATURE OF NIMONIC 80 - II. K. F. A. Walles and A. Graham. June 1953. 25p. diagrs., 3 tabs. (NGTE R. 137)

The results of a few experiments on creep recovery enable the arguments of Report No. R. 100 to be extended. A new form of time-temperature variable is proposed which, without change of constants, satisfactorily coordinates N. P. L. and Mond-Nickel long-time creep data on Nimonic 80, N. G. T. E. short-time creep tests on Nimonic 80 drawn from store, and Mond-Nickel long-time data for an early heat of Nimonic 80A. Apart from this improvement, the situation previously reported is not affected. Support is given for the Andrade formula for creep.

MISCELLANEOUS

NACA TN 2968

Errata No. 1 on "PROPELLER-NOISE CHARTS FOR TRANSPORT AIRPLANES." Harvey H. Hubbard. June 1953.

NACA TN 3036

Errata No. 1 on "THE FLOW ABOUT A SECTION OF A FINITE-ASPECT-RATIO NACA 0015 AIRFOIL ON A TRANSONIC BUMP." Jack A. Mellenthin. October 1953.

UNPUBLISHED PAPERS

N-12074*

National Bureau of Standards.
TABLE OF THE FIRST MOMENT OF RANKED EXTREMES. September 20, 1951. (i), 6p. (National Bureau of Standards. Rept. 1167)

This tabulation of the first moment of ranked extremes is one item of a project aimed at the improved application of the theory of extreme values to the analysis of gust loads of airplanes.

N-25272*

Advisory Group for Aeronautical Research and Development. SOME APPLICATIONS OF STRAIN GAGES IN AERONAUTICAL RESEARCH. Ira H. Abbott. FLIGHT TEST APPLICATIONS OF STRAIN GAGES. Walter K. Rickert. (Presented at Rome AGARD conference, December 12-19, 1952) 53p. diagrs., photos. (Advisory Group for Aeronautical Research and Development. AG2/M1)

The purpose of this report is to give information on the state of the art of strain-gage measurement of flight test quantities in the U. S. The applications made by the NACA of strain gages to aeronautical research are classified into three categories. First, the direct measurement of strain and stress in structures with reference to high-temperature applications is discussed. Secondly, the use of strain gages to measure the aerodynamic loads on aircraft in flight as experienced by the NACA is described. Thirdly, the use of strain gages in instrumentation is presented. The application of strain gages to wind tunnel balances is discussed in some detail. Application of strain gages to aircraft flight testing is considered, and their future use in the problem of servo operated control systems for aircraft is predicted.

N-25704 *

California U., Los Angeles.
SPECTRAL EMISSION TRANSIENTS IN COMBUSTION SYSTEMS. Bruce R. Mead, Loren Varner and Peter Moody. June, 1953. iv, 47p. diagrs., photos. (California U., Los Angeles. Rept. 53-16)

The combustion process is considered with respect to extinguishment of flames by chemical action. An apparatus has been developed for measuring the quantities of energy that are present in transient spectral lines in flames which occur during initiation and extinguishment periods of combustion. These lines are associated with specific molecular groupings and provide means for quantitatively evaluating paths of energy release that are active during initiation and extinguishment periods of combustion.

N-25854*

Advisory Group for Aeronautical Research and Development. METHODS USED BY NACA FOR DATA REDUCTION. Ira H. Abbott. (Presented at Rome AGARD conference, December 12-19, 1952) 17p. diagrs., photos. (Advisory Group for Aeronautical Research and Development. AG3/M2)

This paper is a survey of various methods of data reduction used by the NACA Laboratories.

DECLASSIFIED NACA REPORTS

NACA RM A7I10

INVESTIGATION OF WING CHARACTERISTICS AT A MACH NUMBER OF 1.53. I - TRIANGULAR WINGS OF ASPECT RATIO 2. Walter G. Vincenti, Jack N. Nielsen and Frederick H. Matteson. December 19, 1947. 83p. diagrs., photos., tab. (NACA RM A7I10) (Declassified from Confidential, 10/5/53)

Measurements of lift, drag, and pitching moment at M = 1.53 are described for three sharp-edged wing models having a triangular plan form of aspect ratio 2 and a common thickness ratio of 5 percent but varying in thickness distribution and camber. The experimental techniques are discussed and the results compared with the predictions of the linear theory.

NACA RM A8E05

INVESTIGATION OF WING CHARACTERISTICS AT A MACH NUMBER OF 1.53. II - SWEPT WINGS OF TAPER RATIO 0.5. Walter G. Vincenti, Milton D. Van Dyke and Frederick H. Matteson. June 28, 1948. 56p. diagrs., photos., 2 tabs. (NACA RM A8E05) (Declassified from Confidential, 10/5/53)

Measured values of lift, drag, and pitching moment at M_O = 1.53 are presented for seven wings varying in sweep angle from 60° sweepforward to 60° sweepback. All wings had a cambered, double-wedge section 5-percent thick and a common taper ratio of 0.5. The experimental results are compared with the predictions of the linear theory.

NACA RM A8E06

INVESTIGATION OF WING CHARACTERISTICS AT A MACH NUMBER OF 1.53. III - UNSWEPT WINGS OF DIFFERING ASPECT RATIO AND TAPER RATIO. Jack N. Nielsen, Frederick H. Matteson and Walter G. Vincenti. June 21, 1948. 64p. diagrs., photos., tab. (NACA RM A8E06) (Declassified from Confidential, 10/5/53)

Measured values of lift, drag, and pitching moment at M = 1.53 are presented for seven unswept wings varying in aspect ratio from 1 to 6 and in taper ratio from 0 to 1. All wings had an isosceles-triangle section 5-percent thick. The experimental results are compared with the predictions of linear theory.

NACA RM L6J01a

AN INVESTIGATION OF THE EFFECTS OF SWEEP ON THE CHARACTERISTICS OF A HIGH-ASPECT-RATIO WING IN THE LANGLEY 8-FOOT HIGH-SPEED TUNNEL. Richard T. Whitcomb. February 14, 1947. 74p. diagrs., photos., 4 tabs. (NACA RM L6J01a) (Declassified from Restricted, 8/14/53)

An untwisted wing, which when unswept has an NACA 65-210 section, an aspect ratio of 9.0 and a taper ratio of 2.5:1.0, has been tested with no sweep, and 30° and 45° of sweepback and sweepforward in conjunction with a typical fuselage at Mach numbers from 0.60 to 0.96 at angles of attack generally between -2° and 10° in the Langley 8-foot high-speed tunnel. Sweep was obtained by rotating the wing semispans about a point in the plane of symmetry. The normal-force, pitching-moment, profile-drag, and loading characteristics for the wings have been obtained from pressure measurements and wake surveys.

NACA RM L6J16

DRAG CHARACTERISTICS OF RECTANGULAR AND SWEPT-BACK NACA 65-009 AIRFOILS HAVING ASPECT RATIOS OF 1.5 AND 2.7 AS DETERMINED BY FLIGHT TESTS AT SUPERSONIC SPEEDS. Sidney R. Alexander and Ellis Katz. February 24, 1947. 19p. diagrs., photos. (NACA RM L6J16) (Declassified from Confidential, 10/21/53)

Tests were conducted to determine the effect of sweepback angle and aspect ratio on the drag of an NACA 65-009 airfoil at supersonic speeds. The data were obtained by tracking rocket-propelled bodies carrying wings of various plan forms. The following wing arrangements were investigated: (a) aspect ratio of 1.5, sweepback angles of 0°, 34°, 45°, and 52°, and (b) aspect ratio of 2.7, sweepback angles of 0°, 34°, and 45°.

NACA RM L6J16a

FLIGHT TESTS TO DETERMINE THE EFFECT OF LENGTH OF A CONICAL WINDSHIELD ON THE DRAG OF A BLUFF BODY AT SUPERSONIC SPEEDS. Sidney R. Alexander and Ellis Katz. January 29, 1947. 13p. diagrs., photo. (NACA RM L6J16a) (Declassified from Confidential, 10/21/53)

Flight tests have been conducted to determine the effect of length of a conical windshield on the drag of a bluff body moving at supersonic speeds. A comparison is made between results thus obtained (for a 3-inch windshield) and the results of previous drag tests of body-windshield combinations (for windshields of 0, 1-inch, and 10-inch length).

NACA RM L6K08a

RESULTS OF TESTS TO DETERMINE THE EFFECT OF A CONICAL WINDSHIELD ON THE DRAG OF A BLUFF BODY AT SUPERSONIC SPEEDS. Sidney R. Alexander. January 14, 1947. 12p. diagrs., photos. (NACA RM L6K08a) (Declassified from Confidential, 10/21/53)

Tests have been conducted to determine the effect of a conical windshield on the drag of a bluff body at supersonic speeds. The following configurations were investigated: a sharp-nose fuselage with stabilizing fins, a blunt-nose fuselage obtained by rounding off the sharp nose to a hemispherical shape, and a blunt-nose fuselage with a conical point, or windshield, having the same nose angle as the original sharp nose and supported at the same position.

NACA RM L7B12

AN INVESTIGATION OF THE DOWNWASH AT THE PROBABLE TAIL LOCATION BEHIND A HIGH-ASPECT-RATIO WING IN THE LANGLEY 8-FOOT HIGH-SPEED TUNNEL. Richard T. Whitcomb. April 22, 1947. 12p. diagrs. (NACA RM L7B12) (Declassified from Restricted, 10/21/53)

Downwash angles have been measured behind a model of a high-aspect-ratio wing at points near the probable tail location at Mach numbers up to 0.89 in the Langley 8-foot high-speed tunnel. The model has an NACA 65-210 section, an aspect ratio of 9.0, a taper ratio of 2.5:1, no twist, dihedral, or sweepback.

NACA RM L7B19

RESULTS OF FLIGHT TESTS AT SUPERSONIC SPEEDS TO DETERMINE THE EFFECT OF BODY NOSE FINENESS RATIO ON BODY AND WING DRAG. Ellis R. Katz. June 26, 1947. 14p. diagrs., photo. (NACA RM L7B19) (Declassified from Confidential, 10/21/53)

Flight tests of rocket-powered models at supersonic speeds have been made to determine the effect of nose fineness ratio of winged bodies on total and component drag at high Mach numbers. Wingless models of three nose fineness ratios and winged models of two nose fineness ratios were flown through a Mach number range up to 1.4.

NACA RM L7D02

FREE-FLIGHT INVESTIGATION OF CONTROL EFFECTIVENESS OF FULL-SPAN 0.2-CHORD PLAIN AILERONS AT HIGH SUBSONIC, TRANSONIC, AND SUPERSONIC SPEEDS TO DETERMINE SOME EFFECTS OF SECTION THICKNESS AND WING SWEEPBACK. Carl A. Sandahl and Alfred A. Marino. May 29, 1947. 14p. diagrs., photos., tab. (NACA RM L7D02) (Declassified form Confidential, 10/21/53)

A rocket-propelled test vehicle to be used in an experimental investigation of aerodynamic control effectiveness at high subsonic, transonic, and supersonic speeds has been developed. The test vehicle (RM-5) and the instrumentation are described and the first data obtained are presented. These data indicate some of the effects of section thickness ratio and wing sweepback on the rolling effectiveness of plain full-span 0.2-chord ailerons deflected 5°.

NACA RM L7D21

AN INVESTIGATION OF THE LATERAL-CONTROL CHARACTERISTICS OF SPOILERS ON A HIGH-ASPECT-RATIO WING OF NACA 65-210 SECTION IN THE LANGLEY 8-FOOT HIGH-SPEED TUNNEL. Arvo A. Luoma. June 24, 1947. 124p. diagrs., photos., 2 tabs. (NACA RM L7D21) (Declassified from Restricted, 10/21/53)

A three-dimensional lateral-control investigation was made of 3- and 6-percent-chord spoilers projecting on the upper surface of a wing of high-aspect ratio. The spoilers were located ahead of conventional 0.20-chord straight-sided-profile plain ailerons and tests were made with the spoilers at the 60- and 70-percent-chord locations. Ailerons and spoilers had the same span of 37.5-percent wing semispan. Spanwise loadings and moments and rolling-moment coefficients were determined from pressure distribution measurements. Hinge-moment data for the conventional aileron were obtained by an electrical strain gage. Data were obtained for Mach numbers up to 0.925.

NACA RM L7I15

HIGH-SPEED WIND-TUNNEL INVESTIGATION OF THE LATERAL CONTROL CHARACTERISTICS OF PLAIN AILERONS ON A WING WITH VARIOUS AMOUNTS OF SWEEP. Arvo A. Luoma, Ralph P. Bielat and Richard T. Whitcomb. December 19, 1947. 67p. diagrs., 3 tabs. (NACA RM L7I15) (Declassified from Restricted, 10/21/53)

Rolling-moment, wing normal-force, wing pitching-moment, and aileron hinge-moment coefficients are presented from tests of straight-sided profile plain ailerons on a wing with 30° and 45° of sweepback and sweepforward for aileron deflections from -10° to 10° at Mach numbers from 0.60 to 0.96. In general, 30° of sweep reduced the large changes of rolling- and aileron hinge-moment coefficients observed on an unswept wing and delayed the speed at which such changes occurred. With 45° of sweep, these characteristics were not materially changed over the speed range covered.

National Advisory Committee for Aeronautics

Research Abstracts

NO. 54 DECEMBER 14, 1953

CURRENT NACA REPORTS

NACA Rept. 1117

A STUDY OF ELASTIC AND PLASTIC STRESS CONCENTRATION FACTORS DUE TO NOTCHES AND FILLETS IN FLAT PLATES. Herbert F. Hardrath and Lachlan Ohman. 1953. ii, 10p. diagrs., tab. (NACA Rept. 1117. Formerly TN 2566)

Six large 24S-T3 aluminum-alloy-sheet specimens containing various notches or fillets were tested in tension to determine their stress concentration factors in the elastic and plastic ranges. The elastic stress concentration factors were found to be slightly higher than those predicted by other methods. A generalization of a relation presented by Stowell gave good agreement with the plastic stress concentration factors as they decreased with increasing plastic strain.

NACA TN 3029

A FUNDAMENTAL INVESTIGATION OF FRETTING CORROSION. H. H. Uhlig, I. Ming Feng, W. D. Tierney, and A. McClellan, Massachusetts Institute of Technology. December 1953. 52p. diagrs., photos., 2 tabs. (NACA TN 3029)

This report summarizes all phases of an investigation of fretting corrosion which has been conducted over a period of several years. The presentation of the information is made in three parts. Part I describes a test machine for measuring fretting damage under controlled experimental conditions. Part II presents data for mild steel fretted against itself. Consideration is given to the effects of humidity, temperature, test duration, atmosphere, relative slip, pressure, and frequency. Part III suggests a mechanism for the fretting process.

NACA TN 3047

IMPINGEMENT OF WATER DROPLETS ON NACA 65A004 AIRFOIL AND EFFECT OF CHANGE IN AIRFOIL THICKNESS FROM 12 TO 4 PERCENT AT 4° ANGLE OF ATTACK. Rinaldo J. Brun, Helen M. Gallagher and Dorothea E. Vogt. November 1953. 45p. diagrs., tab. (NACA TN 3047)

The trajectories of droplets in the air flowing past an NACA 65A004 airfoil at an angle of attack of 4° were determined. The amount of water in droplet form impinging on the airfoil, the area of droplet impingement, and the rate of droplet impingement per unit area on the airfoil surface were calculated from the trajectories and presented to cover a large range of flight and atmospheric conditions. The effect of a change in airfoil thickness from 12 to 4 percent at 4° angle of attack is presented by comparing the impingement calculations for the NACA 65A004 airfoil with those for the NACA 65_1-208 and 65_1-212 airfoils. The rearward limit of impingement on the upper surface decreases as the airfoil thickness decreases. The rearward limit of impingement on the lower surface increases with a decrease in airfoil thickness. The total water intercepted decreases as the airfoil thickness is decreased.

NACA TN 3049

AN ANALYTICAL INVESTIGATION OF THE EFFECT OF THE RATE OF INCREASE OF TURBULENT KINETIC ENERGY IN THE STREAM DIRECTION ON THE DEVELOPMENT OF TURBULENT BOUNDARY LAYERS IN ADVERSE PRESSURE GRADIENTS. Bernard Rashis. November 1953. 30p. diagrs., 2 tabs. (NACA TN 3049)

A general integral form of the boundary-layer equation which includes the Reynolds normal-stress term is derived. Two special equations are obtained from the general form. They are the modified momentum equation and the modified kinetic-energy equation. In addition, the parameters which control the dissipation of mean-flow kinetic energy by the shearing stress and the Reynolds normal stress are suggested.

NACA TN 3056

A FLIGHT INVESTIGATION OF LAMINAR AND TURBULENT BOUNDARY LAYERS PASSING THROUGH SHOCK WAVES AT FULL-SCALE REYNOLDS NUMBERS. Eziaslav N. Harrin. December 1953. 20p. diagrs., photos. (NACA TN 3056)

An investigation was made in flight at free-stream Mach numbers up to about 0.76 and Reynolds numbers up to about 26×10^6 to determine the behavior of laminar and turbulent boundary layers passing through shock waves. Boundary-layer and pressure-distribution measurements were made on a short-span airfoil built around a wing of a fighter airplane. The free-stream Mach numbers reached in the tests were sufficiently high to give extensive regions of local supersonic flow. Comparison is made with results of tests at low Reynolds numbers (up to 1/10-scale) of other investigations.

*AVAILABLE ON LOAN ONLY.

ADDRESS REQUESTS FOR DOCUMENTS TO NACA, 1724 F ST., NW., WASHINGTON 25, D. C., CITING CODE NUMBER ABOVE EACH TITLE, THE REPORT TITLE AND AUTHOR.

BRITISH REPORTS

N-27007*

Royal Aircraft Establishment (Gt. Brit.)
THE CALCULATION OF THE PRESSURE DISTRIBUTION OVER THE SURFACE OF TWO-DIMENSIONAL AND SWEPT WINGS WITH SYMMETRICAL AEROFOIL SECTIONS. J. Weber. July 1953. 84p. diagrs., 13 tabs. (RAE Aero 2497. Rewritten and amended version of RAE Aero 2391)

A simple method is described for calculating the pressure distribution on the surface of a thick two-dimensional airfoil section, at any incidence, in incompressible potential flow. It is particularly suitable for practical applications, since knowledge of the section ordinates only is required. This paper gives a complete derivation of the theory including a detailed discussion of the approximations made and their effect on the accuracy of the results. The pressure distributions calculated by the present method are identical with the exact values for airfoils of elliptic cross section, and the numerical values for Joukowsky airfoils agree well with the exact solutions.

N-27056*

Royal Aircraft Establishment (Gt. Brit.)
DESIGN AND CALIBRATION AT LOW SPEEDS OF A STATIC TUBE AND A PITOT-STATIC TUBE WITH SEMI-ELLIPSOIDAL NOSE SHAPES. D. J. Kettle. May 1953. 31p. diagrs., 5 tabs. (RAE Tech. Note Aero 2247)

A new static tube and a new pitot-static tube have been designed and calibrated in the No. 1 and the No. 2 11-1/2 foot by 8-1/2 foot wind tunnels of the R. A. E., using a long static tube, the error of which is believed to be very small, as a standard for comparison. The results show that the static pressure measured by these tubes is in error due to the supporting strut and to the nose shape of the tube by an amount which may be calculated for positions of the static slot, or holes, greater than 10 tube diameters ahead of the strut. The readings show no measurable scale effect in the speed range 100-230 ft/sec. The static tube is insensitive to yaw in the range $\pm 1^{o}$ with a square-edged slot and is even less sensitive to yaw when the slot edges are rounded. The turbulence of the tunnel has an effect on the static-pressure reading.

N-27057*

Royal Aircraft Establishment (Gt. Brit.)
COMPRESSIBILITY EFFECT ON GUST LOADS. J. K. Zbrozek. August 1953. 20p. diagrs. (RAE Tech. Note Aero 2254)

Theoretical calculations of the gust alleviation factor for a range of Mach numbers show an appreciable decrease in its value with increasing Mach number. The reduction in the value of the gust factor at $M = 0.7$ is about 10 percent for sharp-edged gusts and lightly loaded aircraft ($\mu_g = 20$) and decreases to about 5 percent for gust length of 10 chords and heavy aircraft ($\mu_g = 100$). The analysis of existing flight records indicates that the gust loads at high Mach numbers can be estimated satisfactorily if the gust factor and the lift slope are corrected for compressibility.

N-27058*

Royal Aircraft Establishment (Gt. Brit.)
WIDE RANGE AMPLIFIER FOR TURBULENCE MEASUREMENTS WITH ADJUSTABLE UPPER FREQUENCY LIMIT. H. Schuh and D. Walker. August 1953. 42p. diagrs. (RAE Aero 2492)

The amplifier described in this report was originally planned for turbulence work at supersonic speeds; it was soon apparent that with some modifications, the same equipment could be used also at subsonic speeds. In its final version, it is suitable for measuring subsonic wind-tunnel turbulence of low intensity.

N-27059*

Royal Aircraft Establishment (Gt. Brit.)
THE TIME VECTOR METHOD FOR STABILITY INVESTIGATIONS. K. H. Doetsch. August 1953. 50p. diagrs., tab. (RAE Aero 2495)

A semigraphical method for the analysis of aircraft stability oscillations is described. It is based on the concept of rotating time vectors representing the forces and moments acting on the aircraft. Rules are developed for the application to damped and divergent oscillations. The method is iterative, simple and rapid. Close correlation with the physical facts of the motion is maintained and the contribution of each force and moment can be visualized. The immediate deduction of approximate formulas and their limitations is demonstrated and the application of the method to automatic control is discussed.

N-27126*

Aeronautical Research Council (Gt. Brit.)
THE FLOW AT THE MOUTH OF A STANTON PITOT. A. Thom. October 2, 1952. 9p. diagrs. (ARC 15,228; FM 1796; Oxford Univ., Engineering Lab. No. 61)

An arithmetical calculation is made of the flow at the mouth of a Stanton pitot as the Reynolds number tends to zero. A stationary eddy is found under the lip of the pitot. A figure is found for the height of the effective center of the pitot rather greater than the experimental value determined by Sir Geoffrey Taylor.

N-27127*

Aeronautical Research Council (Gt. Brit.)
INTEGRATION OF THE EQUATIONS OF TRANSONIC FLOW IN TWO DIMENSIONS. D. Meksyn. November 25, 1952. 23p. 2 tabs. (ARC 15,412; FM 1819)

The problem of integration of the equations of compressible flow past a solid body has been considered in numerous papers. The solutions have been quite laborious. In this paper, a method is given in which the integration leads to an algebraic equation of the fifth degree which can be evaluated at any given point. The critical point of this equation determines the critical Mach number when a shock wave first appears. The method is applied to the motion past a circular cylinder and to the flow past an airfoil of thickness 1/10 consisting of two arcs with cusps at the leading and trailing edges. The results agree with Kaplan's calculations.

N-27128*

Aeronautical Research Council (Gt. Brit.)
THE ARITHMETIC OF FIELD EQUATIONS.
A. Thom. November 26, 1952. 29p. diagrs.
(ARC 15,419; FM 1821; Oxford Univ., Engineering Lab. No. 63)

The paper describes in detail an older and more rapid method than relaxation of approximating to the solution of equations of the Laplace and Poisson type. The corresponding fourth order equations are also discussed. A description is given of the propagation of errors in the fields due to various causes.

N-27129*

Aeronautical Research Council (Gt. Brit.)
ON THE ENERGY SCATTERED FROM THE INTERACTION OF TURBULENCE WITH SOUND OR SHOCK WAVES. M. J. Lighthill. December 1, 1952. 24p. diagrs., tab. (ARC 15,432; FM 1825)

The energy scattered when a sound wave passes through turbulent fluid flow is studied by means of the author's general theory of sound generated aerodynamically. Energy freely scattered when turbulence is convected through the stationary shock wave pattern in a supersonic jet may form an important part of the sound field of the jet.

MISCELLANEOUS

NACA TN 2893

Errata No. 1 on "THEORETICAL AND MEASURED ATTENUATION OF MUFFLERS AT ROOM TEMPERATURE WITHOUT FLOW, WITH COMMENTS ON ENGINE-EXHAUST MUFFLER DESIGN."
Don D. Davis, Jr., George L. Stevens, Jr., Dewey Moore and George M. Stokes. February 1953.

DECLASSIFIED NACA REPORTS

THE FOLLOWING REPORT HAS BEEN DECLASSIFIED FROM SECRET TO UNCLASSIFIED, 11/10/53.

NACA RM L52E22

NOTES ON THE GUST PROBLEM FOR HIGH-SPEED LOW-ALTITUDE BOMBERS. Langley Gust Loads Branch. June 5, 1952. 23p. diagrs., 3 tabs. (NACA RM L52E22)

Available information pertaining to the gust problem for the high-speed low-altitude bomber has been collected and coordinated. Gust data of interest in this special problem have been presented and the general information for design has been indicated.

THE FOLLOWING REPORTS HAVE BEEN DECLASSIFIED FROM CONFIDENTIAL TO UNCLASSIFIED, 11/10/53.

NACA RM L6J14

DRAG MEASUREMENTS OF SYMMETRICAL CIRCULAR-ARC AND NACA 65-009 RECTANGULAR AIRFOILS HAVING AN ASPECT RATIO OF 2.7 AS DETERMINED BY FLIGHT TESTS AT SUPERSONIC SPEEDS. Sidney R. Alexander. March 7, 1947. 10p. diagrs., photo. (NACA RM L6J14)

Flight tests have been conducted at supersonic speeds to determine the drag characteristics at zero lift of a wing having a circular-arc airfoil section with a maximum thickness of 9 percent chord. The wing plan form was rectangular and had an aspect ratio of 2.7. Included for comparison are results of similar tests previously conducted on an NACA 65-009 airfoil. For the Mach number range investigated (0.85 to 1.22), the NACA 65-009 airfoil produced lower values of drag coefficient than the circular-arc airfoil.

NACA RM L6J23

RESULTS OF PRELIMINARY FLIGHT INVESTIGATION OF AERODYNAMIC CHARACTERISTICS OF THE NACA TWO-STAGE SUPERSONIC RESEARCH MODEL RM-1 STABILIZED IN ROLL AT TRANSONIC AND SUPERSONIC VELOCITIES. Marvin Pitkin, William N. Gardner and Howard J. Curfman, Jr. March 19, 1947. 55p. diagrs., photos. (NACA RM L6J23)

The design of a two-stage, solid-fuel, rocket propelled, general research pilotless aircraft (RM-1) suitable for investigating stability and control at supersonic velocities is discussed. The flight-test investigation conducted thus far is discussed and information is presented on zero-length launchers and operational flight-test techniques of two-stage rockets.

NACA RM L6K08c

DRAG MEASUREMENTS AT TRANSONIC SPEEDS OF NACA 65-009 AIRFOILS MOUNTED ON A FREELY FALLING BODY TO DETERMINE THE EFFECTS OF SWEEPBACK AND ASPECT RATIO. Charles W. Mathews and Jim Rogers Thompson. January 22, 1947. 14p. diagrs., photos. (NACA RM L6K08c)

Drag measurements at transonic speeds on rectangular airfoils and on airfoils swept back 45° are reported. These airfoils, which were mounted on cylindrical test bodies, are part of a series being tested in free drops from high altitude to determine the effect of variation of basic airfoil parameters on airfoil drag characteristics at transonic speeds. These rectangular and sweptback airfoils had the same span, airfoil section (NACA 65-009), and chord perpendicular to the leading edge. The tests were made to compare the drag of rectangular and sweptback airfoils at a higher aspect ratio than had been used in a similar comparison reported previously.

NACA RM L52E05 ~ BCL -

PRELIMINARY EXPERIMENTS ON THE ELASTIC COMPRESSIVE BUCKLING OF PLATES WITH INTEGRAL WAFFLE-LIKE STIFFENING. Norris F. Dow and William A. Hickman. July 1952. 13p. diagrs., photo., tab. (NACA RM L52E05)

An experimental investigation was made of the elastic compressive buckling strength of plates having various configurations of integral stiffening. Configurations tested included ribbing that was longitudinal, transverse, longitudinal and transverse, and skewed at various angles to the sides of the plates to form a diamond or waffle-like pattern. The 45° waffle stiffening was found to be the most effective of all those considered, giving a buckling load nearly double that for the same waffle pattern with the ribbing longitudinal and transverse.

NACA RM L53E13a

FORMULAS FOR THE ELASTIC CONSTANTS OF PLATES WITH INTEGRAL WAFFLE-LIKE STIFFENING. Norris F. Dow, Charles Libove and Ralph E. Hubka. Ausust 1953. 67p. diagrs., tab. (NACA RM L53E13a)

Formulas are derived for the elastic constants of plates with integral ribbing. The constants, which include the effectiveness of the ribs for resisting deformations other than bending and stretching in their longitudinal directions, are defined in terms of four coefficients, and methods for the evaluation of these coefficients are discussed. Four of the more important elastic constants are predicted by these formulas and are compared with test results.

National Advisory Committee for Aeronautics

Research Abstracts

NO. 55 **DECEMBER 23, 1953**

CURRENT NACA REPORTS

NACA Rept. 1096

EXPERIMENTAL DETERMINATION OF THE EFFECT OF HORIZONTAL-TAIL SIZE, TAIL LENGTH, AND VERTICAL LOCATION ON LOW-SPEED STATIC LONGITUDINAL STABILITY AND DAMPING IN PITCH OF A MODEL HAVING 45° SWEPTBACK WING AND TAIL SURFACES. Jacob H. Lichtenstein. 1952. ii, 22p. diagrs., photos., 3 tabs. (NACA Rept. 1096. Formerly TN 2381; TN 2382)

An investigation has been conducted in the Langley stability tunnel to determine the effects of horizontal tails of various sizes and at various tail lengths (when located on the fuselage center line) and also the effects of vertical location of the horizontal tail relative to the wing on the low-speed static longitudinal stability and on the steady-state rotary damping in pitch for a complete-model configuration. The wing and tail surfaces had the quarter-chord lines swept back 45° and had aspect ratios of 4.

NACA Rept. 1098

SUMMARY OF METHODS FOR CALCULATING DYNAMIC LATERAL STABILITY AND RESPONSE AND FOR ESTIMATING LATERAL STABILITY DERIVATIVES. John P. Campbell and Marion O. McKinney. 1952. ii, 40p. diagrs., 2 tabs. (NACA Rept. 1098. Formerly TN 2409)

A summary of methods for making dynamic lateral stability and response calculations and for estimating the aerodynamic stability derivatives required for use in these calculations is presented. The processes of performing calculations of the time histories of lateral motions, of the period and damping of these motions, and of the lateral stability boundaries are presented as a series of simple straightforward steps. Existing methods for estimating the stability derivatives are summarized and, in some cases, simple new empirical formulas are presented. Detailed estimation methods are presented for low-subsonic-speed conditions but only a brief discussion and a list of references are given for transonic- and supersonic-speed conditions.

NACA Rept. 1102

THE LINEARIZED CHARACTERISTICS METHOD AND ITS APPLICATION TO PRACTICAL NON-LINEAR SUPERSONIC PROBLEMS. Antonio Ferri. 1952. ii, 18p. diagrs. (NACA Rept. 1102. Formerly TN 2515)

The method of characteristics has been linearized by assuming that the flow field can be represented as a basic flow field determined by nonlinearized methods and a linearized superposed flow field that considers small changes in boundary conditions. The method has been applied to two-dimensional rotational flow, to calculations of axially symmetric flow, to slender bodies without symmetry, and to wing problems.

NACA Rept. 1104

PRELIMINARY INVESTIGATION OF A NEW TYPE OF SUPERSONIC INLET. Antonio Ferri and Louis M. Nucci. 1952. ii, 19p. diagrs., photos., tab. (NACA Rept. 1104. Formerly TN 2286)

A supersonic inlet with supersonic deceleration of the flow entirely outside of the inlet is considered. A particular arrangement with fixed geometry having a central body with a circular annular intake is analyzed, and it is shown theoretically that this arrangement gives high pressure recovery for a large range of Mach number and mass flow and, therefore, is practical for use on supersonic airplanes and missiles. Experimental results confirming the theoretical analysis give pressure recoveries which vary from 95 percent for Mach number 1.33 to 86 percent for Mach number 2.00. These results were originally presented in a classified document of the NACA in 1946.

NACA TN 3055

FRICTION AND WEAR INVESTIGATION OF MOLYBDENUM DISULFIDE. I - EFFECT OF MOISTURE. Marshall B. Peterson and Robert L. Johnson. December 1953. 28p. diagrs., photos. (NACA TN 3055)

Low-speed kinetic friction studies show that for molybdenum disulfide MoS_2 lubricated steel surfaces coefficients of friction were greater at high humidity than with dry air. MoS_2 powder did not adhere to steel surfaces at high humidity, and as a result, metallic contact was greater and friction and wear increased. Increased wear with greater humidity may have been caused by corrosion of steel specimens by acids formed on contact of moisture with MoS_2. Variations in shear area resulted from changes in humidity, slider geometry, surface finish, and method of film application. Larger shear areas caused greater friction when MoS_2 filled the surface interstices and was sheared.

NACA TN 3058

TRANSIENT TEMPERATURE DISTRIBUTIONS IN SIMPLE CONDUCTING BODIES STEADILY HEATED THROUGH A LAMINAR BOUNDARY LAYER. Hermon M. Parker. December 1953. 42p. diagrs. (NACA TN 3058)

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An analysis is made of the transient heat-conduction effects in three simple semi-infinite bodies: the insulated flat plate, the conical shell, and the slender solid cone. The bodies are assumed to have constant initial temperatures and at zero time to begin to move at a constant speed and zero angle of attack through a homogeneous atmosphere. The heat input is taken as that through a laminar boundary layer. Radiation heat transfers and transverse temperature gradients are assumed to be zero. The appropriate heat-conduction equations are solved by an iteration method, the zeroeth order terms describing the situation in the limit of small time. The method is presented and the solutions are calculated to three orders which are sufficient to give reasonably accurate results when the forward edge has attained one-half the total temperature rise (nose half-rise time). Flight Mach number and air properties occur as parameters in the result. Approximate expressions for the extent of the conduction region and nose half-rise times as functions of the parameters of the problem are presented.

NACA TN 3087

EXPERIMENTAL INVESTIGATION OF TWO-DIMENSIONAL TUNNEL-WALL INTERFERENCE AT HIGH SUBSONIC SPEEDS. Earl D. Knechtel. December 1953. 13p. diagrs. (NACA TN 3087)

Results are shown of an investigation of tunnel-wall interference in a two-dimensional-flow, rectangular, closed-throat wind tunnel through a Mach number range from 0.3 to 0.9 and a corresponding Reynolds number range from 0.9×10^6 to 1.8×10^6. For ratios of airfoil chord to tunnel height below approximately 0.15, correction of aerodynamic data for wall interference by the small-perturbation theory of NACA Rep. 782 was found to yield results in satisfactory agreement with essentially interference-free data.

NACA TN 3089

ONE-DIMENSIONAL, COMPRESSIBLE, VISCOUS FLOW RELATIONS APPLICABLE TO FLOW IN A DUCTED HELICOPTER BLADE. John R. Henry. December 1953. 16p. diagrs. (NACA TN 3089)

One-dimensional, steady-state, compressible, viscous flow relations are presented which permit the determination of flow conditions at any radial position in a ducted helicopter blade. The relations are required for estimating the performance of proposed helicopter jet-propulsion systems which involve ducting air or gases through the blade from root to tip. A limited number of calculations over a wide range of helicopter operating conditions and relative duct sizes are also presented. The "choking" problem in the straight duct is discussed.

NACA TN 3090

INVESTIGATION OF SANDWICH CONSTRUCTION UNDER LATERAL AND AXIAL LOADS. Wilhelmina D. Kroll, Leonard Mordfin and William A. Garland, National Bureau of Standards. December 1953. 58p. diagrs., photos., 4 tabs. (NACA TN 3090)

Tests under combined axial load and lateral pressure were made of sandwich panels with simply supported loaded edges and free unloaded edges to determine the strength of panels of various thicknesses and to compare the results with computed values. The theory, derived in this paper, is based on the theory for buckling of simply supported sandwich columns and was conservative in predicting larger strains or deflections than those measured. Agreement between computed maximum loads and experimental failing loads was within 9 percent.

NACA TN 3093

EFFECT OF TYPE OF POROUS SURFACE AND SUCTION VELOCITY DISTRIBUTION ON THE CHARACTERISTICS OF A 10.5-PERCENT-THICK AIRFOIL WITH AREA SUCTION. Robert E. Dannenberg and James A. Weiberg. December 1953. 59p. diagrs., photos., 5 tabs. (NACA TN 3093)

Results are presented of an investigation of a two-dimensional, 10.51-percent-thick symmetrical airfoil with area suction near the leading edge. Lift and suction-flow characteristics were determined with different porous surfaces (perforated plates and sintered steel) for various suction velocity distributions. The flow requirements were ascertained over a range of free-stream velocities. The maximum lift was independent of the surface of the materials tested.

NACA RM E53J12

EFFECT OF DIFFUSION PROCESSES AND TEMPERATURE ON SMOKING TENDENCIES OF LAMINAR DIFFUSION FLAMES. Rose L. Schalla. December 1953. 23p. diagrs., photos. (NACA RM E53J12)

The effects of diffusion processes on the smoking tendencies of eight laminar diffusion flames were investigated by varying the rate and concentration of air and oxygen supplied to the flame. Increasing the rate at which air was supplied permitted rather limited increases in the smoke-free burning rate. Increasing the concentration of oxygen from 21 to 45 percent increased the smoke-free fuel flow for pentene-1, neopentane, isobutane, ethylene, and n-butane, but decreased the smoke-free burning rate for butene-1, cyclopropane, and propene in the range of 25 to 40 percent oxygen. Increasing the flame temperature caused the smoke-free fuel flow to increase except for butene-1, cyclopropane, and propene, where initial rates were lower. The variations in smoke formation with oxygen enrichment were tentatively explained by considering the effect of temperature on the initial decomposition reactions of the fuel molecule.

BRITISH REPORTS

N-27230*

Aeronautical Research Council (Gt. Brit.)
DYNAMIC LONGITUDINAL STABILITY MEASUREMENTS ON A SINGLE-ROTOR HELICOPTER (HOVERFLY MK. I). W. Stewart. With an appendix on THE THEORETICAL ESTIMATION OF THE STABILITY. G. J. Sissingh. 1953. 24p. diagrs. (ARC R & M 2505; ARC 11,578. Formerly RAE Aero 2244)

Flight measurements have been made of the phugoid motion of the Hoverfly Mk. I helicopter, following an arbitrary longitudinal displacement of the control, the latter being returned to its initial position and held fixed. The tests were done throughout the speed range for power-on conditions and in autorotation for various center-of-gravity positions and for forward and backward initial displacement of the stick.

N-27231*

Aeronautical Research Council (Gt. Brit.)
TESTS ON THE HURRICANE L. 1696 IN THE 24-FT WIND TUNNEL. D. W. Bottle and T. V. Somerville. 1953. 10p. diagrs., photo., 5 tabs. (ARC R & M 2562; ARC 5344. Formerly RAE BA 1697)

Tests on a Hurricane in the 24-foot wind tunnel at the Royal Aircraft Establishment were required to find if any simple modifications could be made which would reduce its drag. Measurements were made of: (1) leak drag, (2) drag of miscellaneous excrescences, (3) cooling drag, and (4) drag of the tail unit. The tests showed that the leak drag plus the drag due to the control gaps was 13 percent of the total profile drag of the aircraft. Of this leak drag, only one-third could be eliminated by methods which could be incorporated in production aircraft without serious modification. This emphasizes the importance of eliminating leaks in the design stage. The drag of the cooling system was reasonably low, and tail-fuselage interference was small.

N-27232*

Aeronautical Research Council (Gt. Brit.)
LANDING OF AN AIRCRAFT ON A SUSPENDED SHEET. J. Taylor. 1953. 37p. diagrs., 3 tabs. (ARC R & M 2574; ARC 10,643. Formerly RAE Structures 3)

An investigation is made into the characteristics of a freely suspended flexible sheet as a shock absorber replacing the conventional undercarriage, particular attention being given to the inertia of the sheet. It is found that when an aircraft is dropped vertically on to the sheet the retarding force is first produced by the inertia of the sheet itself, and not until later in the descent by the reactions from the side supports of the sheet. By careful adjustments of the mass and tension of the sheet "retardation efficiencies" exceeding 80 percent can be achieved. The effect of the aircraft having a forward component of velocity increases the contribution of sheet momentum. For reasonably practical landing speeds and sheet dimensions, virtually the whole of the momentum of descent is absorbed by sheet inertia. Under such conditions still higher retardation efficiencies are obtainable and, with a suitable design of aircraft keel, rebound may be entirely eliminated.

N-27233*

Aeronautical Research Council (Gt. Brit.)
WIND-TUNNEL TESTS ON THE 30 PERCENT SYMMETRICAL GRIFFITH AEROFOIL WITH DISTRIBUTED SUCTION OVER THE NOSE. N. Gregory, W. S. Walker and A. N. Devereux. 1953. 14p. diagrs., photos. (ARC R & M 2647. Formerly ARC 11,599; Perf. 461; FM 1260)

This report describes tests carried out on the 30 percent Griffith symmetrical airfoil with continuous suction applied through a porous capping fitted over the front 15 percent of the upper surface. Throughout the range of incidence covered in the experiments, distributed suction was found to decrease the slot suction necessary to prevent separation, especially when the distributed suction caused rearward movement of the transition position. The profile drag of the airfoil was measured, and estimates were made of the equivalent drag coefficients for the work done by the suction pumps. Assuming no losses additional to those in the boundary layer, it was found that the effect of distributed suction was to reduce slightly the overall drag of the airfoil. Measurements of the velocity within the boundary layer were made at various chordwise positions on the porous surface; the profiles recorded were very close to the theoretical. Distributed suction was able to delay transition when this would otherwise be precipitated by a ridge on the surface, or by adverse pressure gradients, but a turbulent boundary layer remained turbulent when suction was applied. The characteristic spread of turbulent flow in the wake of a small particle on the surface was much reduced by distributed suction; under favorable conditions, the wake was entirely eliminated.

N-27234*

Aeronautical Research Council (Gt. Brit.)
AEROFOIL OSCILLATIONS AT HIGH MEAN INCIDENCES. W. P. Jones. 1953. 9p. diagrs. (ARC R & M 2654. Formerly ARC 11,502; 0.724)

The problem of the estimation of the aerodynamic forces acting on two-dimensional airfoils oscillating at mean incidences below the stall is considered. A method of calculation is suggested which makes use of the steady motion characteristics of the airfoil. At low frequencies, good agreement with the measured aerodynamic derivatives should be obtained as the method is such that it gives the correct values at zero frequency. A comparison between the estimated and measured values of the pitching-moment derivatives for a particular airfoil is made, and this shows that the method suggested gives better agreement with experiment than the usual vortex-sheet theory.

N-27235*

Aeronautical Research Council (Gt. Brit.)
CORRECTIONS TO VELOCITY FOR WALL CONSTRAINT IN ANY 10 x 7 RECTANGULAR SUBSONIC WIND TUNNEL. J. Y. G. Evans. 1953. 42p. diagrs., photos. (ARC R & M 2662; ARC 12,526. Formerly RAE Aero 2307)

The validity and accuracy of methods of determining corrections to the measured velocity in a wind tunnel to compensate for the constraining effect of the walls are reviewed following recent experimental evidence from the R. A. E. 10- by 7-foot subsonic wind tunnel. It is concluded that such corrections, commonly known as "blockage" corrections, can be successfully applied at Mach numbers up to 0.96 but some modifications are necessary to the formulas at present in use. Formulas for the calculation of the longitudinal distribution of blockage increment due to any model, necessary to check the validity of the method in particular cases, are presented in a form which, it is hoped, will facilitate their use in any 10 by 7 wind tunnel. Formulas for the corresponding wall velocity increments, used to check the accuracy of the method by comparison with measured wall pressures, are also given.

N-27236*

Aeronautical Research Council (Gt. Brit.)
SOME HIGH-SPEED TESTS ON TURBINE CASCADES. E. A. Bridle. 1953. 14p. diagrs., photos. (ARC R & M 2697; ARC 12,455. Formerly NGTE R. 48)

High-speed wind-tunnel tests on seven cascades of turbine blades are described, the blades having conventional sections including both reaction and impulse designs. The two-dimensional performance over wide ranges of incidence at Mach numbers up to 1.0 is discussed, special importance being attached to the effects of compressibility. It is shown that the effect of increasing the degree of reaction is to reduce the total-head loss and to increase the unstalled incidence range. High Mach numbers alone are not found to cause a catastrophic increase in loss with these particular blade designs, while the $\cos^{-1}$ throat/pitch rule is found to be approximately true only at high Mach numbers.

N-27237*

Aeronautical Research Council (Gt. Brit.)
THE IMPROVEMENT IN PRESSURE RECOVERY IN SUPERSONIC WIND TUNNELS. H. Eggink. 1953. 18p. diagrs., photos. (ARC R & M 2703; ARC 12,527. Formerly RAE Aero 2326; SD 34)

The inefficient pressure recovery of present-day supersonic wind tunnels, which leads to high costs of plant installation and operation, is discussed and methods of improvement suggested. In particular, the diffuser system, where most of the losses occur, is studied in detail; the improvement to be expected in the pressure recovery by the use of convergent-divergent types is explained and methods of overcoming the necessity for high starting powers with this arrangement are presented. Diffuser experiments based on recent investigations into breakaway phenomena in supersonic flow are described which result in a considerable improvement of pressure recovery. A deceleration from $M = 2.48$ at the working section to $M = 1.42$ at the diffuser throat was obtained using a variable diffuser throat.

N-27238*

Aeronautical Research Council (Gt. Brit.)
THE DESIGN AND TESTING OF SUPERSONIC NOZZLES. R. Harrop, P. I. F. Bright, J. Salmon and M. T. Caiger. 1953. 40p. diagrs., photos., 7 tabs. (ARC R & M 2712; ARC 12,114; ARC 13,383. Formerly RAE Aero 2293; RAE Aero 2293a)

The theory of the flow through a throat near sonic velocity is developed, and is followed by a discussion of the conventional method of designing supersonic nozzles using the method of characteristics. A method of improving the Mach number distribution of the nozzle using the experimental results is developed. The nozzles designed were tested in a 3-inch square wind tunnel in which the Mach number distribution was obtained by shaping the top wall of the working section. The Mach number distribution along the bottom wall was determined from the pressures measured by a series of static-pressure holes along the wall. Considerable difficulty was found in improving the distribution; this was considered to be due to the discontinuity in curvature at the point of inflexion and the influence on the boundary layer of the sudden relaxation of the pressure gradient along the wall. An alternative method of design was developed which avoided this discontinuity in curvature, and considerably better results were obtained when attempts were made to improve the experimental Mach number distribution.

N-27239*

Aeronautical Research Council (Gt. Brit.)
ELASTICITY OF A SHEET REINFORCED BY STRINGERS AND SKEW RIBS, WITH APPLICATIONS TO SWEPT WINGS. E. H. Mansfield. 1953. 27p. diagrs. (ARC R & M 2758; ARC 12,990. Formerly RAE Structures 52)

A rigorous theory has been developed for determining the stresses and displacements in a sheet reinforced by stringers and ribs which are not at right angles to the stringers. The solution of many problems of practical importance has been facilitated by the introduction of a stress function. The theory has been applied to a cylinder of rectangular section stiffened with such skew ribs (a simplified representation of a swept wing). It is shown that there are axes about which applied moments produce pure twist or pure curvature of the cylinder. There are simple formulas for determining these axes and the relationships between twist and curvature and the applied moments.

N-27240*

Aeronautical Research Council (Gt. Brit.)
POLYMETHYL METHACRYLATE (PERSPEX TYPE) PLASTICS; CRAZING, THERMAL AND MECHANICAL PROPERTIES. H. Warburton Hall and E. W. Russell. 1953. 27p. diagrs., photos., 2 tabs. (ARC R & M 2764; ARC 12,829. Formerly RAE Chem. 454)

The report summarizes the more practical aspects of the results of a long-term investigation of the basic physical and chemical properties of polymethyl methacrylate ("Perspex" type) plastic. Thermal, elastic, crazing, solvent absorption, and mechanical properties are included and the effect of these on the service efficiency of a plastic structure is described. Experimental evidence is given concerning the essential role of tensile stress and absorbed solvent in causing crazing and recommendations concerning means to reduce or avoid the incidence of crazing are included. The basic thermal properties are compared with those of metals and the dangers of differential expansion in combined metal-plastic structures are noted, together with the serious effects of chilling of plastic structures during the "hot-forming" operation. Details are given of appropriate heat treatments designed to remove casting and workshop strains without causing distortion.

N-27241*

Aeronautical Research Council (Gt. Brit.)
SOME PRELIMINARY MODEL EXPERIMENTS ON THE WHIRLING OF SHAFTS. E. Downham. 1953. 20p. diagrs., photos. (ARC R & M 2768; ARC 13,733. Formerly RAE Structures 82)

Experimental work is now being done to establish a basis for the solution of whirling problems on turbine and contrarotating shaft systems in the design stage. This report is concerned primarily with the degree of accuracy to be expected from experiments on models. In experiments here described results are obtained for a simple cantilever system which are in close agreement with theory. With more complicated systems the error is somewhat greater owing to practical effects not covered by theory, though still acceptable for most design purposes.

N-27242*

Aeronautical Research Council (Gt. Brit.)
FLOW PATTERNS IN THE WAKE OF AN OSCILLATING AEROFOIL. J. B. Bratt. 1953. 27p. diagrs., photos. (ARC R & M 2773. Formerly ARC 13,001; FM 1423; 0.864)

Part I of the report gives an account of experiments made with the National Physical Laboratory smoke generator to obtain smoke patterns in the wake of an airfoil performing a rolling oscillation in a wind stream. Calculations are given in part II relating to the smoke patterns produced by a nozzle in uniform motion relative to (a) an infinite row of equally spaced two-dimensional discrete vortices of alternate sign and (b) an infinite two-dimensional vortex sheet with sinusoidal distribution of strength. Comparison with certain of the smoke patterns discussed in part I suggests that the wake vorticity can be treated very closely as a system of discrete vortices, and this is supported by the consideration that the elements of a continuous vortex sheet would in general be subject to normal induced velocities, which would tend to break the sheet up. The tendency for this to occur would be greater for the higher values of ω, wince the variation of vorticity with distance along the wake would be greater. The induced velocities for a uniform infinite vortex sheet would be zero.

N-27250*

Aeronautical Research Council (Gt. Brit.)
EXPERIMENTS ON RIGID PARACHUTE MODELS. R. Jones. 1953. 21p. diagrs., 10 tabs. (ARC R & M 2520. Formerly ARC 7218; Ae. 2363)

The investigations described in this report were undertaken for the Aeronautical Research Committee in order to study the effect of porosity on the stability of a parachute. Experiments were conducted to obtain data which could be applied in the usual way to the standard equations of motion.

N-27251*

Aeronautical Research Council (Gt. Brit.)
THE BUCKLING IN COMPRESSION OF PANELS WITH SQUARE TOP-HAT SECTION STRINGERS. W. S. Hemp and K. H. Griffin. 1953. 14p. diagrs., tab. (ARC R & M 2635; ARC 12,462. Formerly College of Aeronautics, Cranfield, Rept. 29)

A simplified panel model is described, together with a number of assumptions about the mode of its buckling. The approach to the calculation of the buckling stress is by splitting the panel into a number of flat plates and treating these by the ordinary plate theory. Use of the boundary conditions between these plates leads to a relation between the buckling stress and the variables of the panel geometry. The results thus obtained are compared with two sets of recent experimental work, and an appendix is included to show the effect of initial panel irregularities on the experimental determination of buckling stresses.

N-27252*

Aeronautical Research Council (Gt. Brit.)
INVESTIGATION OF SKIN BUCKLING. D. J. Farrar. 1953. 62p. diagrs., 12 tabs. (ARC R & M 2652; ARC 11,036; ARC 11,037; ARC 11,038. Formerly MOS S & TM 12A/47; S & TM 12B/47; S & TM 12C/47; Bristol Aeroplane Co., Ltd. CR 434)

The present tests were conducted on aluminum alloy plates in endwise compression, with varying conditions of edge support, to provide data on the buckling stress and post-buckling behavior of aircraft skins. All the plates tested were 35 inches long and nominally 0.064 inch thick. The plate width between the supports was varied between 35 and 120 times its thickness. Both clad (D.T.D. 546) and unclad (D.T.D. 646) material were tested. Three types of edge support were used: rows of steel balls in vee-grooved blocks, intended to imitate pin-edged conditions; rows of steel rollers in recessed blocks, intended to imitate clamp-edged conditions; and a single type of stringer used in previous panel tests. Measurements were made of the plate load and mean strain, and of the shape of the skin buckles. The test technique is discussed and the experimental results compared with theory.

N-27253*

Aeronautical Research Council (Gt. Brit.)
A REVISED INDEX OF MATHEMATICAL TABLES FOR COMPRESSIBLE FLOW. R. C. Tomlinson. 1953. 12p. diagrs. (ARC R & M 2691; ARC 11,582. Revised edition of ARC 9893; FM 976)

This report contains information of all the revelant tables known to the author, which can be obtained by workers outside the establishment of origin. The purpose of the index is to make available to workers in the field of compressible flow a reference from which they may trace a tabulation of any function they require, if it exists.

N-27254*

Aeronautical Research Council (Gt. Brit.)
WIND-TUNNEL TESTS ON A 12-FT DIAMETER HELICOPTER ROTOR. H. B. Squire, R. A. Fail and R. C. W. Eyre. 1953. 19p. diagrs., photos., 5 tabs. (ARC R & M 2695; ARC 12,524. Formerly RAE Aero 2324)

Measurements of the thrust, torque, and flapping angle for a 12-foot diameter rotor over a range of blade angle, shaft inclination, and tip-speed ratio have been made to give information on the validity of the standard rotor theory and of the effect of stalling on the retreating blade. Good agreement with the theory was obtained over the normal operating range, using airfoil characteristics determined from the measurements in the static thrust condition. Stalling was found to be progressive in character showing first by an increase in torque and flapping angle and later by a fall in thrust, as compared with the calculated values.

N-27255*

Aeronautical Research Council (Gt. Brit.)
SOME RELATED OSCILLATION PROBLEMS. W. J. Duncan. 1953. 12p. diagrs. (ARC R & M 2707; ARC 12,406. Formerly College of Aeronautics, Cranfield, Rept. 27)

Two simple means for establishing a relation between a pair of oscillation problems are briefly discussed. In the first, the displacements are connected by use of a differential operator. The set of natural frequencies is identical for the two problems and results of interest are obtained when the transformed boundary conditions can be physically interpreted. In this manner, it is shown, for example, that a flywheel on a uniform shaft can be transformed into a flexible coupling and a mass carried on a uniform beam into a flexible hinge. In the second, the connection is established by use of the concept of mechanical admittance. Here the frequency equations are simply related but the frequencies are not.

N-27256*

Aeronautical Research Council (Gt. Brit.)
VELOCITY DISTRIBUTION ON UNTAPERED SHEARED AND SWEPT-BACK WINGS OF SMALL THICKNESS AND FINITE ASPECT RATIO AT ZERO INCIDENCE. S. Neumark and J. Collingbourne. 1953. 50p. diagrs. (ARC R & M 2717; ARC 12,491. Formerly RAE Aero 2316)

This report is a continuation of an earlier one and puts forward several new solutions of the problems of velocity distribution on finite or semi-infinite untapered wings, at zero incidence. The solutions are based on the first order method of sources and sinks, which is shown to be sufficiently accurate to deal with problems involving tips or kinks. The fundamental case considered is that of a semi-infinite sheared wing, and the theory is built up to embrace finite sheared and sweptback wings, straight wings being dealt with as special cases. Complete detailed solutions are given for wings with biconvex parabolic profile, and the problems involving arbitrary profiles are investigated in a more general way. The velocity distribution in the regions of kinks and tips differing considerably from that on an infinite sheared wing, some local positive or negative drag arises in these regions.

The drag distribution is calculated for the case of a biconvex parabolic profile, and it is found that, while the total resultant drag must obviously be nil for a finite wing, it may differ from zero for infinite or semi-infinite wings. This "potential" drag is generally small.

N-27257*

Aeronautical Research Council (Gt. Brit.)
SCHLIEREN TESTS ON SOME CONVENTIONAL TURBINE CASCADES. J. A. Dunsby. 1953. 14p. diagrs., photos. (ARC R & M 2728; ARC 12,893. Formerly NGTE R. 56)

Schlieren tests on a series of conventional turbine cascades have shown that the variations in performance at high speed can be accounted for by shock-wave and boundary-layer interaction. The rise in loss coefficient sometimes encountered at outlet Mach numbers of 0.6 to 0.8 is shown to be due to the formation of a λ shock series on the upper surface of the blade, the subsequent fall in loss coefficient and increase in deflection as the outlet Mach number rises to unity being caused by the formation of a shock system at outlet which forces the separated part of the boundary layer back on to the blade surface. It is shown that a λ shock series may form on a boundary layer which is apparently turbulent. This has not been observed before.

N-27258*

Aeronautical Research Council (Gt. Brit.)
STRESSES IN BUILT-UP BEAMS DUE TO AN ABRUPT CHANGE IN SHEAR STRESS AT A LOADING STATION. J. Taylor. 1953. 18p. diagrs., photos. (ARC R & M 2775; ARC 12,737. Formerly RAE Structures 48)

Owing to the abrupt change in shear stress at loading sections of beams there is a concentration of direct stress in the outer fibers of the beam near the loading section. A method of calculating this concentration is described. The highest stress concentrations occur in short deep beams and are greater for wooden than metal beams. The method is applied to the spars of two wooden aircraft and stress concentrations 1.06 and 1.4 are found at the fuselage attachments. Strain measurements were made at positions on a wooden beam under load and the theoretical predictions verified.

N-27259*

Aeronautical Research Council (Gt. Brit.)
THE EVALUATION OF DOWNWASH AT LARGE SPANWISE DISTANCES FROM A VORTEX LATTICE. H. C. Garner. 1953. 8p. diagrs., 6 tabs. (ARC R & M 2808. Formerly ARC 13,624; Perf. 727; S & C 2472)

This note explains an improved numerical method of evaluating the contributions to the downwash at moderate or large spanwise distances from a vortex lattice. By allowing freedom of choice of the chordwise positions of the discrete vortices of the lattice, it is possible to select three definite chordwise positions and strengths of vortices at each of these positions dependent on the chordwise pressure distribution, so as to determine the downwash with good accuracy for three particular pressure distributions proportional to $\cot \frac{1}{2}\theta$, $\sin \theta$, and $\sin 2\theta$. The corresponding chordwise loading factors have also been evaluated for deflected flaps.

N-27260*

Aeronautical Research Council (Gt. Brit.)
THE TWO-DIMENSIONAL SUBSONIC FLOW OF AN INVISCID FLUID ABOUT AN AEROFOIL OF ARBITRARY SHAPE. L. C. Woods. 1953. 58p. diagrs., 9 tabs. (ARC R & M 2811. Formerly ARC 13,240; FM 1456; ARC 13,395; FM 1475; ARC 13,460; FM 1489; ARC 13,533; FM 1499)

The paper describes and applies exact methods of calculating the incompressible flow about thick airfoils of general shape in a free stream, and about symmetrical airfoils between channel walls. One of these methods is extended to an approximate treatment of subsonic compressible flow by making use of von Kármán's transformation.

N-27263*

Aeronautical Research Council (Gt. Brit.)
GROWTH OF THE TURBULENT WAKE CLOSE BEHIND AN AEROFOIL AT INCIDENCE. D. A. Spence. 1953. 18p. diagrs. (ARC CP 125)

Knowledge of the variation close behind a trailing edge of the wake displacement thickness $\delta^* = \int \left(1 - \frac{u}{U}\right) dy$ is necessary in calculations of the circulation round an airfoil. Examination of data now available reveals that in the wake: (1) velocity profiles on either side of the line of minimum velocity may be derived from the corresponding trailing-edge boundary-layer profiles by change of scale of each coordinate; (2) the velocity defect at corresponding points follows a universal recovery law of the form $K(x - x_0)^{-\frac{1}{2}}$ even close to the trailing edge. An immediate consequence of these two empirical properties is a simple relation for the form parameter $H = \delta^*/\theta$ at points in the wake in terms of trailing-edge values. In conjunction with the momentum equation, this makes δ^* determinate. Agreement with experiment is very satisfactory.

N-27264*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE LIFT SLOPE, AND SOME OTHER PROPERTIES, OF DELTA AND SWEPT-BACK WINGS. E. F. Relf. 1953. 9p. diagrs., tab. (ARC CP 127)

In studying and comparing various theories for the determination of the distribution of loading on wings, Garner has given values for the lift slope of several families of sweptback and delta wings deduced from several different lifting-surface theories. In figure 8 of reference 1, Garner has plotted these lift slopes as functions of the aspect ratio A, for different values of the angle of sweep. It occurred to the writer to try plotting the ratio of the lift slope to that for elliptic loading instead of the lift slope itself, and when this was done it was noticed that the above ratio was very nearly independent of aspect ratio A, and gave a unique curve for all the available results when plotted against sweepback angle A. It has been possible to make some comparisons of theoretical deductions drawn from the above with measurements made in the C. A. T. on four delta wings, one swept wing, a tapered swept wing on a body, and two untapered swept wings on a body at high Reynolds numbers, where one could expect a close approximation to potential theory. While analyzing the C. A. T. results, values of the quantity K in the formula $C_D = C_{D_0} - \frac{K}{\pi A} C_L^2$ were collected and studied. Lastly, a study was made of scale effects in the C. A. T. tests.

N-27265*

Aeronautical Research Council (Gt. Brit.)
METHOD FOR THE DETERMINATION OF THE PRESSURE DISTRIBUTION OVER A FINITE THIN WING AT A STEADY LOW SPEED. G. J. Hancock. 1953. 11p. diagrs. (ARC CP 128)

For any given pressure distribution across a finite thin wing at low speed, the wing surface can be obtained by direct double integration. Therefore, the pressure distribution across a given wing surface may be obtained by the superposition of a number of solutions in which the wing surface is known for a prescribed pressure distribution. The method has been applied for the determination of the pressure distribution across a thin uncambered delta wing.

N-27266*

National Gas Turbine Establishment (Gt. Brit.)
AN ANALYSIS OF THE AIR FLOW THROUGH THE NOZZLE BLADES OF A SINGLE STAGE TURBINE. I. H. Johnston. 1953. 18p. diagrs. (ARC CP 131)

This memorandum presents the results of detailed traverses made on three of the nozzle assemblies designed for a single stage experimental turbine. The effects of pitch/chord ratio on gas outlet angle and total head loss are recorded and discussed in the light of corresponding work published elsewhere. The value of pitch/chord ratio giving minimum total head loss is found to compare well with the optimum pitching given by two-dimensional results obtained from cascade tests on blades of a similar nature.

N-27267*

Aeronautical Research Council (Gt. Brit.)
TESTS ON AN AXIAL COMPRESSOR WITH VARIOUS STATOR BLADE STAGGERS. R. A. Jeffs, E. L. Hartley and P. Rooker. 1953. 18p. diagrs., tab. (ARC CP 132)

This memorandum presents the results of a series of low speed tests on six stages of a medium stagger free vortex design of axial compressor blading, in which the stagger of the stator blades was varied over a wide range while the rotor blade stagger remained at its design figure. It is shown that efficiencies in excess of 85 percent were achieved over a range of stator blade stagger from -50° to $+10^{\circ}$, compared with the design figure of -25.4°. This performance augurs well for the improvement of the performance of axial flow compressors away from their design point by the method of altering the stator blade stagger in some of the stages.

N-27268*

Aeronautical Research Council (Gt. Brit.)
A RELAXATION TREATMENT OF SHOCK WAVES.
L. C. Woods. 1953. 9p. diagrs. (ARC CP 134)

Emmons has given a relaxation method of dealing with shock waves when the compressible stream function is the dependent variable. This paper briefly outlines a procedure to adopt when $\log \frac{1}{q}$ (q = velocity magnitude) is taken as the dependent variable. A method of allowing for the presence of vorticity behind the shock wave is also given.

N-27287*

Ministry of Supply (Gt. Brit.)
THE STOVE-ENAMELLING OF ALUMINIUM ALLOYS - EFFECTS ON TENSILE PROPERTIES.
October 1953. 7p. diagrs. (MOS S & TM 3/53)

An investigation on the effects of short period heating of aluminum alloys in the range 120° C-200° C was made. Curves are presented showing the effects of heating on the 0.1 percent proof stress and ultimate stress of the material. A further investigation was made on the possibility of recovery of properties taking place either by prolonging the low-temperature stoving time or by leaving the material for a long time at room temperature after stoving.

N-27293*

Royal Aircraft Establishment (Gt. Brit.)
THE R.A.E. 4 FT x 3 FT EXPERIMENTAL LOW TURBULENCE WIND TUNNEL. PART IV. FURTHER TURBULENCE MEASUREMENTS.
H. Schuh. June 1953. 78p. diagrs., 7 tabs. (RAE Aero 2494)

Further measurements were made in the working section of this 4-foot by 3-foot wind tunnel. The influence of the number of screens in the bulge on the turbulence in the working section was studied, and the intensity and scale of turbulence was measured at the end of the second diffuser and at various places downstream and in the bulge.

N-27299*

Forest Products Research Lab. (Gt. Brit.)
TRIALS OF TIMBER FOR PLYWOOD MANUFACTURE. SMALL SCALE TESTS ON FOUR SPECIES (CANARIUM, OKWEN, SEPETIR AND SERRETTE). PROGRESS REPORT TWENTY-TWO. October 1953. 16p. 3 tabs. (Forest Products Research Lab.)

Four species of wood were evaluated as to their usefulness in the manufacture of plywood. Data on their processing, drying, gluing qualities, and pressure compression properties is given.

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Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1099

AIR FORCES AND MOMENTS ON TRIANGULAR AND RELATED WINGS WITH SUBSONIC LEADING EDGES OSCILLATING IN SUPERSONIC POTENTIAL FLOW. Charles E. Watkins and Julian H. Berman. 1952. ii, 25p. diagrs., tab. (NACA Rept. 1099. Formerly TN 2457)

This analysis treats the air forces and moments in supersonic potential flow on oscillating triangular wings and a series of sweptback and arrow wings with subsonic leading edges and supersonic trailing edges. The linearized velocity potential for the wings undergoing sinusoidal torsional oscillations simultaneously with vertical translations is derived in the form of a power series in terms of a frequency parameter. Although as many terms of such a series expansion as may be desired can be determined, the terms after the first few become very cumbersome. Closed expressions that include the reduced frequency to the third power, an order which is sufficient for a large class of practical applications, are given for the velocity potential and components of chordwise section force and moment coefficients.

NACA Rept. 1103

GENERALIZED THEORY FOR SEAPLANE IMPACT. Benjamin Milwitzky. 1952. iii, 75p. diagrs., 4 tabs. (NACA Rept. 1103)

The motions, hydrodynamic loads, and pitching moments experienced in impacts of V-bottom seaplanes are analyzed and compared with experiment. The analysis is presented in terms of generalized variables which are related through a single parameter, called the approach parameter κ. For use in the design of seaplanes, charts are presented showing the generalized relationships which apply throughout the impact; charts are also presented which show the variations with κ of the generalized variables at the instants of maximum acceleration, maximum pitching moment about the step, maximum penetration, and exit during rebound. The effects of chine immersion on the maximum load are also determined. Extensive experimental data are presented to permit evaluation of the theoretical results.

NACA Rept. 1118

METHOD FOR CALCULATION OF LAMINAR HEAT TRANSFER IN AIR FLOW AROUND CYLINDERS OF ARBITRARY CROSS SECTION (INCLUDING LARGE TEMPERATURE DIFFERENCES AND TRANSPIRATION COOLING). E. R. G. Eckert and John N. B. Livingood. 1953. ii, 29p. diagrs. (NACA Rept. 1118. Formerly TN 2733)

A method which permits approximation of local heat-transfer coefficients in the laminar-flow region around cylinders of arbitrary cross section from those for wedge-type profiles is extended to include the effects of large temperature differences and transpiration cooling. Charts prepared from exact solutions of the laminar boundary-layer equations for wedge-type profiles which allow for these effects yield results with a minimum of calculation. Application of the method to circular and elliptic transpiration cooled cylinders is made to determine local heat-transfer coefficients and surface temperatures and to determine the variation in coolant flow required for maintaining a constant surface temperature.

NACA Rept. 1119

RECIPROCITY RELATIONS IN AERODYNAMICS. Max. A. Heaslet and John R. Spreiter. 1953. ii, 16p. diagrs. (NACA Rept. 1119. Formerly TN 2700)

Reserve-flow theorems in aerodynamics are shown to be based on the same general concepts involved in many reciprocity theorems in the physical sciences. Reciprocal theorems for both steady and unsteady motion are found as a logical consequence of this approach. No restrictions on wing plan form or flight Mach number are made beyond those required in linearized compressible-flow analysis. A number of examples are listed, including general integral theorems for lifting, rolling, and pitching wings and for wings in nonuniform downwash fields. Correspondence is also established between the build-up of circulation with time of a wing starting impulsively from rest and the build-up of lift of the same wing moving in the reverse direction into a sharp-edge gust.

NACA TN 3030

A METHOD FOR CALCULATING THE SUBSONIC STEADY-STATE LOADING ON AN AIRPLANE WITH A WING OF ARBITRARY PLAN FORM AND STIFFNESS. W. L. Gray and K. M. Schenk, Boeing Airplane Company. December 1953. ii, 120p. diagrs., tab. (NACA TN 3030)

*AVAILABLE ON LOAN ONLY.

ADDRESS REQUESTS FOR DOCUMENTS TO NACA, 1724 F ST., NW., WASHINGTON 25, D. C., CITING CODE NUMBER ABOVE EACH TITLE, THE REPORT TITLE AND AUTHOR.

A method for computing the span load distribution on an elastic airplane wing at specified airplane weights and load factors is given. The method which applies for subcritical Mach numbers for wings of arbitrary plan form and stiffness distribution includes the effects of external stores and fuselage on the spanwise loading. Modifications are outlined for treating tail-boom and tailless airplane configurations and for calculating the divergence dynamic pressure of a swept wing with a large external store. A method is also outlined for reducing wind-tunnel data to obtain effective aerodynamic coefficients which are Mach number can readily be evaluated from the aerodynamic coefficients thus obtained.

NACA TN 3054

INVESTIGATION AT SUPERSONIC SPEEDS OF THE WAVE DRAG OF SEVEN BOATTAIL BODIES OF REVOLUTION DESIGNED FOR MINIMUM WAVE DRAG. August F. Bromm, Jr. and Julia M. Goodwin. December 1953. 14p. diagrs., photo. (NACA TN 3054)

Results are presented from an investigation of the variation with Reynolds number and Mach number of the wave drag of seven boattail bodies of revolution designed for minimum wave drag according to the theory presented in NACA TN 2550.

NACA TN 3057

A SIMPLIFIED MATHEMATICAL MODEL FOR CALCULATING AERODYNAMIC LOADING AND DOWNWASH FOR WING-FUSELAGE COMBINATIONS WITH WINGS OF ARBITRARY PLAN FORM. Martin Zlotnick and Samuel W. Robinson, Jr. January 1954. 38p. diagrs. (NACA TN 3057. Formerly RM L52J27a)

For the purpose of calculating the aerodynamic loading on the fuselage, the midwing wing-fuselage combination with a fuselage of circular cross section can be represented by a simple system of horseshoe vortices located on the wing with images located inside the fuselage. By using this simplified mathematical model or the extension of it given in an appendix for nonmidwing configurations with fuselages of arbitrary cross section, a method for calculating the lift and longitudinal center of pressure on the fuselage in the presence of the wing at subsonic speeds is presented. In addition the report shows how the simplified mathematical model can be used for calculating the downwash behind the wing and for calculating the spanwise lift distribution on the wing for midwing configurations with axisymmetric fuselages.

NACA TN 3060

USE OF ELECTRIC ANALOGS FOR CALCULATION OF TEMPERATURE DISTRIBUTION OF COOLED TURBINE BLADES. Herman H. Ellerbrock, Jr., Eugene F. Schum and Alfred J. Nachtigall. December 1953. 116p. diagrs., photos., 6 tabs. (NACA TN 3060)

An investigation was conducted to develop simple, inexpensive electric analogs for determining temperatures of cooled turbine blades. The accuracy of such analogs was determined by fabricating three for specific blade configurations and comparing values of blade temperatures obtained with them with calculated values of blade temperature when air-cooled blades were considered and by relaxing the analog values for liquid-cooled blades to determine whether the residuals were acceptable. In general, good agreement was achieved between calculated and analog values of blade temperature.

NACA TN 3061

STRESSES AROUND RECTANGULAR CUTOUTS IN TORSION BOXES. Paul Kuhn and James P. Peterson. December 1953. 71p. diagrs., 2 tabs. (NACA TN 3061)

A method is presented for calculating the stresses produced by rectangular cutouts of any size in torsion boxes. The problem is divided into a "box problem" and a "cover problem." The box problem is a special case of the general method of analyzing torsion boxes without cutouts. In the cover problem, simple shear-lag theory is used to obtain "key" stresses; the final distributions are obtained from these key stresses by means of simple rules or empirical distribution curves. Comparisons with the results from three series of tests in which the dimensions of the cutouts varied over a wide range are shown.

NACA TN 3088

DETERMINATION OF THE FLYING QUALITIES OF THE DOUGLAS DC-3 AIRPLANE. Arthur Assadourian and John A. Harper. December 1953. 67p. diagrs., photos., tab. (NACA TN 3088)

Data are presented showing the longitudinal and lateral stability and control characteristics and the stalling behavior of the Douglas DC-3 airplane and the compliance of these flying qualities with the current Air Force-Navy specifications. Even though the DC-3 was designed and built more than two decades ago, the airplane satisfied most of the current specifications for its type. However, the airplane had static longitudinal instability for certain conditions of airspeed and center-of-gravity position in the power-on configurations, the specified maximum elevator control-force gradient in maneuvers was exceeded in most cases, the rudder forces required to overcome the adverse aileron yaw were excessive and the rudder and aileron forces in steady sideslips fended to lighten at the higher sideslip angles. Typical frequency-response characteristics of the airplane are also presented for those interested in automatic stabilization.

NACA TN 3091

FLOW PROPERTIES OF STRONG SHOCK WAVES IN XENON GAS AS DETERMINED FOR THERMAL EQUILIBRIUM CONDITIONS. Alexander P. Sabol. December 1953. 29p. diagrs., photos., 2 tabs. (NACA TN 3091)

The results of calculations are presented for the purpose of showing the effects of ionization and electronic excitation on the flow properties of one dimensional shock waves in xenon gas. The calculations use statistical-mechanics theory with the assumption that thermal equilibrium exists at all points in the flow. The calculations are made by both including and neglecting the effects of electronic excitation, and the results of the calculations are qualitatively compared with available experimental data.

NACA TN 3092

HYDRODYNAMIC DRAG OF 12- AND 21-PERCENT-THICK SURFACE-PIERCING STRUTS. Claude W. Coffee, Jr. and Robert E. McKann. December 1953. 28p. diagrs., photos., tab. (NACA TN 3092)

An investigation has been made to determine the hydrodynamic drag of three surface-piercing untapered struts at approximately 0° angle of yaw at depths up to 6 chords for speeds up to 80 fps at various angles of rake. Two struts had NACA 66_1-012 airfoil sections, one with a 4-inch chord and the other with an 8-inch chord. The third strut had an NACA 66_4-021 airfoil section and a 4-inch chord.

NACA TN 3094

THE RESISTANCE TO AIR FLOW OF POROUS MATERIALS SUITABLE FOR BOUNDARY-LAYER-CONTROL APPLICATIONS USING AREA SUCTION. Robert E. Dannenberg, James A. Weiberg and Bruno J. Gambucci. January 1954. 21p. diagrs., photos., tab. (NACA TN 3094)

Measurements have been made of resistance to air flow of commercially available porous materials. Three general types of porous media were tested - granular (sintered metals), fibrous (felt cloths and filter papers), and perforated. The flow-resistance characteristics were ascertained over a wide range of differential pressures across the material. The flow resistance of one of the materials was determined for various values of air pressure at the upstream face of the material.

NACA TN 3114

ANALYSIS OF MULTICELL DELTA WINGS ON CAL-TECH ANALOG COMPUTER. Richard H. MacNeal and Stanley U. Benscoter, California Institute of Technology. December 1953. 84p. diagrs., 6 tabs. (NACA TN 3114)

Using the Cal-Tech analog computer, structural analyses have been made of two delta wings with 45° leading edges. One of these has a constant-depth rectangular cross section and the other has a biconvex cross section that is linearly tapered in the spanwise direction. The wings extend through the fuselage and are rigidly supported along two lines at the faces of the fuselage. Deflections and all internal forces have been calculated for concentrated static loads. Vibration modes are also presented. The effects of neglecting shearing strains in the ribs and spars and also of assuming the ribs to be rigid have been investigated by modifying the electric circuits to correspond to these simplifications.

NACA RM E53I29

EFFECTS OF ADDITIVES ON PRESSURE LIMITS OF FLAME PROPAGATION OF PROPANE-AIR MIXTURES. Frank E. Belles and Dorothy M. Simon. December 1953. 36p. diagrs., tab. (NACA RM E53I29)

Seven additives in 0.5-volume-percent concentration were studied for their effects on the low-pressure limits of flame propagation of propane-air mixtures. The limits were measured in a flame tube of new design. Mixtures containing approximately 2 to 8 percent propane by volume were studied. The limit curves were without lobes on the rich side and were closely related to quenching-distance data measured by the flash-back of a Bunsen flame. The data were analyzed by means of the experimental curves and the Le Chatelier law governing the flammability limits of mixed fuels. Ethyl nitrate and chloropicrin were found to be definite promoters of flame propagation in rich mixtures. Chloropicrin and methyl bromide inhibited propagation in lean mixtures; it was concluded that the effect is chemical and that these additives do not act merely as inert gases. None of the additives promoted flame propagation in lean mixtures more than could be explained by the contribution of the additive to the total fuel in the mixture. Methyl bromide increased the minimum pressure for flame propagation and was the only additive that had an appreciable effect on the minimum. Carbon disulfide had a large inhibitory effect on flame propagation in lean mixtures, as defined by deviations from the requirements of Le Chatelier's law.

BRITISH REPORTS

N-27317*

Royal Aircraft Establishment (Gt. Brit.)
STRENGTH DATA ON CIRCULAR METAL CYLINDERS UNDER AXIAL COMPRESSION. J. H. Shelley. August 1953. 87p. diagrs., photos., 3 tabs. (RAE Tech. Note Structures 122)

Failure of circular metal cylinders under axial compression is examined empirically for the practical range of the wall thickness/radius ratio. The cylinders considered are those of length such that end conditions do not have an appreciable effect upon

failure, but not long enough to fail as Euler struts. The paper is based on experimental results given in 15 separate publications, and covers wide ranges of material specifications, manufacturing methods, testing procedures, and specimen sizes. The design proposals submitted use as far as practicable the formulas suggested by other authors, and are compared with the experimental results obtained for 381 steel and 143 aluminum alloy specimens over the full range of t/R.

MISCELLANEOUS

NACA Rept. 1096

Errata No. 1 on "EXPERIMENTAL DETERMINATION OF THE EFFECT OF HORIZONTAL-TAIL SIZE, TAIL LENGTH, AND VERTICAL LOCATION ON LOW-SPEED STATIC LONGITUDINAL STABILITY AND DAMPING IN PITCH OF A MODEL HAVING 45° SWEPTBACK WING AND TAIL SURFACES." Jacob H. Lichtenstein. 1952.

NACA Rept. 1099

Errata No. 1 on "AIR FORCES AND MOMENTS ON TRIANGULAR AND RELATED WINGS WITH SUBSONIC LEADING EDGES OSCILLATING IN SUPERSONIC POTENTIAL FLOW." Charles E. Watkins and Julian H. Berman. 1952.

NACA Rept. 1103

Errata No. 1 on "GENERALIZED THEORY FOR SEAPLANE IMPACT." Benjamin Milwitzky. 1952.

N-27631

Advisory Group for Aeronautical Research and Development. SPECIFICATIONS FOR AGARD WIND TUNNEL CALIBRATION MODELS. (Presented at Rome AGARD conference, December 16-17, 1952) 4p. diagrs. (Advisory Group for Aeronautical Research and Development. AG4/M3)

Two standard wind-tunnel models accepted by the AGARD are described. One is the NACA RM-10 on which considerable data are available immediately. The RM-10 is designated as AGARD calibration model A. The other, AGARD calibration model B, is a new configuration consisting of a body-wing combination. The wing is a delta wing with a span four times the body diameter. The wing consists of an equilateral triangle with a symmetrical circular-arc section. The body is a body of revolution.

DECLASSIFIED NACA REPORTS

THE FOLLOWING REPORTS HAVE BEEN DECLASSIFIED FROM RESTRICTED TO UNCLASSIFIED, 12/11/53.

NACA RM 51B05

PROPERTIES OF LOW-CARBON N-155 ALLOY BAR STOCK FROM 1200° TO 1800° F. J. W. Freeman and A. E. White, University of Michigan. May 3, 1951. 103p. diagrs., photos., 21 tabs. (NACA RM 51B05)

Results are presented of an investigation undertaken to establish rupture and total-deformation strengths ("design" data) at 1200° to 1800° F for typical commercial treatments of low-carbon N-155 alloy. Rupture data are given for bar stock from two heats at 1200°, 1350°, and 1500° F and for one of the heats at 1650° and 1800° F in several conditions of prior treatment. Because the variation between heats indicated that the data would be of questionable value as typical design data, the work was stopped with data on stress and time for total deformation somewhat incomplete and with very little duplication between the two heats.

NACA RM 51D20

REVIEW OF CURRENT AND ANTICIPATED LUBRICANT PROBLEMS IN TURBOJET ENGINES. NACA Subcommittee on Lubrication and Wear. Appendix A: THE DEVELOPMENT OF LUBRICANTS FOR EXTREME TEMPERATURE OPERATIONS FOR CURRENT AND PROJECTED TURBINE-POWERED AIRCRAFT ENGINES. C. M. Murphy and W. A. Zisman. Appendix B: AIRCRAFT TURBINE LUBRICANTS FOR MILITARY USE. C. C. Singleterry. Appendix C: BEARING PROBLEMS IN CURRENT AND PROJECTED TURBO POWER PLANT. C. J. McDowall. Appendix D: INVESTIGATIONS OF ROLLING BEARINGS AT SKF INDUSTRIES, INC. H. Styri. Appendix E: LUBRICANTS FOR OPERATION OF AIRCRAFT GAS TURBINE ENGINES OVER WIDE TEMPERATURE RANGES. NACA Lewis Flight Propulsion Laboratory Staff. April 20, 1951. 46p. diagrs., 4 tabs. (NACA RM 51D20)

Present and future lubricants for aircraft gas-turbine engines using rolling contact bearings must meet operating requirements of fludity, lubricity, volatility, and stability over bearing operating temperature regions of (1) -65° to 350° F (current), (2) -65° to 500° F, and (3) -65° to 750° F. The most promising lubricants for these temperature ranges involve the use of synthetics (that is, aliphatic diesters) in whole or in part.

NACA RM 53B19

WEIGHT BAR CHARTS. B. J. Saelman and H. W. Vick, Lockheed Aircraft Corporation. June 1953. 62p. diagrs., tab. (NACA RM 53B19)

The weight breakdowns in bar chart form in the present report have been prepared to give an indication of "how we spend our weight." They are expected to focus attention on the design functions that warrant weight reduction activity on future models.

NACA RM A50A04a

CHORDWISE AND SPANWISE LOADINGS MEASURED AT LOW SPEEDS ON A LARGE TRIANGULAR WING HAVING AN ASPECT RATIO OF 2 AND A THIN, SUBSONIC-TYPE AIRFOIL SECTION. David Graham. March 13, 1950. 55p. diagrs., photo., 2 tabs. (NACA RM A50A04a)

Pressure data have been obtained on a large triangular wing having an aspect ratio of 2 and a modified NACA 0005 section. The data were obtained at zero angle of sideslip through an angle-of-attack range from zero lift through the stall with three deflections of a trailing-edge flap. Chordwise pressure distributions, section lift characteristics, section centers of pressure, and span load distribution are presented. The tests were conducted at a dynamic pressure of 25 pounds per square foot resulting in a Reynolds number, based on the mean aerodynamic chord, of 15.3×10^6. The Mach number was 0.13.

NACA RM A50A10

EFFECTS OF TWIST AND CAMBER ON THE LOW-SPEED CHARACTERISTICS OF A LARGE-SCALE 45° SWEPT-BACK WING. Lynn W. Hunton. March 20, 1950. 32p. diagrs., photos., tab. (NACA RM A50A10)

Tests were made of a large-scale, semispan, swept-back, wing-fuselage model cambered and twisted for an ideal lift coefficient of 0.4 and of a similar model but having no camber and no twist. The 0.25 chord lines of the wings were swept back 45° and the wings had an aspect ratio of 6.0 and a taper ratio of 0.5. The aerodynamic characteristics, span loading, and tuft-study results for the models are presented for a Reynolds number of 8 million at a Mach number of 0.2. Predicted results from available theoretical methods are compared with the experimental data.

NACA RM A50B13

PRESSURE COEFFICIENTS AT MACH NUMBERS FROM 0.60 TO 0.85 FOR A SEMISPAN WING WITH NACA 0012-64 SECTION, 20-PERCENT-CHORD PLAIN AILERON, AND 0° AND 45° SWEEPBACK. Walter J. Krumm. April 19, 1950. 36p. diagrs., 30 tabs. (NACA RM A50B13)

The pressure measurements obtained during tests of a semispan wing having the NACA 0012-64 section are presented as coefficients. The measurements were made at Mach numbers from 0.60 to 0.85 for the wing with 0° and with 45° sweepback and with a 20-percent-chord, plain, trailing-edge aileron.

NACA RM A50E09

THE EFFECTS OF COMPRESSIBILITY ON THE PRESSURES ON A BODY OF REVOLUTION AND ON THE AERODYNAMIC CHARACTERISTICS OF A WING-NACELLE COMBINATION CONSISTING OF THE BODY OF REVOLUTION MOUNTED ON A SWEPT-BACK WING. Frederick W. Boltz and Benjamin H. Beam. July 26, 1950. 68p. diagrs., photos., 2 tabs. (NACA RM A50E09)

Results of wind-tunnel tests are presented for a semispan model of a wing-nacelle combination and for an isolated body of revolution similar to the nacelle. The wing had the leading edge swept back 37.25°, an aspect ratio of 6.04, a taper ratio of 0.5, zero twist, and NACA 64_1-212 sections. The simulated nacelle and the body of revolution each had a fineness ratio of 6.5. Lift, drag, pitching-moment, and pressure data for the wing-nacelle combination were obtained for Mach numbers from 0.18 to 0.92 at a Reynolds number of 2,000,000. Drag and pressure data were obtained for the isolated body of revolution for Mach numbers from 0.18 to 0.95 at a Reynolds number of 3,700,000.

NACA RM A50H17

HIGH-SPEED AERODYNAMIC CHARACTERISTICS OF A LATERAL-CONTROL MODEL. III - SECTION CHARACTERISTICS, FENCE STUDIES, AND TABULATED PRESSURE COEFFICIENTS WITH MODIFIED NACA 0012-64 SECTION, 26.6-PERCENT-CHORD, PLAIN AILERON, 0° AND 45° SWEEPBACK. Walter J. Krumm and Joseph W. Cleary. November 22, 1950. 79p. diagrs., photos., 4 tabs. (NACA RM A50H17)

The spanwise variations of section normal-force and pitching-moment coefficients were determined from wind-tunnel pressure-distribution measurements of a semispan wing with a modified NACA 0012-64 section and a 26.6-percent-chord plain aileron. Tests were made with the wing unswept and swept back 45° for Mach numbers covering the force-divergence range of the unswept wing. The effect of wing fences on the static longitudinal stability of the swept wing was investigated. Wing pressure coefficients are presented in tables.

NACA RM A50H23

WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF A JET-ENGINE NACELLE ON THE AERODYNAMIC CHARACTERISTICS OF A 37.25° SWEPTBACK WING AT HIGH SUBSONIC SPEEDS. Frederick W. Boltz and Donald A. Buell. October 24, 1950. 28p. diagrs., photos. (NACA RM A50H23)

This report presents results of wind-tunnel tests of a model of a jet-engine nacelle in combination with a wing having the leading edge swept back 37.25° and an aspect ratio of 6.04. The nacelle was mounted on the lower surface of the wing with the air inlet slightly behind the wing leading edge and normal to the nacelle axis. Lift, drag, pitching moment, and ram-recovery data are presented for Mach numbers from 0.18 to 0.92 at a constant Reynolds number of 2,000,000. Surface pressure data are presented for Mach numbers near that of drag divergence.

NACA RM A50J24

THE EFFECTS OF CAMBER AND TWIST ON THE AERODYNAMIC LOADING AND STALLING CHARACTERISTICS OF A LARGE-SCALE 45° SWEPT-BACK WING. Lynn W. Hunton and Joseph K. Dew. January 24, 1951. 40p. diagrs., photo., tab. (NACA RM A50J24)

Pressure-distribution measurements were obtained on a large-scale, semispan, sweptback, wing fuselage model cambered and twisted for a design lift coefficient of 0.4 and on a similar model having no camber and no twist. The wings had 45° sweepback of the quarter-chord line, an aspect ratio of 6.0, and a taper ratio of 0.5. Pressure distributions are presented from tests made at a Reynolds number of 8 million and a Mach number of 0.2. Stalling characteristics and spanwise distributions of local lift coefficient and local center of pressure are derived from the data. Theoretical span loadings are compared with the experimental results.

NACA RM A50K28a

THE EFFECTS OF INCREASING THE LEADING-EDGE RADIUS AND ADDING FORWARD CAMBER ON THE AERODYNAMIC CHARACTERISTICS OF A WING WITH 35° OF SWEEPBACK. Fred A. Demele and Fred B. Sutton. February 9, 1951. 27p. diagrs., photo., tab. (NACA RM A50K28a)

Presented in this report are results of an investigation of a sweptback wing which was modified by increasing the leading-edge radius and introducing a small amount of camber over the forward portion of the chord. The wing had 35° of sweepback at the quarter-chord line, and an aspect ratio of 4.5. The original wing section was the NACA 64A010 normal to the quarter-chord line. Aerodynamic characteristics are presented for Reynolds numbers from 2,000,000 to 11,000,000 at a Mach number of 0.21 and for Mach numbers from 0.21 to 0.94 at a Reynolds number of 2,000,000. A comparison is made with results of an investigation of the unmodified wing.

NACA RM A51C12a

INFLUENCE OF AIRFOIL TRAILING-EDGE ANGLE AND TRAILING-EDGE-THICKNESS VARIATION ON THE EFFECTIVENESS OF A PLAIN FLAP AT HIGH SUBSONIC MACH NUMBERS. Albert D. Hemenover and Donald J. Graham. May 22, 1951. 103p. diagrs., photos., 5 tabs. (NACA RM A51C12a)

The effects of variation of trailing-edge angle and trailing-edge thickness on the characteristics of a 10-percent-chord thick NACA airfoil section with a 25-percent-chord plain flap are appraised from wind-tunnel tests at Mach numbers from 0.3 to 0.9 and Reynolds numbers varying correspondingly from 1 to 2 million. The airfoil trailing-edge angle was varied from 18° to 6°, and the trailing-edge thickness from zero to the thickness at the flap hinge line.

NACA RM A51D02

INVESTIGATION IN THE AMES 12-FOOT PRESSURE WIND TUNNEL OF A MODEL HORIZONTAL TAIL OF ASPECT RATIO 3 AND TAPER RATIO 0.5 HAVING THE QUARTER-CHORD LINE SWEPT BACK 45°. Carl D. Kolbe and Angelo Bandettini. June 25, 1951. 97p. diagrs., photo., 2 tabs. (NACA RM A51D02)

The airfoil section of the model of a horizontal tail was the NACA 64A010 in planes inclined 45° to the plane of symmetry. The test Reynolds number was varied from 2,000,000 to 18,000,000 at a Mach number of 0.25 and the Mach number was varied from 0.25 to 0.94 at Reynolds numbers of 2,000,000 and 4,000,000. Lift, drag, pitching moment, hinge moment, and the pressure difference across the elevator-nose seal are reported.

NACA RM A51D18

EFFECTS OF DOUBLE-SLOTTED FLAPS AND LEADING-EDGE MODIFICATIONS ON THE LOW-SPEED CHARACTERISTICS OF A LARGE-SCALE 45° SWEPT-BACK WING WITH AND WITHOUT CAMBER AND TWIST. Harry A. James and Joseph K. Dew. July 1951. 37p. diagrs., photo., 3 tabs. (NACA RM A51D18)

Tests were made on two large-scale, semispan, wing-fuselage models swept back 45° (aspect ratio 6.0, taper ratio 0.5) equipped with partial-span, double-slotted flaps and various leading-edge modifications. One wing was cambered and twisted for a design lift coefficient of 0.4; the other wing had no camber and no twist. The lift, drag, and pitching-moment characteristics were determined at a Reynolds number of 8 million. Theoretical predictions of lift increment due to flaps and the lift at which flow separation first occurred are compared with experiment.

NACA RM A51E29

LOW-SPEED CHARACTERISTICS OF A 45° SWEPT WING WITH LEADING-EDGE INLETS. Robert E. Dannenberg. August 1951. 48p. diagrs., photos., tab. (NACA RM A51E29)

Pressure-distribution and wake measurements were made to determine the effect of leading-edge inlets on the low-speed aerodynamic characteristics of a 45° swept wing that completely spanned the wind tunnel. The inlets extended over approximately the central third of the span of the wing and varied in entrance height from 15 to 50 percent of the wing thickness. The section characteristics were obtained for a wide range of angles of attack and inlet-velocity ratios.

NACA RM A51G31

THE FORCES AND PRESSURE DISTRIBUTION AT SUBSONIC SPEEDS ON A PLANE WING HAVING 45° OF SWEEPBACK, AN ASPECT RATIO OF 3, AND A TAPER RATIO OF 0.5. Carl D. Kolbe and Frederick W. Boltz. October 1951. 159p. diagrs., photo., 22 tabs. (NACA RM A51G31)

Lift, drag, pitching-moment, and static-pressure data for a model of a plane wing having an aspect ratio of 3 and a taper ratio of 0.5 are reported. The line joining the quarter-chord points of the airfoil sections was swept back 45°. The airfoil sections were the NACA 64A010 in planes inclined 45° to the plane of symmetry. Data are presented for Reynolds numbers from 4,000,000 to 18,000,000 at a Mach number of 0.25 and for Mach numbers from 0.08 to 0.96 at a Reynolds number of 4,000,000. Also included are data at a Reynolds number of 8,000,000 for Mach numbers of 0.08, 0.25, and 0.60. The investigation included a study of the effect of various seals at the model-turntable juncture on the forces, moments, and pressure distribution on the model. Pressure data at seven spanwise stations on the model are presented in tabular form.

NACA RM A51G31a

SUMMARY OF RESULTS OF A WIND-TUNNEL INVESTIGATION OF NINE RELATED HORIZONTAL TAILS. Jules B. Dods, Jr. and Bruce E. Tinling. October 1951. 105p. diagrs., photos., 2 tabs. (NACA RM A51G31a)

A compilation of data is presented for models of nine related horizontal tails. The majority of the results were obtained at a Mach number of approximately 0.20. Three of the models were tested throughout the subsonic Mach number range to a maximum of 0.94. The Reynolds number range was from 2 to 4 million. The models had aspect ratios from 2 to 6, angles of sweepback from 5.7° to 45°, and had 30-percent-chord, sealed, plain flaps. The lift coefficient, hinge moment coefficient, and pressure coefficients across the elevator nose seal are presented. The effects of sweepback, aspect ratio, and Mach number on the lift and hinge-moment parameters are summarized. Comparisons of the experimental results with theoretical calculations are presented.

NACA RM A52A14a

LOW-SPEED AERODYNAMIC CHARACTERISTICS OF A LARGE-SCALE 60° SWEPT-BACK WING WITH HIGH LIFT DEVICES. Mark W. Kelly. March 1952. 54p. diagrs., photo., 7 tabs. (NACA RM A52A14a)

Tests were made in the Ames 40- by 80-foot wind tunnel of a 60° sweptback wing with fuselage and of the combination with various configurations of double-slotted flaps, split flaps, leading-edge slats, and ailerons. Lift, drag, pitching-moment, and rolling-moment data are presented as well as pressure distribution data over the slat, the wing, and flaps. The tests covered a Reynolds number range from 4.0×10^6 to 10.0×10^6. The use of double-slotted flaps and leading-edge slats extended the linear range of the pitching-moment curve from a lift coefficient of about 0.35 to a lift coefficient of about 0.88.

NACA RM A52B19

LOW-SPEED AERODYNAMIC CHARACTERISTICS OF A LARGE-SCALE 45° SWEPT-BACK WING WITH PARTIAL-SPAN SLATS, DOUBLE-SLOTTED FLAPS, AND AILERONS. Harry A. James. April 1952. 101p. diagrs., photos., 9 tabs. (NACA RM A52B19)

Tests were made in the Ames 40- by 80-foot wind tunnel of a 45° sweptback wing with fuselage in combination with various configurations of double-slotted flaps, leading-edge slats, and ailerons. Lift, drag, pitching-moment, and rolling-moment data are presented as well as pressure-distribution data over the slat, wing, and flaps. The tests covered a Reynolds number range from 2.5×10^6 to 8×10^6. The use of double-slotted flaps and leading-edge slats extended the near linear range of the pitching moment from a lift coefficient of about 0.76 to a lift coefficient of about 1.41.

NACA RM A52D01b

BOUNDARY-LAYER MEASUREMENTS ON SEVERAL POROUS MATERIALS WITH SUCTION APPLIED. George B. McCullough and Bruno J. Gambucci. June 1952. 26p. diagrs., photos., tab. (NACA RM A52D01b)

Boundary-layer velocity profiles were measured on several porous materials for a stream velocity of 165 feet per second with ratios of suction velocity to free-stream velocity from 0 to 0.0182. The measurements were made on the wall of a small wind tunnel in a region of nearly zero pressure gradient and in which transition from laminar to turbulent flow was occurring on the smooth impervious wall. The effects of surface roughness and suction velocity are shown.

NACA RM A52J08

DOWNWASH CHARACTERISTICS AND VORTEX-SHEET SHAPE BEHIND A 63° SWEPT-BACK WING-FUSELAGE COMBINATION AT REYNOLDS NUMBER OF 6.1×10^6. William H. Tolhurst, Jr. December 1952. 45p. diagrs., photo. (NACA RM A52J08)

The downwash characteristics and vortex-sheet shape have been experimentally determined for a 63° sweptback wing of aspect ratio 3.5 with a fuselage and with boundary-layer control on the wing to prevent separation. Downwash-angle contour maps are presented for nine vertical transverse planes located between 0.57 and 2.71 semispans aft of the 0.25 mean aerodynamic chord point for three angles of attack at a Reynolds number of 6.1×10^6. The shape of the vortex sheet is presented for the various survey planes and angles of attack. Theoretical and experimental downwash angles are compared.

NACA RM A53A14

EXPERIMENTAL AND THEORETICAL STUDY OF THE INTERFERENCE AT LOW SPEED BETWEEN SLENDER BODIES AND TRIANGULAR WINGS. Edward J. Hopkins and Hubert C. Carel. May 1953. 40p. diagrs., photos., tab. (NACA RM A53A14)

Measurements of the forces and moments were made at a Mach number of 0.25 for several geometrically similar triangular wings (aspect ratio, 2.0) in the presence of a slender body of revolution and for the wings combined with the body. The ratios of maximum body diameter to wing span were 0.196, 0.259, 0.343, and 0.500. Comparisons are made between the experimental results and results calculated by the method given in NACA RM A51G24 which employs the theories of Weissinger, Multhopp, and Lennertz.

NACA RM E50A04

APPLICATION OF BLADE COOLING TO GAS TURBINES. Herman H. Ellerbrock, Jr. and Louis J. Schafer, Jr. May 31, 1950. 102p. diagrs., photos. (NACA RM E50A04)

A review of current knowledge on turbine-blade cooling and a description of pertinent NACA investigations are presented. The gains, which can be obtained by operating turbojet and turbine-propeller engines at high gas temperatures, are shown. Analyses are presented, which give the performance possibilities of various methods of blade cooling as well as the possibility of using nonstrategic blade materials. Finally, the performance characteristics of cooled turbines and of engines using cooled turbines are briefly discussed.

NACA RM E50A05

PRELIMINARY ANALYSIS OF PROBLEM OF DETERMINING EXPERIMENTAL PERFORMANCE OF AIR-COOLED TURBINE. I - METHODS FOR DETERMINING HEAT-TRANSFER CHARACTERISTICS. Herman H. Ellerbrock, Jr. and Robert R. Ziemer. June 12, 1950. 48p. diagrs. (NACA RM E50A05)

In determining the experimental performance of an air-cooled turbine, the heat-transfer characteristics must be evaluated. The suggested formulas that are required to determine these characteristics are presented. The formulas have a form in which dependent parameters are expressed as unknown functions of independent parameters. Methods of experimenting to determine these functions are suggested. In some cases general heat-transfer discussions that lead to the suggested forms of the formulas are given.

NACA RM E50A06

PRELIMINARY ANALYSIS OF PROBLEM OF DETERMINING EXPERIMENTAL PERFORMANCE OF AIR-COOLED TURBINE. II - METHODS FOR DETERMINING COOLING-AIR-FLOW CHARACTERISTICS. Herman H. Ellerbrock, Jr. June 7, 1950. 20p. diagrs. (NACA RM E50A06)

In the determination of the performance of an air-cooled turbine, the cooling-air-flow characteristics between the root and the tip of the blades must be evaluated. The methods, which must be verified and the unknown functions evaluated, that are expected to permit the determination of pressure, temperature, and velocity through the blade cooling-air passages from specific investigations are presented.

NACA RM E50A31

ALTITUDE-CHAMBER PERFORMANCE OF BRITISH ROLLS-ROYCE NENE II ENGINE. III - 18.00-INCH-DIAMETER JET NOZZLE. Ralph E. Grey, Virginia L. Brightwell and Zelmar Barson. July 10, 1950. 60p. diagrs., 2 tabs. (NACA RM E50A31)

An altitude-chamber investigation of British Rolls-Royce Nene II turbojet engine was conducted over range of altitudes from sea level to 65,000 feet and ram pressure ratios from 1.10 to 3.50, using an 18.00-inch-diameter jet nozzle. The 18.00-inch-diameter jet nozzle gave slightly lower values of net-thrust specific fuel consumption than either the 18.41- or the standard 18.75-inch-diameter jet nozzles at high flight speeds. At low flight speeds, the 18.41-inch-diameter jet nozzle gave the lowest values of net-thrust specific fuel consumption.

NACA RM E50B10

ALTITUDE-CHAMBER PERFORMANCE OF BRITISH ROLLS-ROYCE NENE II ENGINE. IV - EFFECT OF OPERATIONAL VARIABLES ON TEMPERATURE DISTRIBUTION AT COMBUSTION-CHAMBER OUTLETS. Sidney C. Huntley. July 3, 1950. 17p. diagrs., photo. (NACA RM E50B10)

Temperature surveys were made at the combustion-chamber outlets of a British Rolls-Royce Nene II engine. The highest mean nozzle-vane and mean gas temperatures were found to occur at a radius approximately 75 percent of the nozzle-vane length from the inner ring of the nozzle-vane assembly. Variations in engine speed, jet-nozzle area, simulated altitude, and simulated flight speed altered the temperature level but did not materially affect the pattern of radial temperature distribution.

NACA RM E50C15

EFFECTS OF INLET ICING ON PERFORMANCE OF AXIAL-FLOW TURBOJET ENGINE IN NATURAL ICING CONDITIONS. Loren W. Acker and Kenneth S. Kleinknecht. May 25, 1950. 61p. diagrs., photos., tab. (NACA RM E50C15)

A flight investigation in natural icing conditions was conducted to determine the effect of inlet ice formations on the performance of axial-flow turbojet engines. The results are presented for icing conditions ranging from a liquid-water content of 0.1 to 0.9 gram per cubic meter and water-droplet size from 10 to 27 microns at ambient-air temperature from 13° to 26° F. The data show time histories of jet thrust, air flow, tail-pipe temperature, compressor efficiency, and icing parameters for each icing encounter. The effect of inlet-guide-vane icing was isolated and shown to account for approximately one-half the total reduction in performance caused by inlet icing.

NACA RM E50C28

COMPARISON OF OUTSIDE-SURFACE HEAT-TRANSFER COEFFICIENTS FOR CASCADES OF TURBINE BLADES. James E. Hubbartt. July 17, 1950. 30p. diagrs., tab. (NACA RM E50C28)

A comparison of available results from heat-transfer investigations on cascades of turbine blades is presented using the Nusselt equation. The conventional correlation procedure is modified by defining the Reynolds number by the average of the velocities and the pressures around the blades. The correlation of the results from impulse blades was improved by using the Reynolds number defined by the average velocity and pressure. The final comparison indicated that several variables, which possibly influence heat transfer, should be investigated.

NACA RM E50D03a

HEAT-TRANSFER AND OPERATING CHARACTERISTICS OF ALUMINUM FORCED-CONVECTION AND STAINLESS-STEEL NATURAL-CONVECTION WATER-COOLED SINGLE-STAGE TURBINES. John C. Freche and A. J. Diaguila. June 30, 1950. 48p. diagrs.. photo., 2 tabs. (NACA RM E50D03a)

Two water-cooled turbines were operated - one with blades and disk of aluminum alloy cooled by forced convection and the other with blades and disk of stainless steel cooled by natural convection. Heat-transfer data, coolant pumping power, and operational data, such as gas temperatures, coolant-flow rates, and blade temperatures, are presented. The heat-transfer results for both turbines agreed with those for static-cascade and stationary-tube investigations. Coolant pumping losses were not excessive and are further reducible by discharging the coolant at a smaller radius.

NACA RM E50D25

ANALYTICAL INVESTIGATION OF FLOW AND HEAT TRANSFER IN COOLANT PASSAGES OF FREE-CONVECTION LIQUID-COOLED TURBINES. E. R. G. Eckert and Thomas W. Jackson. July 18, 1950. 45p. diagrs. (NACA RM E50D25)

The theoretical aspect of the problem of free-convection liquid cooling of turbine blades was investigated using boundary-layer calculations. A method of improving the heat transfer in a hole with a small diameter-to-length ratio is described. Comparisons of theoretical equations with experimental results for a free-convection water-cooled turbine are made and the effect of Coriolis forces on the cooling effect is discussed.

NACA RM E50D27

PERFORMANCE OF 24-INCH SUPERSONIC AXIAL-FLOW COMPRESSOR IN AIR. III - COMPRESSOR PERFORMANCE WITH INLET GUIDE VANES. Melvin J. Hartmann and Edward R. Tysl. July 10, 1950. 15p. diagrs. (NACA RM E50D27)

The use of inlet guide vanes with the 24-inch supersonic compressor resulted in a decrease in maximum pressure ratio and adiabatic efficiency, and a slight increase in equivalent mass flow. The loss in total pressure and efficiency resulted from reduced diffusion in the rotor-blade passages, increased shock losses at the higher entrance Mach number, and increased boundary-layer thickness, separation, and transfer of mass flow toward the rotor hub. The unsteady flow field created at the compressor entrance by the guide-vane wakes is also responsible for some of the losses. This inherent loss will be encountered whenever inlet guide vanes are used with the shock-in-rotor type of supersonic compressor.

NACA RM E50E03

INVESTIGATION OF AERODYNAMIC AND ICING CHARACTERISTICS OF WATER-INERTIA-SEPARATION INLETS FOR TURBOJET ENGINES. Uwe von Glahn and Robert E. Blatz. July 26, 1950. 54p. diagrs., photos., 3 tabs. (NACA RM E50E03)

Aerodynamic and icing investigations of several internal water-inertia-separation inlets designed to prevent entrance of water into a turbojet engine in an icing condition are presented. Comparisons of total-pressure loss, mass flow, and icing characteristics are made. Complete icing protection of inlet guide vanes was not achieved. Approximately 8 percent of the volume of water entering the inlets remained in the air. For nonicing operation, total-pressure losses were comparable to those of direct-ram inlets. Under icing conditions, considerable total-pressure losses were obtained with inertia-separation inlets.

NACA RM E50E04

NUMERICAL SOLUTION OF EQUATIONS FOR ONE-DIMENSIONAL GAS FLOW IN ROTATING COOLANT PASSAGES. W. Byron Brown and Richard J. Rossbach. June 26, 1950. 119p. diagrs., tabs. (NACA RM E50E04)

In order to analyze the compressible flow in a blade coolant passage of an air-cooled gas turbine, a one-dimensional analysis was made including the combined effects of area change, wall friction, heat transfer, and rotation. The necessary numerical methods for the simultaneous solution of the resulting equations expressing the conservation of energy and momentum in differential form are presented. The solution of these equations can be greatly simplified with little loss in accuracy by employing constant mean values for the coefficients in the energy equation. Tables are presented in order to facilitate the required computations with the minimum of interpolation.

NACA RM E50E18

PRELIMINARY ANALYSIS OF PROBLEM OF DETERMINING EXPERIMENTAL PERFORMANCE OF AIR-COOLED TURBINE. III - METHODS FOR DETERMINING POWER AND EFFICIENCY. Herman H. Ellerbrock, Jr. and Robert R. Ziemer. August 2, 1950. 55p. diagrs. (NACA RM E50E18)

Suggested formulas are given for determining air-cooled turbine-performance characteristics, such as power and efficiency, as functions of certain parameters. These functions, generally being unknown, are determined from experimental data obtained from specific investigations. Special plotting methods for isolating the effect of each parameter are outlined.

NACA RM E50E22

PRELIMINARY ANALYSIS OF EFFECTS OF AIR COOLING TURBINE BLADES ON TURBOJET-ENGINE PERFORMANCE. Wilson B. Schramm, Alfred J. Nachtigall and Vernon L. Arne. August 2, 1950. 34p. diagrs., tab. (NACA RM E50E22)

The effects of turbine-blade cooling on engine performance were analytically investigated for a turbojet engine in which cooling air is bled from the engine compressor. The analysis was made for a constant turbine-inlet temperature and a range of altitudes to determine the minimum cooling requirements to permit substitution of nonstrategic materials in turbine blading. The results indicate that, for a constant inlet temperature, air cooling of the turbine blades increases the specific fuel consumption and decreases the thrust of the engine. The highest possible cooling effectiveness is desirable to minimize coolant weight flow and its effects on engine performance.

NACA RM E50F02

EXTENSION OF BOUNDARY-LAYER HEAT-TRANSFER THEORY TO COOLED TURBINE BLADES. W. Byron Brown and Patrick L. Donoughe. August 11, 1950. 51p. diagrs., tab. (NACA RM E50F02)

An equation for average heat transfer of a surface was derived when the boundary layer changed from laminar to turbulent. Influences on the heat transfer through a laminar boundary layer of Mach number, temperature ratio (gas temperature divided by wall temperature), and exponents of gas-property temperature relations were shown to be relatively small for air with Mach numbers less than 2 and temperature ratios between 1 and 4. Good agreement was obtained with experimental results from cylinders, an airfoil, and turbine blades.

NACA RM E50F05

EXPERIMENTAL AND ANALYTICAL STUDY OF BALANCED-DIAPHRAGM FUEL DISTRIBUTORS FOR GAS-TURBINE ENGINES. David M. Straight and Harold Gold. August 14, 1950. 62p. diagrs., photos. (NACA RM E50F05)

Eight possible fuel distributor arrangements for distributing fuel equally to a plurality of spray nozzles are presented and analyzed with emphasis on meeting fuel-system requirements of fuel-distribution accuracy, spray-nozzle pressure variations, and fuel-system pressures. The experimental performance of three distributors is discussed. Data are presented for a fuel distributor model distributing 19.5 to 862 pounds per hour of fuel to each of 10 spray nozzles with a maximum deviation of 3.3 percent from equal distribution. Methods for distributing wider ranges of fuel-flow rates are included.

NACA RM E50F09

ANALYTICAL DETERMINATION OF LOCAL SURFACE HEAT-TRANSFER COEFFICIENTS FOR COOLED TURBINE BLADES FROM MEASURED METAL TEMPERATURES. W. Byron Brown and Jack B. Esgar. August 11, 1950. 66p. diagrs. (NACA RM E50F09)

Analytical methods are presented for the determination of local values of outside and inside heat-transfer coefficients and effective gas temperatures by use of turbine-blade-temperature measurements. The methods are derived for a number of configurations that can be applied to typical cooled-turbine-blade shapes as well as to other types of heat-transfer apparatus.

NACA RM E50F14

EFFECT OF RETRACTABLE IGNITION PLUG ON PLUG FOULING BY CARBON DEPOSITS. Jerrold D. Wear and Theodore E. Locke. August 24, 1950. 25p. diagrs., photos. (NACA RM E50F14)

Investigations of ignition-plug fouling, starting, altitude combustion efficiencies, altitude operational limits, and combustor-outlet-temperature distribution with a retractable ignition plug and with a standard ignition plug were conducted. The retractable ignition plug did not become fouled when investigated with fuels and at engine conditions that did foul the standard plug. Starting, altitude combustion efficiencies, and altitude operational limits determined with the standard plug were unaffected by use of the retractable plug. A slightly improved temperature distribution was obtained with the retractable plug.

NACA RM E50G11

INVESTIGATION OF EFFECTS OF INLET-AIR VELOCITY DISTORTION ON PERFORMANCE OF TURBOJET ENGINE. E. William Conrad and Adam E. Sobolewski. September 13, 1950. 41p. diagrs., photos. (NACA RM E50G11)

To determine effect of nonuniform inlet-air velocities a full scale, axial-flow turbojet engine was investigated in Lewis altitude wind tunnel at altitudes from 20,000 to 50,000 feet, 0.21 flight Mach number and corrected engine speeds from 77.3 percent of rated speed to rated speed. Total-pressure variations as large as 103 pounds per square foot in radial direction and 90 pounds per square foot in circumferential direction at 30,000 feet were obtained. With the distortions investigated, net thrust varied between 0.95 and 1.03 of the thrust with uniform inlet-air distribution. Similarly the ratio of specific fuel consumption varied from 1.00 to 1.04. Within the range of this investigation, the effects of nonuniform inlet velocity were not serious for the engine investigated.

NACA RM E50G14

COMBUSTION EFFICIENCIES IN HYDROCARBON-AIR SYSTEMS AT REDUCED PRESSURES. Robert R. Hibbard, Isadore L. Drell, Allen J. Metzler and Adolph E. Spakowski. September 13, 1950. 12p. diagrs. (NACA RM E50G14)

In preliminary results obtained with quiescent fuel-air mixtures and with small diffusion flames, combustion efficiencies close to 100-percent were obtained at pressures much lower than those found in turbojet combustors at 60,000-foot altitude; in general, efficiencies were high at pressures approaching the limiting values for inflammation. Apparently, it is possible to burn flames with high efficiency at high altitudes if sufficient volume is available and undesired quenching processes do not occur. The reaction-zone volume required to effect a given rate of heat release rapidly increased with a decrease in pressure. It appears, however, that only a small fraction of the volume available in a turbojet combustor is required to effect the engine's design rate of heat release.

NACA RM E50I04

EXPERIMENTAL INVESTIGATION OF AIR-COOLED TURBINE BLADES IN TURBOJET ENGINE. I - ROTOR BLADES WITH 10 TUBES IN COOLING-AIR PASSAGES. Herman H. Ellerbrock, Jr. and Francis S. Stepka. December 12, 1950. 76p. diagrs., photos., 2 tabs. (NACA RM E50I04)

The experimental results of air cooling turbine blades are presented herein. A method was developed for predicting cooled-blade temperatures by use of a temperature-difference ratio defined as φ and a calculated value of the solid-uncooled-blade temperature. By the use of this method predictions were made of the allowable turbine-inlet temperatures that may be attained with air cooling of turbine blades.

NACA RM E50I14

EXPERIMENTAL INVESTIGATION OF AIR-COOLED TURBINE BLADES IN TURBOJET ENGINE. II - ROTOR BLADES WITH 15 FINS IN COOLING-AIR PASSAGES. Robert O. Hickel and Herman H. Ellerbrock, Jr. November 20, 1950. 56p. diagrs., photos., 3 tabs. (NACA RM E50I14)

A turbine-blade-cooling investigation was conducted on a modified production turbojet engine to determine experimentally the cooling effectiveness of a cooled blade with 15 fins inserted in the hollow blade shell. The results showed that the 15-fin blade cooled very well at the midchord, but that the leading and trailing edges were considerably hotter. The 15-fin blade showed increased cooling effectiveness, particularly near the midchord, over that of a blade with 10 tubes inserted in the blade shell investigated earlier.

NACA RM E50I15

ALTITUDE PERFORMANCE OF J35-A-17 TURBOJET ENGINE IN AN ALTITUDE CHAMBER. K. R. Vincent and B. M. Gale. January 3, 1951. 53p. diagrs., 3 tabs. (NACA RM E50I15)

Simulated flight performance of a J35-A-17 turbojet engine in an altitude chamber is presented for range of altitudes from 20,000 to 30,000 feet at flight Mach number of 0.62 and for range of flight Mach numbers from 0.42 to 1.22 at altitude of 30,000 feet. Performance variables jet thrust, net thrust, air flow, fuel flow, net-thrust specific fuel consumption, and tail-pipe total gas temperature are presented as functions of engine speed. Engine performance generalized for altitudes up to 30,000 feet and for flight Mach numbers at which critical flow exists in exhaust nozzle with the exception of corrected net thrust and net thrust specific fuel consumption.

NACA RM E50J06

EXPERIMENTAL INVESTIGATION OF AIR-COOLED TURBINE BLADES IN TURBOJET ENGINE. III - ROTOR BLADES WITH 34 STEEL TUBES IN COOLING-AIR PASSAGES. Robert O. Hickel and Gordon T. Smith. December 11, 1950. 39p. diagrs., photos., 2 tabs. (NACA RM E50J06)

An experimental investigation to determine the cooling effectiveness of air-cooled turbine blades with 34 steel tubes inserted in the blade shell was made in a production turbojet engine over a range of engine speeds from 4000 to 9000 rpm and coolant flows from about 0.005 to 0.125 pound per second per blade. Results showed that only a limited increase, if any, in cooling effectiveness was obtained with the 34-tube blade over that of the 10-tube and 15-fin blades, which were previously investigated.

NACA RM E50J23

DETERMINATION OF GAS-TO-BLADE CONVECTION HEAT-TRANSFER COEFFICIENTS ON A FORCED-CONVECTION, WATER-COOLED SINGLE-STAGE ALUMINUM TURBINE. John C. Freche and Eugene F. Schum. January 3, 1951. 17p. diagrs., tab. (NACA RM E50J23)

Gas-to-blade convection heat-transfer coefficients were obtained on a forced-convection, water-cooled, single-stage aluminum turbine over a range of gas-flow Reynolds numbers, inlet-gas temperatures, and at several computed gas-flow inlet angles. The convection coefficients were correlated by the conventional Nusselt equation. Individual correlation curves were obtained for each gas-flow inlet angle. Comparison of the correlation curve obtained at the design gas-flow inlet angle with static-cascade results and with gas-to-blade heat-transfer results computed by boundary-layer theory showed close agreement.

NACA RM E50K01

INVESTIGATIONS OF SLOT CONFIGURATIONS FOR FILM-COOLED TURBINE BLADES BY FLOW VISUALIZATION METHODS. E. R. G. Eckert, Thomas W. Jackson and Allen C. Francisco. January 12, 1951. 57p. diagrs., photos. (NACA RM E50K01)

Two visual methods of obtaining qualitative information on the effectiveness of different slot configurations used to distribute cooling air around turbine blades are discussed. One method indicates the coolant coverage of the blade by means of a paint which changes its color under the influence of ammonia mixed with the cooling air. The other method makes the cooling air visible by mixing smoke with it. Cooling films generated by rows of cooling holes flush to the blade surface, rows of holes ending in grooves, and slots were studied.

NACA RM E50K10

EXPERIMENTAL INVESTIGATION OF EFFECTS OF DESIGN CHANGES ON PERFORMANCE OF LARGE-CAPACITY CENTRIFUGAL COMPRESSORS. Joseph R. Withee, Jr., Karl Kovach and Ambrose Ginsburg. March 2, 1951. 35p diagrs., photos., tab. (NACA RM E50K10)

An investigation was conducted to determine the effects of several design changes on the performance of large-capacity, double-entry, centrifugal compressors. Design changes that resulted in major improvements in performance were the use of a fully machined parabolic-blade inducer, increased impeller inlet-to-tip radius ratio, and a fully machined diffuser.

NACA RM E50K15

SURVEY OF ADVANTAGES AND PROBLEMS ASSOCIATED WITH TRANSPIRATION COOLING AND FILM COOLING OF GAS-TURBINE BLADES. E. R. G. Eckert and Jack B. Esgar. February 12, 1951. 39p. diagrs. (NACA RM E50K15)

An introduction to transpiration and film cooling methods as applied to gas-turbine blades is presented. The physical processes of these cooling methods are explained and information available for prediction of blade temperatures and heat-transfer rates is surveyed.

NACA RM E50L07

THERMAL CONDUCTIVITY OF 14 METALS AND ALLOYS UP TO 1100°F. Jerry E. Evans, Jr. March 2, 1951. 15p. diagrs., tab. (NACA RM E50L07)

The thermal conductivity of 14 metals and alloys was determined in temperature ranges having a maximum of 1100° F. The metals tested include steels, high-temperature alloys, molybdenum disilicide, aluminum alloys, brass, and silver. A comparison method was used to obtain the results in which the thermal conductivity of the test sample was compared with the conductivity of high-purity lead.

NACA RM E50L20

AVERAGE OUTSIDE-SURFACE HEAT-TRANSFER COEFFICIENTS AND VELOCITY DISTRIBUTIONS FOR HEATED AND COOLED IMPULSE TURBINE BLADES IN STATIC CASCADES. James E. Hubbartt and Eugene F. Schum. March 9, 1951. 35p. diagrs., photos. (NACA RM E50L20)

Gas-to-blade and blade-to-gas convective heat-transfer coefficients were experimentally obtained from a static cascade of impulse blades that could be heated or cooled. Blade peripheral velocities were measured and compared with calculated velocities obtained from a theory derived for impulse-type blades. The convective coefficients were correlated by the conventional Nusselt equation wherein Reynolds number was multiplied by a gas-to-blade temperature ratio. Blade peripheral calculated velocities were approximately 20 percent lower than measured velocities. Comparison of correlated curves for the heated and cooled blade with heat-transfer results computed by boundary-layer theory showed agreement within 4 percent at high experimental values of Reynolds number and 23 percent at low values.

NACA RM E51A03

A SUMMARY OF DESIGN INFORMATION FOR WATER-COOLED TURBINES. John C. Freche. March 9, 1951. 26p. diagrs. (NACA RM E51A03)

Information pertinent to the design of water-cooled turbines is tabulated. A design procedure is outlined. Calculation methods, design, fabrication, material, and operating considerations required for water-cooled turbine design are discussed.

NACA RM E51A19

EXPERIMENTAL INVESTIGATION OF AIR-COOLED TURBINE BLADES IN TURBOJET ENGINE. IV - EFFECTS OF SPECIAL LEADING- AND TRAILING-EDGE MODIFICATIONS ON BLADE TEMPERATURE. Herman H. Ellerbrock, Jr., Charles F. Zalabak and Gordon T. Smith. April 13, 1951. 71p. diagrs., photos., 3 tabs. (NACA RM E51A19)

Six air-cooled blade configurations with special modifications for cooling the leading and trailing edges were fabricated and experimentally investigated in a production turbojet engine. Results of this investigation are presented and compared with results obtained from blade configurations previously investigated. The most promising of these blade designs may operate satisfactorily when fabricated of nonstrategic material at present turbine-inlet gas temperatures. General considerations necessary for cooled-blade design are discussed.

NACA RM E51A22

EXPERIMENTAL INVESTIGATION OF AIR-COOLED TURBINE BLADES IN TURBOJET ENGINE. V - ROTOR BLADES WITH SPLIT TRAILING EDGES. Gordon T. Smith and Robert O. Hickel. April 2, 1951. 17p. diagrs., tab. (NACA RM E51A22)

An air-cooled turbine-blade configuration with special provision for cooling the trailing edge by passing cooling air through a series of radial slots was investigated. The results of this investigation are presented and compared to the results obtained from other blade configurations previously investigated.

NACA RM E51C09

EFFECT OF BLADE-SURFACE FINISH ON PERFORMANCE OF A SINGLE-STAGE AXIAL-FLOW COMPRESSOR. Jason J. Moses and George K. Serovy. April 16, 1951. 25p. diagrs., photos., 2 tabs. (NACA RM E51C09)

A set of modified NACA 5509-34 rotor and stator blades was investigated with rough-machined, hand-filed, and highly polished surface finishes over a range of weight flows at six equivalent tip speeds from 672 to 1092 feet per second to determine the effect of blade-surface finish on the performance of a single-stage axial-flow compressor. Surface-finish effects decreased with increasing compressor speed and with decreasing flow at a given speed. In general, finishing blade surfaces below the roughness that may be considered aerodynamically smooth on the basis of an admissible-roughness formula will have no effect on compressor performance.

NACA RM E51C29

EXPERIMENTAL INVESTIGATION OF AIR-COOLED TURBINE BLADES IN TURBOJET ENGINE. VI - CONDUCTION AND FILM COOLING OF LEADING AND TRAILING EDGES OF ROTOR BLADES. Vernon L. Arne and Jack B. Esgar. May 18, 1951. 51p. diagrs., 3 tabs. (NACA RM E51C29)

A turbine-blade-cooling investigation was conducted on a modified commercial turbojet engine to determine experimentally the cooling and pressure-drop characteristics of a copper-clad conduction-cooled blade and three variations of a film-cooled blade. The copper-clad blade had very low temperature gradients combined with structural rigidity. All the film-cooled blades had high leading- and trailing-edge cooling effectiveness at high cooling-air flows, but the effectiveness tended to decrease rapidly as cooling-air flow was reduced below some critical value.

NACA RM E51D12

PRELIMINARY STUDY OF CIRCULATION IN AN APPARATUS SUITABLE FOR DETERMINING CORROSIVE EFFECTS OF HOT FLOWING LIQUIDS. Leland G. Desmon and Don R. Mosher. June 1951. 17p. diagrs., photos. (NACA RM E51D12)

A simple apparatus for inducing flow of a liquid medium in toroidal shaped channels is described. No pumps, valves or flow meters are required. The apparàtus is particularly applicable to the determination of the corrosive effects of flowing liquid metals on structural materials. Preliminary tests, wherein fluid velocities of 25 feet per second were obtained, are described.

NACA RM E51E07

SOME EFFECTS OF SOLIDITY ON TURNING THROUGH CONSTANT-THICKNESS CIRCULAR-ARC GUIDE VANES IN AXIAL ANNULAR FLOW. Harry Mankuta and Donald C. Guentert. August 1951. 19p. diagrs. (NACA RM E51E07)

An investigation was conducted on sheet-metal, circular arc compressor inlet guide vanes in an annular cascade with untapered walls to determine the effect of solidity on turning through a blade row. Guide vanes of 30° and 40° camber were investigated over a range of solidity from 0.5 to 4.0. An equation similar in form to Constant's rule that may be used to predict turning angles in cascades of configuration similar to that of this investigation was obtained from the data. Surveys made downstream of the guide vanes indicated that lower solidities than those presently used may be employed without exceeding loading limitations.

NACA RM E51E18

DETERMINATION OF BLADE-TO-COOLANT HEAT-TRANSFER COEFFICIENTS ON A FORCED-CONVECTION, WATER-COOLED, SINGLE-STAGE TURBINE. John C. Freche and Eugene F. Schum. July 1951. 25p. diagrs., 2 tabs. (NACA RM E51E18)

Blade-to-coolant convective heat-transfer coefficients were obtained on a forced-convection water-cooled single-stage turbine over a large laminar flow range and over a portion of the transition range between laminar and turbulent flow. The convective coefficients were correlated by the general relation for forced-convection heat transfer with laminar flow. Natural-convection heat transfer was negligible for this turbine over the Grashof number range investigated. Comparison of turbine data with stationary tube data for the laminar flow of heated liquids showed good agreement. Calculated average midspan blade temperatures using theoretical gas-to-blade coefficients and blade-to-coolant coefficients from stationary-tube data resulted in close agreement with experimental data.

NACA RM E51E21

EVALUATION OF CENTRIFUGAL COMPRESSOR PERFORMANCE WITH WATER INJECTION. William L. Beede, Joseph T. Hamrick and Joseph R. Withee, Jr. July 1951. 14p. diagrs. (NACA RM E51E21)

The effects of water injection on a compressor are presented. To determine the effects of varying water-air ratio, the compressor was operated at a constant equivalent impeller speed over a range of water-air ratios and weight flows. Operation over a range of weight flows at one water-air ratio and two inlet air temperatures was carried out to obtain an indication of the effects of varying inlet air temperature. Beyond a water-air ratio of 0.03 there was no increase in maximum air-weight flow, a negligible rise in peak total-pressure ratio, and a decrease in peak adiabatic efficiency. An increase in inlet air temperature resulted in an increase in the magnitude of evaporation. An analysis of data indicated that the magnitude of evaporation within the compressor impeller was small.

NACA RM E51E23

EXPERIMENTAL INVESTIGATION OF AIR-COOLED TURBINE BLADES IN TURBOJET ENGINE. VII - ROTOR-BLADE FABRICATION PROCEDURES. Roger A. Long and Jack B. Esgar. September 1951. 30p. diagrs., photos. (NACA RM E51E23)

Fabrication procedures for a variety of air-cooled turbine-blade configurations, which were used in experimental investigations to determine the effectiveness of air-cooled blades in a turbojet engine, are presented. The blade shells were cast or formed from sheet metal or tubes. Additional heat-transfer surface was provided in the coolant passage by brazing fins or small tubes to the blade shell. Fabrication of blades with special methods of cooling leading and trailing edges is also discussed.

NACA RM E51E24

CALCULATED EFFECTS OF TURBINE ROTOR-BLADE COOLING-AIR FLOW, ALTITUDE, AND COMPRESSOR BLEED POINT ON PERFORMANCE OF A TURBOJET ENGINE. Vernon L. Arne and Alfred J. Nachtigall. August 1951. 24p. diagrs., 2 tabs. (NACA RM E51E24)

Effects of air-cooling turbine rotor blades on performance of a turbojet engine were calculated for a range of altitudes from sea level to 40,000 feet and a range of coolant flows up to 3 percent of compressor air flow, for two conditions of coolant bleed from the compressor. Bleeding at required coolant pressure resulted in a sea-level thrust reduction approximately twice the percentage coolant flow and in an increase in specific fuel consumption approximately equal to percentage coolant flow. For any fixed value of coolant flow ratio the percentage thrust reduction and percentage increase in specific fuel consumption decreased with altitude. Bleeding coolant at the compressor discharge resulted in an additional 1 percent loss in performance at sea level and in smaller increase in loss of performance at higher altitudes.

NACA RM E51F04

ANALYTICAL INVESTIGATION OF TWO LIQUID COOLING SYSTEMS FOR TURBINE BLADES. Thomas W. Jackson and John N. B. Livingood. August 1951. 27p. diagrs. (NACA RM E51F04)

A simplified analysis was made to determine flow characteristics and heat transfer in the laminar and turbulent flow regions for two turbine liquid-cooling systems, a straight-through-flow system and a recirculatory, or loop, flow system. Nondimensional charts, which simplify calculations of heat-transfer coefficients and coolant temperatures, are presented. Results of a sample calculation showed that, for a blade temperature of 1000° F, an increase in effective gas temperature of 350° F could be obtained by use of the loop cooling system instead of the straight-through system.

NACA RM E51F06

PERFORMANCE OF SINGLE-STAGE COMPRESSOR DESIGNED ON BASIS OF CONSTANT TOTAL ENTHALPY WITH SYMMETRICAL VELOCITY DIAGRAM AT ALL RADII AND VELOCITY RATIO OF 0.7 AT ROTOR HUB. Jack R. Burtt and Robert J. Jackson. September 1951. 14p. diagrs. (NACA RM E51F06)

A typical inlet axial-flow compressor inlet stage, which was designed on the basis of constant total enthalpy with symmetrical velocity diagram at all radii, was investigated. At a tip speed of 1126 feet per second, a peak pressure ratio of 1.28 was obtained at an efficiency of 0.76. At this tip speed, the highest practical flow was 28 pounds per second per square foot frontal area with an efficiency of 0.78. Data for a rotor relative inlet Mach number range of from 0.5 to 0.875 indicates that the critical value for any stage radial element is approximately 0.80 for the stage investigated.

NACA RM E51F22

CALCULATIONS OF LAMINAR HEAT TRANSFER AROUND CYLINDERS OF ARBITRARY CROSS SECTION AND TRANSPIRATION-COOLED WALLS WITH APPLICATION TO TURBINE BLADE COOLING. E. R. G. Eckert and John N. B. Livingood. September 1951. 57p. diagrs., 2 tabs. (NACA RM E51F22)

An approximate method for development of flow and thermal boundary layers in laminar regime on cylinders with arbitrary cross section and transpiration-cooled walls is obtained by use of Karman's integrated momentum equation and an analogous heat-flow equation. Incompressible flow with constant property values throughout boundary layer is assumed. Shape parameters for approximated velocity and temperature profiles and functions necessary for solution of boundary-layer equations are presented as charts, reducing calculations to a minimum. The method is applied to determine local heat-transfer coefficients and surface temperatures in the laminar region of transpiration-cooled turbine blades for a given flow rate. Coolant flow distributions necessary for maintaining uniform blade temperatures are also determined.

NACA RM E51G10

DETERMINATION AND USE OF THE LOCAL RECOVERY FACTOR FOR CALCULATING THE EFFECTIVE GAS TEMPERATURE FOR TURBINE BLADES. Jack B. Esgar and Alfred L. Lea. September 1951. 30p. diagrs., photos. (NACA RM E51G10)

In an experimental investigation of local recovery factors for a blade having a pressure distribution similar to that of a typical reaction-type turbine blade, it was found that the recovery factors were essentially independent of Mach number, Reynolds number, pressure gradient, and position on the blade surface except for regions where the boundary layer was probably in the transition range from laminar to turbulent. The recommended value of local subsonic recovery factor for use in calculating the effective gas temperature for gas turbine blades was 0.89.

NACA RM E51G30

PERFORMANCE OF A CASCADE IN AN ANNULAR VORTEX-GENERATING TUNNEL OVER RANGE OF REYNOLDS NUMBERS. Sidney Thurston and Ralph E. Brunk. September 1951. 33p. diagrs. (NACA RM E51G30)

Total-pressure deficiency for an annular cascade of 65-(12)10 blades was measured at three radial stations over a range of Reynolds numbers from 50,000 to 250,000 and at angles of attack of 15° and 25°. The variation of turning angle and shape of static pressure distribution at these stations is also shown.

NACA RM E51G31

PRELIMINARY INVESTIGATION OF MOLYBDENUM DISULFIDE - AIR-MIST LUBRICATION FOR ROLLER BEARINGS OPERATING TO DN VALUES OF 1×10^6 AND BALL BEARINGS OPERATING TO TEMPERATURES OF 1000° F. E. F. Macks, Z. N. Nemeth and W. J. Anderson. October 1951. 38p. diagrs., photos., 2 tabs. (NACA RM E51G31)

The effectiveness of molybdenum disulfide MoS_2 as a bearing lubricant was determined at high temperature and at high speeds. A 1-inch-bore ball bearing operated at temperatures to 1000° F, a speed of 1725 rpm, and a thrust load of 20 pounds when lubricated only with MoS_2-air mist. A 75-millimeter-bore cageless roller bearing, provided with a MoS_2-syrup coating before operation and lubricated with MoS_2-air mist during operation, operated at DN values to 1×10^6 with a load of 368 pounds.

NACA RM E51H14

EXPERIMENTAL INVESTIGATION OF AIR-COOLED TURBINE BLADE IN TURBOJET ENGINE. VIII - ROTOR BLADES WITH CAPPED LEADING EDGES. Gordon T. Smith and Robert O. Hickel. October 1951. 23p. diagrs., tab. (NACA RM E51H14)

An air-cooled turbine blade with a capped leading edge was investigated in a modified commercial turbojet engine over a range of engine speed from 4000 to 11,350 rpm. The cooling performance of the capped-leading-edge configuration was superior to all leading-edge cooling modifications previously investigated.

NACA RM E51I11

INVESTIGATIONS OF AIR-COOLED TURBINE ROTORS FOR TURBOJET ENGINES. I - EXPERIMENTAL DISK TEMPERATURE DISTRIBUTION IN MODIFIED J33 SPLIT-DISK ROTOR AT SPEEDS UP TO 6000 RPM. Wilson B. Schramm and Robert R. Ziemer. January 1952. 37p. diagrs., photos., 2 tabs. (NACA RM E51I11)

The experimental results of the disk temperature distribution in an air-cooled J33 split-disk turbine rotor fitted with nontwisted hollow air-cooled blades with nine tubes in the coolant passage are presented. These results were obtained at speeds up to 6000 rpm and the data correlated so that the disk temperatures at rated engine conditions could be estimated.

NACA RM E51I17

BLADE-TO-COOLANT HEAT-TRANSFER RESULTS AND OPERATING DATA FROM A NATURAL-CONVECTION WATER-COOLED SINGLE-STAGE TURBINE. Anthony J. Diaguila and John C. Freche. November 1951. 22p. diagrs., tab. (NACA RM E51I17)

Blade-to-coolant heat-transfer data and operating data were obtained with a natural-convection water-cooled turbine over a range of turbine speeds and inlet-gas temperatures. The convective coefficients were correlated by the general relation for natural-convection heat transfer. The turbine data were displaced from a theoretical equation for natural convection heat transfer in the turbulent region and from natural-convection data obtained with vertical cylinders and plates; possible disruption of natural convection circulation within the blade coolant passages was thus indicated. Comparison of nondimensional temperature-ratio parameters for the blade leading edge, midchord, and trailing edge indicated that the blade cooling effectiveness is greatest at the midchord and least at the trailing edge.

NACA RM E51J03

INVESTIGATIONS OF AIR-COOLED TURBINE ROTORS FOR TURBOJET ENGINES. II - MECHANICAL DESIGN, STRESS ANALYSIS, AND BURST TEST OF MODIFIED J33 SPLIT-DISK ROTOR. Richard H. Kemp and Merland L. Moseson. January 1952. 46p. diagrs., photos., tab. (NACA RM E51J03)

A full-scale J33 air-cooled split turbine rotor was designed and spin-pit tested to destruction. Stress analysis and spin-pit results indicated that the rotor was structurally sound. Operation of a similar rotor in a J33 turbojet engine, however, showed that the rear disk of the rotor operated at temperatures substantially higher than the forward disk. An extension of the stress analysis to include the temperature difference between the two disks indicated that engine modifications are required to permit operation of the two disks at more nearly the same temperature level.

NACA RM E51J10

EXPERIMENTAL INVESTIGATION OF AIR-COOLED TURBINE BLADES IN TURBOJET ENGINE. IX - EVALUATION OF THE DURABILITY OF NONCRITICAL ROTOR BLADES IN ENGINE OPERATION. Francis S. Stepka and Robert O. Hickel. December 1951. 26p. diagrs., photos., 4 tabs. (NACA RM E51J10)

The durability of five different structural or cooling configurations or combination of both of air-cooled blades made of noncritical materials was investigated in a modified turbojet engine. The greater part of the investigation was conducted at an engine speed of 11,500 rpm, a turbine-inlet temperature of approximately 1670° F, and a cooling-air to combustion gas flow ratio per blade of 0.05. The results of the investigation indicated that air-cooled blades made of noncritical metals can be operated for extended periods of time in engines at current inlet temperatures; however, before these blades are considered completely satisfactory for gas-turbine application, some means such as coatings is required to inhibit the oxidation of the blades.

NACA RM E51K02

EXPERIMENTAL INVESTIGATION OF COOLANT-FLOW CHARACTERISTICS OF A SINTERED POROUS TURBINE BLADE. Edward R. Bartoo, Louis J. Schafer, Jr. and Hadley T. Richards. February 1952. 28p. diagrs., photos. (NACA RM E51K02)

Local cooling-air flow rates through the walls of a sintered porous-metal turbine blade were measured at room temperature for a range of pressure drops. In order to check the validity of the correlation procedure, this procedure was used to correlate air-flow rates through two porous disks at temperatures up to 600° F. Data indicate the method permits room-temperature flow data to be used for heat-transfer work at elevated temperatures with reasonable accuracy. Cooling-air flow distribution around the periphery of the test blade is presented for two internal cooling air pressures with the blade in a 1000° F gas stream at a cascade-inlet Mach number of 0. 45.

NACA RM E51K08

EXPERIMENTAL INVESTIGATION OF THE HEAT-TRANSFER CHARACTERISTICS OF AN AIR-COOLED SINTERED POROUS TURBINE BLADE. Louis J. Schafer, Jr., Edward R. Bartoo and Hadley T. Richards. February 1952. 33p. diagrs., photos. (NACA RM E51K08)

The results of a heat-transfer investigation on a transpiration-cooled turbine blade are presented. The investigation was made on a static cascade. Blade-peripheral wall-temperature distributions were measured and compared with the temperature distribution on a convection-cooled blade. A correlation of the blade-wall temperatures obtained at various gas temperatures and gas weight flows was made on the basis of a temperature-difference ratio. Blade-wall temperatures calculated using an approximate theory for turbulent flow are compared with the measured blade-wall temperatures.

NACA RM E52A04

OXIDATION-RESISTANCE MECHANISM AND OTHER PROPERTIES OF MOLYBDENUM DISILICIDE. W. A. Maxwell. March 1952. 17p. diagrs., photos., tab. (NACA RM E52A04)

The outstanding oxidation resistance of molybdenum disilicide at 2400° F and above was found to depend on the formation of a protective siliceous coating in which α-cristobalite has been identified. Molybdenum disilicide is not inherently resistant to oxidation and in powdered form burns at low temperatures. Melting and casting experiments have demonstrated the decomposition of the material at the melting point. The room-temperature modulus of elasticity has been determined and electric-resistivity data are given to 2000° F.

NACA RM E52B13

EXPERIMENTAL INVESTIGATION OF AIR-COOLED TURBINE BLADES IN TURBOJET ENGINE. X - ENDURANCE EVALUATION OF SEVERAL TUBE-FILLED ROTOR BLADES. Jack B. Esgar and John L. Clure. May 1952. 45p. diagrs., photos., 5 tabs. (NACA RM E52B13)

Results are presented of endurance investigations of a variety of air-cooled tube-filled turbine-rotor blades to evaluate (1) new shell-to-base attachment methods, (2) coatings for providing oxidation resistance, and (3) durability of improved type of blade at reduced coolant-flow rates. The improved type of blade could operate satisfactorily at rated-speed endurance conditions at coolant-flow ratios as low as 0.03, but oxidation limited the blade life even though the blades were protected with the coatings that were investigated.

NACA RM E52C12

INVESTIGATIONS OF AIR-COOLED TURBINE ROTORS FOR TURBOJET ENGINES. III- EXPERIMENTAL COOLING-AIR IMPELLER PERFORMANCE AND TURBINE ROTOR TEMPERATURES IN MODIFIED J33 SPLIT-DISK ROTOR UP TO SPEEDS OF 10,000 RPM. Alfred J. Nachtigall, Charles F. Zalabak and Robert R. Ziemer. May 1952. 42p. diagrs., photos., 3 tabs. (NACA RM E52C12)

The experimental results of the cooling-air impeller performance and the turbine rotor temperature distributions in an air-cooled J33 split-disk turbine rotor fitted with air-cooled, tube-filled blades are presented for engine speeds up to 10,000 rpm. Engine alterations which reduced the temperature-level difference between the forward and rear disks of the rotor permitted operation over the extended speed range. Disk temperature data were correlated so that disk temperatures at rated engine conditions could be estimated. Calculated disk stresses at rated engine conditions are presented and indicate that the configuration investigated is structurally sound.

NACA RM E52D01

PRESSURE DROP IN COOLANT PASSAGES OF TWO AIR-COOLED TURBINE-BLADE CONFIGURATIONS. W. Byron Brown and Henry O. Slone. June 1952. 57p. diagrs., photos., tab. (NACA RM E52D01)

Friction coefficients were experimentally determined for both isothermal and nonisothermal flows in a pressure drop investigation conducted on two air-cooled turbine-blade configurations. A reasonable check was obtained between the air-cooled-blade friction coefficients. The data were used to develop a simplified flow equation for calculating over-all pressure drops through air-cooled blades and to examine the magnitude of entrance losses which might be expected in the entrance sections of air-cooled blades. A procedure that may be used for the calculation of air-cooled-blade pressure drops is presented.

NACA RM E52D21

COMPARISON OF CALCULATED AND EXPERIMENTAL TEMPERATURES OF WATER-COOLED TURBINE BLADES. Eugene F. Schum, John C. Freche and William J. Stelpflug. July 1952. 36p. diagrs., 3 tabs. (NACA RM E52D21)

Analytical methods were applied to calculate average and local blade temperatures and maximum allowable inlet gas temperatures for a forced-convection, water-cooled aluminum turbine. Comparison of calculated with experimental temperatures, obtained over a gas-temperature range from 400° to 1600° F, resulted in generally good agreement. A stationary water-cooled low-conductivity material (stainless steel) blade with a high-conducitivty material (copper) inserted in the trailing edge was also investigated over a gas-temperature range from 400° to 900° F and proved to be an effective method of reducing the trailing-edge temperature. Calculated trailing edge temperatures agreed well with experimental data.

NACA RM E52F23

RADIANT HEAT TRANSFER FROM FLAMES IN A SINGLE TUBULAR TURBOJET COMBUSTOR. Leonard Topper. August 1952. 30p. diagrs., tab. (NACA RM E52F23)

An experimental investigation of thermal radiation from the flame of a single tubular turbojet-engine combustor to the combustor liner is presented. The effects of combustor inlet-air pressure, air mass flow, and fuel-air ratio on the radiant intensity and on the temperature and emissivity of the flame are reported. The total radiation of the "luminous" flames (containing incandescent soot particles) was much greater (4 to 21 times) than the "nonluminous" molecular radiation. The intensity of radiation from the flame increased rapidly with an increase in combustor inlet-air pressure; it was affected to a lesser degree by variations in fuel-air ratio and air mass flow.

NACA RM E52F30

EXPERIMENTAL INVESTIGATION OF FREE-CONVECTION HEAT TRANSFER IN VERTICAL TUBE AT LARGE GRASHOF NUMBERS. E. R. G. Eckert and A. J. Diaguila. August 1952. 37p. diagrs., photos., tab. (NACA RM E52F30)

Local free-convection heat-transfer coefficients and temperature fields in the turbulent flow range were obtained within a vertical, stationary tube closed at the bottom, heated along its walls, and having a length-to-diameter ratio of 5. Convective heat-transfer coefficients were correlated by the general relations for free-convection heat transfer. These coefficients, converted to dimensionless Nusselt numbers were 35 percent below known relations for vertical flat plates. Air temperature measurements within the tube indicated a thin boundary layer along the heated wall surface and unstable conditions in the air flow.

NACA RM E52G11

CARBON-DEPOSITION CHARACTERISTICS OF MIL-F-5624A FUELS CONTAINING HIGH-BOILING AROMATIC HYDROCARBONS. Edmund R. Jonash, Jerrold D. Wear and William P. Cook. August 1952. 11p. diagrs., photos., 2 tabs. (NACA RM E52G11)

The effects of additions of typical high-boiling single-ring and dicyclic aromatic hydrocarbons (triisopropylbenzene and monomethylnaphthalene) on the carbon deposition characteristics of MIL-F-5624A, grade JP-3 and JP-4, fuel were determined in a single J33 combustor. The addition of the aromatic hydrocarbon components increased the carbon-deposition characteristics of the base fuels. These effects were satisfactorily predicted by the NACA K factor and the smoking tendency correlations previously developed.

NACA RM E52H05

INVESTIGATION OF TITANIUM CARBIDE BASE CERAMALS CONTAINING EITHER NICKEL OR COBALT FOR USE AS GAS-TURBINE BLADES. C. A. Hoffman and A. L. Cooper. August 1952. 33p. photos., diagrs., 5 tabs. (NACA RM E52H05)

The following two materials were investigated for use as gas-turbine-blade material: 65 percent TiC plus 20 percent Co plus 15 percent (CbTaTi)C and 65 percent TiC plus 20 percent Ni plus 15 percent (CbTaTi)C. Concurrently, the effectiveness of a number of methods of preventing ceramal-blade-root failure was studied. Blade temperatures from 1500° to 1900° F and wheel speeds from 10,000 to 26,000 rpm were used. Stellite 21 and S-816 alloy blades were used for comparison. Prior to the blade evaluation, physical-property evaluations of the ceramals were made. The results indicate that both the 66.5 percent TiC plus 18.5 percent Co plus 15 percent (CbTaTi)C and 66.5 percent TiC plus 18.5 percent Ni and 15 percent (CbTaTi)C ceramals should be considered further for gas-turbine-blade use. The oxidation resistance of either of these materials appears to be adequate for practical blade application. Further work on blade root design and mounting methods is required to eliminate root failure as the factor limiting the usefulness of these ceramals as gas turbine blade material.

NACA RM E52H19

INVESTIGATION OF EFFECTS OF REYNOLDS NUMBER ON LARGE DOUBLE-ENTRY CENTRIFUGAL COMPRESSOR. Karl Kovach and Joseph R. Withee, Jr. October 1952. 26p. diagrs. (NACA RM E52H19)

An investigation was conducted on a large-capacity double-entry centrifugal compressor to determine the effects of Reynolds number on over-all performance and also to obtain some idea of the origin and nature of the effects. The decreases in over-all performance at design tip speed (1545 ft/sec) for a change in pressure altitude from 20,000 to 50,000 feet were: (1) peak total-pressure ratio, 3.4 percent, (2) maximum equivalent weight flow, 3.8 percent, and (3) peak efficiency, 0.02. The origin of at least part of the Reynolds number effects in this compressor is in the inlet and the inducer sections.

NACA RM E52H28

INVESTIGATION OF AXIALLY SYMMETRIC AND TWO-DIMENSIONAL MULTINOZZLES FOR PRODUCING SUPERSONIC STREAMS. Eli Reshotko and Rudolph C. Haefeli. October 1952. 35p. diagrs., photos., tab. (NACA RM E52H28)

The flow characteristics of three axially symmetric multinozzles of nominal design Mach numbers 3.46, 3.07, and 7.01 and a two-dimensional multinozzle of nominal design Mach number 3.07 were investigated. Three types of disturbance, classified as oblique shock waves, corner shock waves, and wakes, were observed in the flow fields. The effect of the geometry of the multinozzles on these disturbances and on the actual Mach number and pressure recovery obtained with the multinozzle is discussed herein. The magnitude of the disturbances was found to depend on the exit turning angle of the individual nozzles. Generally, Mach number variations of 4-1/2 percent or less existed in a region which could be used as a test section. The use of multinozzles, however, appears to be restricted to experiments in which nonuniformity of flow and large pressure losses can be tolerated and for which simple fabrication and quick interchange of nozzles are desired.

NACA RM E52J31

EXPERIMENTAL INVESTIGATION OF RADOME ICING AND ICING PROTECTION. James P. Lewis and Robert J. Blade. January 1953. 60p. diagrs., photos. (NACA RM E52J31)

In an investigation of radome icing and icing protection in the NACA Lewis icing research tunnel, the impingement of water and the formation of ice on two radome configurations were found to agree well with theory and experience. The ice formations on the radomes produced serious effects on radar performance. The ethylene glycol fluid-protection system gave adequate icing protection for both anti-icing and de-icing. The radomes were investigated at airspeeds up to 290 miles per hour, air total temperatures of -15° to 20° F, water contents up to 1.0 gram per cubic meter, and angles of attack of 0° and 4°.

NACA RM E52L15a

PRELIMINARY INVESTIGATION OF ZIRCONIUM BORIDE CERAMALS FOR GAS-TURBINE BLADE APPLICATIONS. Charles A. Hoffman. April 1953. 13p. photos., diagrs., 2 tabs. (NACA RM E52L15a)

Zirconium boride ZrB_2 ceramals were investigated for possible gas-turbine-blade application. Included in the study were thermal shock evaluations of disks, preliminary turbine-blade operation, and observations of oxidation resistance. Thermal shock disks of the following three compositions were studied: (a) 97.5 percent ZrB_2 plus 2.5 percent B by weight; (b) 92.5 percent ZrB_2 plus 7.5 percent B by weight; and (c) 100 percent ZrB_2. Thermal shock disks were quenched from temperatures of 1800°, 2000°, 2200°, and 2400° F. The life of turbine blades containing 93 percent ZrB_2 plus 7 percent B by weight was determined in gas-turbine tests. The blades were run at approximately 1600° F and 15,000 to 26,000 rpm. The thermal shock resistance of the 97.5 percent ZrB_2 plus 2.5 percent boron ceramals compares favorably with that of TiC plus Co and TiC plus Ni ceramals. Oxidation of the disks during the thermal shock evaluation was slight for the comparatively short time (8.3 hr) up through 2000° F. Oxidation of a specimen was severe, however, after 100 hours at 2000° F. The turbine blade performance evaluation of the 93 percent ZrB_2 plus 7 percent B composition was preliminary in scope; no conclusions can be drawn.

NACA RM E52L19a

EXPERIMENTAL INVESTIGATION OF A LIGHT-WEIGHT ROCKET CHAMBER. John E. Dalgleish and Adelbert O. Tischler. March 1953. 12p. photos. (NACA RM E52L19a)

Experiments have been conducted with a jacketed rocket combustion chamber that was fabricated by hydraulic-forming from sheet metal. Rocket combustion chambers made by this method have been used successfully. Runs with these combustion chambers have been made at over-all heat-transfer rates of 1.7 Btu per square inch per second with water cooling and also with ammonia as a regenerative coolant.

NACA RM E52L31

THERMAL-SHOCK RESISTANCE OF A CERAMIC COMPRISING 60 PERCENT BORON CARBIDE AND 40 PERCENT TITANIUM DIBORIDE. C. M. Yeomans and C. A. Hoffman. March 1953. 7p. photos., 3 tab. (NACA RM E52L31)

Thermal-shock resistance of a ceramic comprising 60 percent boron carbide and 40 percent titanium diboride was investigated. The material has thermal shock resistance comparable to that of NBS body 4811C and that of zirconia, but is inferior to beryllia, alumina, and titanium-carbide ceramals. It is not considered suitable for turbine blades.

NACA RM E53A21

FUEL CHARACTERISTICS PERTINENT TO THE DESIGN OF AIRCRAFT FUEL SYSTEMS. Henry C. Barnett and R. R. Hibbard. June 1953. i, 104p. diagrs., 9 tabs. (NACA RM E53A21)

Because of the importance of fuel properties in design of aircraft fuel systems the present report has been prepared to provide information on the characteristics of current jet fuels. In addition to information on fuel properties, discussions are presented on fuel specifications, the variations among fuels supplied under a given specification, fuel composition, and the pertinence of fuel composition and physical properties to fuel system design. In some instances the influence of variables such as pressure and temperature on physical properties is indicated. References are cited to provide fuel system designers with sources of information containing more detail than is practicable in the present report.

NACA RM E53E25

ANALYTICAL INVESTIGATION OF FUEL TEMPERATURES AND FUEL-EVAPORATION LOSSES ENCOUNTERED IN LONG-RANGE HIGH-ALTITUDE SUPERSONIC FLIGHT. Richard J. McCafferty. August 1953. 38p. diagrs., 2 tabs. (NACA RM E53E25)

Two types of fuel losses were considered, loss due to adiabatic evaporation during climb and loss due to aerodynamic-heating effects. Heat-balance relations were employed to estimate amount of heat transferred to fuel contained in a cylindrical fuselage. Influence of flight speed, flight altitude, fuel withdrawal rate, tank size, tank pressurization, insulation, and initial fuel temperature on evaporation of JP-4 fuel was predicted. Influence of fuel volatility was determined by comparing evaporation obtained with JP-4 fuel and that obtained with JP-5. Results of analysis predicted, for an uninsulated tank, JP-4 fuel-boiling losses of 38 percent of total fuel weight carried by aircraft at the maximum flight speed and altitude considered. Fuel losses increased with increasing flight speed and flight time but decreased with increasing altitude. Fuel loss caused by adiabatic evaporation could be eliminated by ground refrigeration, tank pressurization, or use of low volatility fuel. Fuel loss due to aerodynamic heating could be eliminated by a combination of insulation of a practical thickness and use of a low volatility fuel; however, if tank pressurization were employed without insulation excessive pressures would be required. Without insulation, a maximum liquid-fuel temperature of 740° F would result if no fuel cooling occurred as a result of fuel evaporation; high liquid-fuel temperatures may create additional fuel handling problems.

NACA RM E53F03

THE SYNTHESIS OF BUTYLSILANES BY A LARGE-SCALE REDUCTION WITH LITHIUM ALUMINUM HYDRIDE. Samuel Kaye, Stanley Tannenbaum and Harold F. Hipsher. July 1953. 12p. photos., diagr. (NACA RM E53F03)

Eighty pounds of butylsilanes required for test purposes was synthesized by reducing butyltrichlorosilane with lithium aluminum hydride in dioxane solution. This was safely and successfully accomplished by operating in steel equipment under an atmosphere of oil-pumped nitrogen to minimize the hazards involved in conducting this operation on a large scale. The apparatus and procedure used to carry out the necessary manipulations are described in this report.

NACA RM E53F26

THERMAL SHOCK RESISTANCE AND HIGH-TEMPERATURE STRENGTH OF A MOLYBDENUM DISILICIDE - ALUMINUM OXIDE CERAMIC. W. A. Maxwell and R. W. Smith. October 1953. 8p. photo., 4 tabs. (NACA RM E53F26)

A ceramic having the nominal composition 75 percent molybdenum disilicide, 25 percent aluminum oxide was evaluated in thermal shock by two methods and high-temperature modulus-of-rupture strengths were determined. The material was found to have improved thermal-shock resistance as compared with pure molybdenum disilicide and to have moderate high-temperature strength.

NACA RM E53I16

FUEL CHARACTERISTICS PERTINENT TO THE DESIGN OF AIRCRAFT FUEL SYSTEMS. SUPPLEMENT I - ADDITIONAL INFORMATION ON MIL-F-7914(AER) GRADE JP-5 FUEL AND SEVERAL FUEL OILS. Henry C. Barnett and Robert R. Hibbard. (Supplement to RM E53A21) November 1953. 39p. diagrs., 3 tabs. (NACA RM E53I16)

Since the release of the first NACA publication of fuel characteristics pertinent to the design of aircraft fuel systems, additional information has become available on MIL-F-7914(AER) grade JP-5 fuel and several of the current grades of fuel oils. In order to make this information available to fuel-system designers as quickly as possible, the present report has been prepared as a supplement to NACA RM E53A21, "Fuel Characteristics Pertinent to the Design of Aircraft Fuel Systems" by Henry C. Barnett and R. R. Hibbard, 1953.

NACA RM L50A04a

MAXIMUM-LIFT CHARACTERISTICS OF A WING WITH THE LEADING-EDGE SWEEPBACK DECREASING FROM 45° AT THE ROOT TO 20° AT THE TIP AT REYNOLDS NUMBERS FROM 2.4×10^6 TO 6.0×10^6. Roy H. Lange. July 6, 1950. 62p. diagrs., photos. (NACA RM L50A04a)

Results are presented of an investigation of the maximum lift characteristics of a wing with the leading-edge sweepback decreasing from 45° at the root to 20° at the tip. The investigation was made for conditions of leading edge smooth and leading edge rough for the basic wing and for the wing with split flaps, leading-edge flaps, outboard slats, and combinations of these high-lift devices at Reynolds numbers from 2.4×10^6 to 6.0×10^6.

NACA RM L50A23a

LOW-SPEED PRESSURE-DISTRIBUTION MEASUREMENTS AT A REYNOLDS NUMBER OF 3.5×10^6 ON A WING WITH LEADING-EDGE SWEEPBACK DECREASING FROM 45° AT THE ROOT TO 20° AT THE TIP. U. Reed Barnett, Jr. and Roy H. Lange. July 7, 1950. 39p. diagrs., photo. (NACA RM L50A23a)

Results are presented of an investigation to determine the pressure distributions over a wing with the leading-edge sweepback decreasing from 45° at the root to 20° at the tip. Tests were made at a Reynolds number of 3.5×10^6 and a Mach number of 0.07 on the wing with and without 60° split flaps.

NACA RM L50C02

LOW-SPEED PITCHING DERIVATIVES OF LOW-ASPECT-RATIO WINGS OF TRIANGULAR AND MODIFIED TRIANGULAR PLAN FORMS. Alex Goodman and Byron M. Jaquet. April 17, 1950. 25p. diagrs., photos., 2 tabs. (NACA RM L50C02)

The present paper presents results of an investigation made in the Langley stability tunnel to determine effects of change in profile and aspect ratio on pitching derivatives of triangular and modified triangular wings. Results were compared with available theories.

NACA RM L50C15a

EXPERIMENTAL INVESTIGATION OF THE EFFECT OF ASPECT RATIO AND MACH NUMBER ON THE FLUTTER OF CANTILEVER WINGS. E. Widmayer, Jr., W. T. Lauten, Jr. and S. A. Clevenson. June 1, 1950. 20p. diagrs., 2 tabs. (NACA RM L50C15a)

The results of some wind-tunnel experiments to investigate the effects of aspect ratio and Mach number on the flutter of uniform, unswept, cantilever wings are reported. Models having aspect ratios ranging from 2 to 13 were tested at Mach numbers up to 0.92. No general attempt is made to correlate the data with three-dimensional-flow theory, but an examination of the data is made on the basis of reference theoretical values obtained from the two-dimensional incompressible flow theory. On this basis a reduction in aspect ratio, in general, increased the ratio of the experimental flutter speed to the calculated flutter speed. The analysis also indicated that for a given aspect ratio, this ratio decreased slightly as the Mach number is increased.

NACA RM L50D06

ABILITY OF PILOTS TO CONTROL SIMULATED SHORT-PERIOD YAWING OSCILLATIONS. William H. Phillips and Donald C. Cheatham. November 13, 1950. 23p. diagrs., photos., tab. (NACA RM L50D06)

The results of an investigation of pilot's ability to control short-period yawing oscillations in a simulating device are presented. Pilot's ability to control the short-period yawing oscillations has been determined as a function of period, control effectiveness, and inherent damping or instability.

NACA RM L50D07

PRESSURE-RISE AND LEAKAGE-LOSS CHARACTERISTICS OF A ROTATING COWLING. Jack F. Runckel and Gerald Hieser. August 30, 1950. 47p. diagrs., photos. (NACA RM L50D07)

Presents results of an investigation of pressure-rise and leakage-loss characteristics of a rotating cowling. A method for predicting the pressure rise is developed and compared with the results obtained experimentally. Design considerations peculiar to this type of cowling are discussed, and methods for estimating the leakage flow and proper setting of the cowling vane are outlined.

NACA RM L50D13

A WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF THRUST-AXIS INCLINATION ON PROPELLER FIRST-ORDER VIBRATION. W. H. Gray, J. M. Hallissy, Jr. and A. R. Heath, Jr. June 9, 1950. 64p. diagrs., photo., tab. (NACA RM L50D13)

Data are presented on aerodynamic excitation of propeller vibration with the thrust axis at two angles of inclination to the air stream. Aerodynamic excitation is calculated and compared with measured values for several conditions. Measured and calculated blade vibratory stresses for several excitation values are presented. The calculated values of exciting force compared well with the measured values at low rotational speeds, not so well at high rotational speeds. First-order blade vibratory stresses were computed with satisfactory accuracy from unpitched propeller loading data.

NACA RM L50D14

LOW-SPEED LATERAL STABILITY AND AILERON-EFFECTIVENESS CHARACTERISTICS AT A REYNOLDS NUMBER OF 3.5 x 10^6 OF A WING WITH LEADING-EDGE SWEEPBACK DECREASING FROM 45° AT THE ROOT TO 20° AT THE TIP. Roy H. Lange and Huel C. McLemore. July 6, 1950. 44p. diagrs., photos. (NACA RM L50D14)

Results are presented of an investigation of the static lateral stability and aileron-effectiveness characteristics of a wing with the leading-edge sweepback decreasing from 45° at the root to 20° at the tip. The investigation is made for the basic wing and for the wing with split flaps, leading-edge flaps, outboard slats, and combinations of these high-lift devices at a Reynolds number of about 3.5 x 10^6.

NACA RM L50E02

LOW-SPEED INVESTIGATION OF LEADING-EDGE AND TRAILING-EDGE FLAPS ON A 47.5° SWEPTBACK WING OF ASPECT RATIO 3.4 AT A REYNOLDS NUMBER OF 4.4 x 10^6. Jerome Pasamanick and Thomas B. Sellers. June 12. 1950. 29p. diagrs.. photo. (NACA RM L50E02)

Presents results of an investigation in the Langley full-scale tunnel of various extensible leading-edge and plain trailing-edge flaps on a wing-fuselage combination. The wing leading-edge sweep was 47.5°, the aspect ratio was 3.4, the taper ratio was 0.51, and the airfoil sections were NACA 64_1A112. The data include the effects of flap design parameters on the lift, drag, and pitching-moment characteristics at zero yaw for a range of angle of attack at a Reynolds number of 4.4 x 10^6.

NACA RM L50E12a

EFFECT OF VARIOUS OUTBOARD AND CENTRAL FINS ON LOW-SPEED YAWING STABILITY DERIVATIVES OF A 60° DELTA-WING MODEL. Alex Goodman. June 19, 1950. 35p. diagrs., photos., 2 tabs. (NACA RM L50E12a)

The results of an investigation conducted in the Langley stability tunnel to determine the effects of various outboard- and central-fin arrangements on the low-speed yawing stability derivatives of a 60° delta-wing model are presented. Calculated values of the effective center of pressure for several of the central fins are also presented. Procedures are suggested for estimating the contribution of fins to the stability derivatives of similar model configurations.

NACA RM L50F16

LOW-SPEED AERODYNAMIC CHARACTERISTICS OF A SERIES OF SWEPT WINGS HAVING NACA 65A006 AIRFOIL SECTIONS. (Revised) Jones F. Cahill and Stanley M. Gottlieb. October 17, 1950. 63p. diagrs., photos. (NACA RM L50F16. Formerly RM L9J20)

An investigation was made to determine the effect of sweep, taper ratio, and aspect ratio on the aerodynamic characteristics of nine semispan wings of NACA 65A006 airfoil section with and without split flaps. Lift, drag, pitching-moment, and wing-root bending-moment characteristics were measured through a range of Reynolds numbers from 1.5 x 10^6 to 12.0 x 10^6. One of these wings was tested with a hinged leading-edge flap of various spans and deflections to determine the effect of this type of flap on longitudinal stability near maximum lift.

NACA RM L50F16a

LOW-SPEED LONGITUDINAL CHARACTERISTICS OF A CIRCULAR-ARC 52° SWEPTBACK WING OF ASPECT RATIO 2.84 WITH AND WITHOUT LEADING-EDGE AND TRAILING-EDGE FLAPS AT REYNOLDS NUMBERS FROM 1.6 x 10^6 TO 9.7 x 10^6. Gerald V. Foster and Roland F. Griner. August 11, 1950. 40p. diagrs., photo., tab. (NACA RM L50F16a)

The results of low-speed tests of a 52° swept wing which had circular-arc sections are presented. The wing exhibited large changes in stability from the low to high lift range. The stability of the wing was improved with the addition of leading-edge flaps which extended over 25 percent of the wing semispan. The aerodynamic characteristics of the wing were not appreciably affected by the variation of Reynolds numbers.

NACA RM L50G17

WIND-TUNNEL INVESTIGATION OF THE LOW-SPEED LONGITUDINAL AND LATERAL CONTROL CHARACTERISTICS OF A TRIANGULAR-WING MODEL OF ASPECT RATIO 2.31 HAVING CONSTANT-CHORD CONTROL SURFACES. Walter D. Wolhart and William H. Michael, Jr. September 6, 1950. 41p. diagrs., photo., 2 tabs. (NACA RM L50G17)

Results are presented of a wind-tunnel investigation of low-speed longitudinal and lateral control characteristics of a model with a triangular wing having NACA $65_{(06)}$-006.5 airfoil sections and aspect ratio 2.31 and equipped with constant-chord control surfaces. The investigation included determination of effects of adding fuselage to wing, adding transition strips, varying the Reynolds number from 1.62×10^6 to 2.62×10^6, and sealing the gap at the nose of the control surface.

NACA RM L50H29

POSITIONING INVESTIGATION OF SINGLE SLOTTED FLAPS ON A 47.7° SWEPTBACK WING AT REYNOLDS NUMBERS OF 4.0×10^6 AND 6.0×10^6. Stanley H. Spooner and Ernst F. Mollenberg. October 9, 1950. 36p. diagrs., photo., 3 tabs. (NACA RM L50H29)

The relationship between flap effectiveness and the horizontal and vertical position of a partial-span single slotted flap on a 47.7° sweptback-wing - fuselage combination is shown. Included are some effects of Reynolds number variation and a comparison with two-dimensional positioning studies of a slotted flap. The low-speed investigation was conducted in the Langley 19-foot pressure tunnel at Reynolds numbers of 4.0×10^6 and 6.0×10^6.

NACA RM L50I29

DESCRIPTION AND ANALYSIS OF A ROCKET-VEHICLE EXPERIMENT ON FLUTTER INVOLVING WING DEFORMATION AND BODY MOTIONS. H. J. Cunningham and R. R. Lundstrom. November 30, 1950. 27p. diagrs., photos., 2 tabs. (NACA RM L50I29)

Flight tests and a mathematical analysis were carried out to demonstrate and confirm a type of subsonic flutter involving rigid-body motions and wing deformations. For the configuration considered, the period of the oscillation was approximately 100 chords per cycle which is well within the range of period found in dynamic-stability work on rigid aircraft with free controls. A mathematical analysis based on two-dimensional incompressible flow provided a conservative prediction of the airspeed at which the low-frequency flutter occurred. It was found that wing-bending stiffness is the important parameter for preventing such flutter.

NACA RM L50L11

THEORETICAL AND ANALOG STUDIES OF THE EFFECTS OF NONLINEAR STABILITY DERIVATIVES ON THE LONGITUDINAL MOTIONS OF AN AIRCRAFT IN RESPONSE TO STEP CONTROL DEFLECTIONS AND TO THE INFLUENCE OF PROPORTIONAL AUTOMATIC CONTROL. Howard J. Curfman, Jr. February 23, 1951. 55p. diagrs., photos. (NACA RM L50L11)

Through theoretical and analog results the effects of two nonlinear stability derivatives on the longitudinal motions of an aircraft have been investigated. Nonlinear functions of pitching-moment and lift coefficients with angle of attack were considered. Analog results of aircraft motions in response to step elevator deflections and to the action of the proportional control systems are presented. The occurrence of continuous hunting oscillations was predicted and demonstrated for the attitude stabilization system with proportional control for certain nonlinear pitching-moment variations and autopilot adjustments.

NACA RM L50L12b

THE EFFECTS OF VARIOUS PARAMETERS INCLUDING MACH NUMBER ON PROPELLER-BLADE FLUTTER WITH EMPHASIS ON STALL FLUTTER. John E. Baker. January 31, 1951. 40p. diagrs., 3 tabs. (NACA RM L50L12b)

The effect of many parameters significant to wing flutter as well as blade twist was studied on several rotating models to determine their significance with respect to propeller stall flutter. The minimum values of the flutter-speed coefficient were found to be slightly greater than 1.0 at subcritical Mach numbers. Of the few parameters that raised the minimum flutter-speed coefficients, forward movement of the section center-of-gravity location and Mach number at supercritical speeds were most significant. The effect of Mach number was of such significance that a tentative criterion for designing completely flutter-free thin supersonic propellers is indicated.

NACA RM L51A10

AN INVESTIGATION OF THE EFFECT OF VERTICAL-FIN LOCATION AND AREA ON LOW-SPEED LATERAL STABILITY DERIVATIVES OF A SEMITAILLESS AIRPLANE MODEL. Lewis R. Fisher and William H. Michael, Jr. March 7, 1951. 41p. diagrs., photos. (NACA RM L51A10)

A low-speed wind-tunnel investigation was conducted in order to determine the effect of vertical-fin location and area on the static and rotary lateral stability derivatives of a semitailless airplane model and to establish the validity of the application of the usual methods for predicting the stability derivatives of such airplanes. Comparisons are made of the experimental and calculated derivatives for the wing and vertical fins wherein consideration is taken of some interference effects.

NACA RM L51A26

INVESTIGATION AT LOW SPEED OF THE EFFECTIVENESS AND HINGE MOMENTS OF A CONSTANT-CHORD AILAVATOR ON A LARGE-SCALE TRIANGULAR WING WITH SECTION MODIFICATION. John G. Hawes and Ralph W. May, Jr. April 24, 1951. 47p. diagrs., photos., tab. (NACA RM L51A26)

Results are presented of an investigation to determine the low-speed longitudinal, lateral, and hinge-moment control characteristics at zero yaw of a large-scale 60° delta wing having a 10-percent-thick biconvex symmetrical airfoil. The wing was also tested with a nose glove having NACA 65-010 section ordinates. The wing was equipped with a constant-chord plain-type semispan ailavator having two segments.

NACA RM L51B09

WIND-TUNNEL INVESTIGATION AT LOW SPEED OF THE EFFECTS OF SYMMETRICAL DEFLECTION OF HALF-DELTA TIP CONTROLS ON THE DAMPING IN ROLL AND YAWING MOMENT DUE TO ROLLING OF A TRIANGULAR-WING MODEL. Walter D. Wolhart. April 6, 1951. 17p. diagrs., photos. (NACA RM L51B09)

Results are presented of a wind-tunnel investigation at low speed to determine the effects of symmetrical deflection of half-delta tip controls on the damping in roll and yawing moment due to rolling of a triangular wing model. The investigation included determination of the effects of control size as well as control deflection.

NACA RM L51D20

LOW-SPEED INVESTIGATION OF SEVERAL TYPES OF SPLIT FLAP ON A 47.7° SWEPTBACK-WING - FUSELAGE COMBINATION OF ASPECT RATIO 5.1 AT A REYNOLDS NUMBER OF 6.0×10^6. Stanley H. Spooner and Ernst F. Mollenberg. July 1951. 41p. diagrs., photo., tab. (NACA RM L51D20)

Results are presented of an investigation to determine the characteristics of a 47.7° sweptback-wing - fuselage combination equipped with split flaps and several modifications thereof. The modifications consisted of extended split (Zap), rotated split, step split, and triangular flaps. The wing had an aspect ratio of 5.1, a taper ratio of 0.383, and NACA 64-210 airfoil sections. The maximum wing thickness in a plane parallel to the plane of symmetry was 7.5 percent of the wing chord. The tests were conducted in the Langley 19-foot pressure tunnel at a Reynolds number of 6.0×10^6 and a Mach number of 0.14.

NACA RM L51D20a

LOW-SPEED STATIC LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A 60° TRIANGULAR-WING MODEL HAVING HALF-DELTA TIP CONTROLS. Byron M. Jaquet, M. J. Queijo and Jacob H. Lichtenstein. June 1951. 30p. diagrs., photos. (NACA RM L51D20a)

The results are presented of an investigation to determine the low-speed static longitudinal stability and control-effectiveness characteristics of a 60° triangular-wing model having half-delta tip controls. Comparisons of results are made with constant-chord flaps. Effects of fuselage and end plates on stability and control characteristics are presented. Results are compared with available theory where possible.

NACA RM L51E11a

EFFECTS OF INLET WALL CONTOUR ON THE PRESSURE RECOVERY OF A 10° 10-INCH-INLET-DIAMETER CONICAL DIFFUSER. Martin R. Copp. September 1951. 29p. diagrs., photos. (NACA RM L51E11a)

An investigation was made with a 10° 10-inch-inlet-diameter conical diffuser of 2:1 area ratio to determine the influence on flow characteristics and pressure recovery of sharpness of curvature of the junction between the walls of a conical diffuser and a cylindrical approach tube. The investigation was performed for two thicknesses of inlet boundary layer over a Reynolds number range of 1.2×10^6 to 3.2×10^6 and a mean inlet Mach number range of approximately 0.28 to choking. The over-all static-pressure recovery, expressed as the ratio of the actual rise in static pressure divided by the ideal rise in static pressure, was entirely independent of the inlet wall shape.

NACA RM L51E16

WING-FLOW INVESTIGATION OF A 45° CONE AS AN ANGLE-OF-ATTACK MEASURING DEVICE AT TRANSONIC SPEEDS. Herbert C. McClanahan, Jr. July 1951. 15p. photos., diagrs. (NACA RM L51E16)

A study of pressure measurements on a cone of 45° apex angle made at angles of attack from -10° to 50° and zero yaw angle through a Mach number range of 0.7 to 1.1 to determine the usefulness of a cone for measuring angle of attack at transonic speeds.

NACA RM L51F22

INVESTIGATION OF LOW-SPEED LATERAL CONTROL AND HINGE-MOMENT CHARACTERISTICS OF A 20-PERCENT-CHORD PLAIN AILERON ON A 47.7° SWEPTBACK WING OF ASPECT RATIO 5.1 AT A REYNOLDS NUMBER OF 6.0×10^6. William M. Hadaway and Reino J. Salmi. October 1951. 31p. diagrs. (NACA RM L51F22)

Contains results of wind-tunnel tests to determine the lateral control, hinge-moment, aileron-load, and balance-chamber-pressure characteristics of a 20-percent-chord plain aileron on a 47.7° sweptback wing of aspect ratio 5.1 having NACA 64-210 airfoil sections with and without high-lift and stall-control devices. The investigation was conducted at a Reynolds number of 6.0×10^6 and a corresponding Mach number of 0.14 for an angle-of-attack range of -4° to approximately 30°.

NACA RM L51G30

A COMPARISON OF THE SPANWISE LOADING CALCULATED BY VARIOUS METHODS WITH EXPERIMENTAL LOADINGS OBTAINED ON A 45° SWEPTBACK WING OF ASPECT RATIO 8 AT A REYNOLDS NUMBER OF 4.0×10^6. William C. Schneider. January 1952. 32p. diagrs., tab. (NACA RM L51G30)

Experimental force and moment data obtained by pressure measurements on a wing of aspect ratio 8.02, 45° sweepback of the quarter-chord line, taper ratio of 0.45, and NACA 631A012 airfoil sections parallel to the plane of symmetry have been compared with the calculated loadings obtained by the standard methods proposed by Weissinger, Falkner, and Multhopp, as well as by variations thereof. On the basis of the present calculations, the Weissinger solution, when the number of control points was increased from 7 (the number suggested by Weissinger) to 15, or the Multhopp solution when using at least 15 control points, resulted in a good compromise between lift-curve slope and load shape, although all of the calculations underestimated C_{L_α}.

NACA RM L51H09a

EXPERIMENTAL AND ANALYTICAL INVESTIGATION OF FLUTTER OF A NONUNIFORM SWEPTBACK CANTILEVER WING WITH TWO CONCENTRATED WEIGHTS. John L. Sewall. December 1951. 33p. diagrs., photos., 3 tabs. (NACA RM L51H09a)

An experimental and analytical investigation of the flutter of a weighted cantilever wing, swept back 34.5°, is reported. Concentrated weights which were 78.4 percent and 42.0 percent of the weight of the wing were mounted at approximately one-third and three-quarters of the span respectively, and flutter data obtained for this weighted condition were analyzed by means of a Rayleigh-Ritz type of flutter theory employing uncoupled still-air vibration modes. Unusually good agreement was obtained by using two modes (fundamental bending and fundamental torsion), and the introduction of three and four higher modes did not appreciably affect this agreement. Additional information related to the theory is given in an appendix.

NACA RM L51H15

COMPARISON OF SEMISPAN AND FULL-SPAN TESTS OF A 47.5° SWEPTBACK WING WITH SYMMETRICAL CIRCULAR-ARC SECTIONS AND HAVING DROOPED-NOSE FLAPS, TRAILING-EDGE FLAPS, AND AILERONS. Stanley Lipson and U. Reed Barnett, Jr. December 1951. 60p. photos., diagrs. (NACA RM L51H15)

An investigation was conducted in the Langley full-scale tunnel to determine the comparative characteristics of a full-span and semispan 47.5° sweptback wing having 10-percent thick biconvex airfoil sections and an aspect ratio of 3.5. The configurations tested were the basic wing, the wing with various combinations of leading- and trailing-edge flaps, and the basic wing with an aileron deflected. The results included both force and pressure measurements and were obtained at a Reynolds number of 4.2×10^6 and a Mach number of 0.07.

NACA RM L51H31

PRELIMINARY INVESTIGATION OF THE TRANSFER OF HEAT FROM A FLAT PLATE AT A MACH NUMBER OF 1.5. M. A. Emmons, Jr. and R. F. Blanchard. December 1951. 23p. diagrs., photos. (NACA RM L51H31)

Surface temperatures and heat transfer to the air stream have been measured for turbulent flow over a flat plate at a Mach number of 1.5 and at a Reynolds number, based on the momentum thicknesses of boundary layer, of approximately 5000. Preliminary data are presented and the surface heat-transfer coefficient calculated from these data is considered to be accurate to ±2.6 percent at a temperature potential of 50° F. These data are in good agreement with the results produced by applying modifications obtained from published information to existing subsonic theories.

NACA RM L51I10

LOW-SPEED WIND-TUNNEL INVESTIGATION OF LATERAL CONTROL CHARACTERISTICS OF A 60° TRIANGULAR-WING MODEL HAVING HALF-DELTA TIP CONTROLS. Byron M. Jaquet and M. J. Queijo. November 1951. 50p. diagrs., photos. (NACA RM L51I10)

Results are presented of a low-speed investigation of the lateral control characteristics of a 60° triangular wing model equipped with half-delta tip controls having areas of 5, 10, and 15 percent of the wing area (sum of left- and right-control areas). Effects of end plates are determined for 10-percent-area controls. Half-delta tip controls are compared with constant-chord controls. Experimental control and rolling effectiveness are compared with theory.

NACA RM L51J05

LOW-SPEED INVESTIGATION OF THE EFFECTS OF WING LEADING-EDGE MODIFICATIONS AND SEVERAL OUTBOARD FIN ARRANGEMENTS ON THE STATIC STABILITY CHARACTERISTICS OF A LARGE-SCALE TRIANGULAR WING. H. Clyde McLemore. January 1952. 64p. diagrs., photo., tab. (NACA RM L51J05)

Results are presented of an investigation in the Langley full-scale tunnel to determine the effects of wing leading-edge modifications and several outboard fin arrangements on the low-speed static-stability characteristics of a large-scale triangular wing having 60° of leading-edge sweep and 10-percent-thick circular-arc airfoil sections parallel to the plane of symmetry. The Reynolds number range was from 2.70×10^6 to 9.72×10^6.

NACA RM L51J19

THEORETICAL CALCULATION OF THE EFFECT OF THE FUSELAGE ON THE SPANWISE LIFT DISTRIBUTION ON A WING. Martin Zlotnick and Franklin W. Diederich. March 1952. 27p. diagrs. (NACA RM L51J19)

A method is presented for calculating the effects of the fuselage on the spanwise lift distribution on a wing by an application of a conformal-mapping procedure to the simplified lifting-surface theory. This method is applicable to any symmetrical wing-fuselage configuration. An outline of the computing procedure and a comparison of the calculated results with experimental results are included. A numerical example is given.

NACA RM L51J23

METHOD OF ESTIMATING THE STICK-FIXED LONGITUDINAL STABILITY OF WING-FUSELAGE CONFIGURATIONS HAVING UNSWEPT OR SWEPT WINGS. Milton D. McLaughlin. January 1952. 41p. diagrs., 3 tabs. (NACA RM L51J23)

A method is given for calculating the stick-fixed longitudinal stability of a wing-fuselage configuration at subcritical Mach numbers. The method applies to unswept- and swept-wing configurations. A variation of the additional fuselage loading due to the presence of the wing is presented. A comparison of the calculated neutral points with neutral points obtained from experiment for 23 wing-fuselage configurations is presented.

NACA RM L51J25

ANALYSIS OF V-g RECORDS FROM THE GRUMMAN F8F-2 AIRPLANE. James O. Thornton. July 1952. 11p. diagrs., tab. (NACA RM L51J25)

V-g records obtained in training and operational flights of the F8F-2 airplane are analyzed statistically to show the frequency with which large values of normal acceleration and airspeed are encountered. A comparison is made with previous V-g results from the F8F-1 airplane.

NACA RM L51K09

THE EFFECT OF SURFACE ROUGHNESS ON THE PERFORMANCE OF A 23° CONICAL DIFFUSER AT SUBSONIC MACH NUMBERS. Jerome Persh. January 1952. 42p. diagrs., photos. (NACA RM L51K09)

An investigation was conducted to determine the effect of surface roughness on the performance of a 2:1 area ratio, 23° conical diffuser with a constant-area tail pipe about 3-1/2 inlet diameters in length. The inlet-boundary-layer thickness was of the order of 5 percent of the inlet diameter. The air flows used in this investigation cover an inlet Mach number range from 0.10 to 0.64 corresponding to Reynolds numbers of 10^6 to 6 x 10^6 based on inlet diameter. The surface of the diffuser was coated with cork particles of a controlled size. Incremental bands of roughness were removed from the downstream edge after each series of pressure measurements were made and the variation of diffuser performance with percent of diffuser length roughened thereby determined.

NACA RM L51K26

FORCE AND PRESSURE INVESTIGATION AT LARGE SCALE OF A 49° SWEPTBACK SEMISPAN WING HAVING NACA 65A006 SECTIONS AND EQUIPPED WITH VARIOUS SLAT ARRANGEMENTS. Stanley Lipson and U. Reed Barnett, Jr. January 1952. 60p. diagrs., photo., tab. (NACA RM L51K26)

The effects of slat span and slat deflection angle on the longitudinal aerodynamic characteristics of a semispan 49.1° sweptback wing, aspect ratio 3.78, having NACA 65A006 airfoil sections have been investigated in the Langley full-scale tunnel. Normal-force measurements were obtained on the extended slat, both with and without a trailing-edge flap deflected. The greater part of the data was obtained at a Reynolds number of 6.1 x 10^6 and a Mach number of 0.10.

NACA RM L51L12

STUDIES OF THE FLOW FIELD BEHIND A LARGE SCALE 47.5° SWEPTBACK WING HAVING CIRCULAR-ARC AIRFOIL SECTIONS AND EQUIPPED WITH DROOPED-NOSE AND PLAIN FLAPS. Roy H. Lange and Marvin P. Fink. March 1952. 57p. diagrs., photos., tab. (NACA RM L51L12)

Results are presented of an investigation at large scale of the downwash, sidewash, and wake characteristics behind a 47.5° sweptback wing having circular-arc airfoil sections and with drooped-nose and plain flaps neutral and deflected 40°. The surveys were made at a Reynolds number of 4.3 x 10^6 and a Mach number of 0.07 and are presented for three longitudinal distances behind the wing. Comparisons are made between the downwash calculated by using experimental span loadings and the experimental downwash obtained.

NACA RM L52C17

A STUDY OF THE CHARACTERISTICS OF HUMAN-PILOT CONTROL RESPONSE TO SIMULATED AIRCRAFT LATERAL MOTIONS. Donald C. Cheatham. May 1952. 39p. diagrs., photos., tab. (NACA RM L52C17)

There are presented studies of the characteristics of pilot ability to control dynamically unstable yawing oscillations, studies of pilot control response to simulated aircraft yawing motions, and studies of the feasibility of representing pilot control response in an analytical form.

NACA RM L52C20

A PRELIMINARY GUST-TUNNEL INVESTIGATION OF LEADING-EDGE SEPARATION ON SWEPT WINGS. George L. Cahen. June 1952. 12p. photos. (NACA RM L52C20)

The results of a series of qualitative studies with tufts on three wings having sweepback angles of 30°, 45°, and 60° show that under certain conditions a leading-edge vortex can exist in the unsteady flow associated with a gust. It was indicated that, if a wing in steady flight prior to entering a gust is at an angle of attack several degrees less than that at which vortex flow first begins in steady flow, it may penetrate the gust without having the vortex develop, even if its angle of attack is increased by the gust into the vortex-flow regime. However, if the wing is within the vortex-flow regime prior to entering a gust, the vortex flow can progress rapidly.

NACA RM L52D04

LOW-SPEED WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF PROPELLER OPERATION AT HIGH THRUST ON THE LONGITUDINAL STABILITY AND TRIM OF A TWIN-ENGINE AIRPLANE CONFIGURATION. William C. Sleeman, Jr. and Edward L. Linsley. July 1952. 66p. diagrs., photos. (NACA RM L52D04)

An investigation was made to determine the effects of dual-rotation propeller operation at high thrust on the static longitudinal stability characteristics of a semispan powered model representing a twin-engine airplane configuration with flaps retracted. The flow field behind the model was studied extensively by several techniques. Dynamic pressure ratios and effective downwash angles were obtained for a wide range of tail heights and the general flow angularity behind the model was obtained by the tuft-grid technique. Effects of extreme power on longitudinal stability were evaluated for several combinations of horizontal tail height and vertical location of the center of gravity.

NACA RM L52D17a

EFFECTS OF SEVERAL HIGH-LIFT AND STALL-CONTROL DEVICES ON THE AERODYNAMIC CHARACTERISTICS OF A SEMISPAN 49° SWEPT-BACK WING. U. Reed Barnett, Jr. and Stanley Lipson. September 1952. 39p. diagrs., photo. (NACA RM L52D17a)

Tests were conducted in the Langley full-scale tunnel of a wing with 49.1° sweepback of the leading edge, aspect ratio 3.78, and NACA 65A006 sections streamwise to determine the effect of a leading-edge flap, a slat, and a plain trailing-edge flap on the aerodynamic characteristics of a wing. Limited tests were also conducted concerning boundary-layer control by suction and blowing. Rolling moments due to a flap-type aileron were also measured. Most of the data were obtained at a Reynolds number of 6.1×10^6 and a Mach number of 0.10.

NACA RM L52D25a

EXPERIMENTAL INVESTIGATION OF FLOW THROUGH THREE HIGHLY LOADED INLET GUIDE VANES HAVING DIFFERENT SPANWISE CIRCULATION GRADIENTS. Loren A. Beatty, Melvyn Savage and James C. Emery. July 1952. 24p. diagrs., tab. (NACA RM L52D25a)

Three highly loaded axial-flow compressor inlet guide vanes with a free vortex and solid body design were designed and tested in a low-speed annular cascade. A comparison between design and measured turning angles was made by both neglecting and taking into account the secondary flow effects. Contour plots of total pressure loss across the guide vane were made. When the radial gradient of circulation was large (the hub axial velocity two or three times greater than that at the tip), actual turning angles were several degrees below design over the outboard 30 percent of the vane. For such guide vanes, the Lieblein and Ackley method for correcting design two-dimensional turning angles by taking into account secondary flows provided fairly good agreement between design and measured turning angles.

NACA RM L52H19

INVESTIGATION AT LOW SPEED OF THE DOWNWASH, SIDEWASH, AND WAKE CHARACTERISTICS BEHIND A LARGE-SCALE TRIANGULAR WING, INCLUDING THE EFFECTS OF YAW, FULL-SPAN TRAILING-EDGE FLAPS, AND TWO LEADING-EDGE MODIFICATIONS. Edward F. Whittle, Jr. and John G. Hawes. October 1952. 65p. diagrs., photos., tab. (NACA RM L52H19)

Results are presented of a low-speed investigation of the downwash, sidewash, and wake characteristics in three planes behind a large-scale 60° triangular wing. Included are the effects of yawing 10°, full-span plain flaps deflected 20°, and two leading-edge nose-glove modifications. Calculations of the static longitudinal stability and trim characteristics of an assumed 60° triangular-wing airplane configuration showing the effect of three tail areas, two longitudinal positions, and various vertical positions are also presented.

NACA RM L52I24

SOME LOW-SPEED STUDIES OF THE EFFECTS OF WING LOCATION ON WING-DEFORMATION-BODY-FREEDOM FLUTTER. E. Widmayer, Jr. November 1952. 21p. diagrs., 3 tabs. (NACA RM L52I24)

Some flutter experiments on unswept wings and 45° swept wings involving wing deformation and fuselage mobility in pitch and performed at low air speeds have been reported. The flutter was obtained for a range of wing locations rearward of the pitching axis and was characterized by low values of reduced frequency. An analysis of the flutter has been made, the flutter being calculated for several approximations to the aerodynamic forces. A comparison of the results of the calculations with the results of the experiments indicates that some accounting of the effect of aspect ratio on the aerodynamic forces is needed to adequately predict the flutter. The experiments using the 45° swept wings yielded no flutter for the range of wing locations and fuselage inertias examined.

NACA RM L52J06

A CASCADE - GENERAL-MOMENTUM THEORY OF OPERATION OF A SUPERSONIC PROPELLER ANNULUS. Bernard B. Klawans and Arthur W. Vogeley. January 1953. 25p. diagrs., 2 tabs. (NACA RM L52J06)

A cascade--general-momentum-theory method for calculating the operating conditions of a supersonic propeller annulus throughout the flight Mach number range is presented. Representative subsonic, transonic, and supersonic solutions are given. The method permits consideration of drag due to lift and thickness, shock interference, and solidity and appears useful in studying the general trends of supersonic propeller operation.

NACA RM L52L30a

SUMMARY OF PILOTS' REPORTS OF CLEAR-AIR TURBULENCE AT ALTITUDES ABOVE 10,000 FEET. Harry Press, Martin H. Schindler and James K. Thompson. March 1953. 18p. diagrs., 5 tabs. (NACA RM L52L30a)

A cooperative program for the collection of pilots' reports of clear-air turbulence encountered at high altitudes in normal civil and military operations was undertaken in 1949. A simple postal-card questionnaire was distributed to groups of civil aircraft operators and selected military units, and a summary of the data obtained from this survey is presented together with some additional reports from Air Weather Service reconnaissance flights.

NACA RM L53A29

LOW-SPEED LATERAL CONTROL CHARACTERISTICS OF AN UNSWEPT WING WITH HEXAGONAL AIRFOIL SECTIONS AND ASPECT RATIO 4.0 AT A REYNOLDS NUMBER OF 6.2×10^6. William M. Hadaway. March 1953. 24p. diagrs., photo. (NACA RM L53A29)

Results of wind-tunnel tests to determine the lateral control, hinge moment, aileron load, and aileron balance chamber pressure characteristics of both a 0.79b/2 and 0.40b/2 outboard 25-percent-chord aileron on a hexagonal 6-percent-thick wing of aspect ratio 4.0 and taper ratio 0.625 are presented. Tests were made at a Reynolds number of 6.2×10^6 and a Mach number of 0.15 with a fuselage attached to the wing. Effects of deflection of leading- and trailing-edge flaps on the aileron characteristics of the outboard aileron were also investigated.

NACA RM L53D09

LOW-SPEED, LARGE-SCALE INVESTIGATION OF AERODYNAMIC CHARACTERISTICS OF A SEMISPAN 49° SWEPTBACK WING WITH A FOWLER FLAP IN COMBINATION WITH A PLAIN FLAP, SLATS, AND FENCES. Edward F. Whittle, Jr. and Stanley Lipson. June 1953. 42p. diagrs., photos., tab. (NACA RM L53D09)

Tests were made in the Langley full-scale tunnel to determine the effect of a Fowler flap on the aerodynamic characteristics of a semispan 49.1° swept-back wing having NACA 65A006 airfoil sections, an aspect ratio of 3.78, and a taper ratio of 0.59. Slats, fences, and a plain flap were tested in combination with the Fowler flap, which was located near the trailing edge of the plain flap. The tests were conducted at Reynolds numbers of 6.1×10^6 and 4.4×10^6 with corresponding Mach numbers of 0.10 and 0.07, respectively.

NACA RM L53E01a

MOMENT OF INERTIA AND DAMPING OF FLUID IN TANKS UNDERGOING PITCHING OSCILLATIONS. Edward Widmayer, Jr. and James R. Reese. June 1953. 9p. diagrs. (NACA RM L53E01a)

Studies were made of the fluid dynamics of some different-shaped fuel tanks considered as being in a horizontal flight attitude and undergoing pitching oscillations of a few degrees. For the tank-full case, comparisons of the experimental moment of inertia of the fluid with some theoretical inertia solutions for tanks having elliptic and rectangular sections were made. In the partially full case the experimentally measured inertias were compared with the solid inertias for the same tank fullness with the view of referring the partially full case to the theoretical solutions for the tank-full condition. Studies of the effective fluid damping indicated that for decaying oscillations the damping is nonlinear with amplitude. For steady oscillations, the damping was large as compared with the initial values for decaying oscillations and tended to increase with increasing frequency and amplitude.

NACA RM L53E06b

AN EXPERIMENTAL INVESTIGATION OF WHEEL SPIN-UP DRAG LOADS. Benjamin Milwitzky, Dean C. Lindquist and Dexter M. Potter. June 1953. 18p. diagrs. (NACA RM L53E06b)

This paper presents some recently obtained information on landing-gear applied drag loads and on the nature of the wheel spin-up phenomenon in landing, based on a program of tests under controlled conditions in the Langley impact basin. In particular, a study has been made of the nature and variation of the coefficient of friction between the tire and the runway during the spin-up process. Also, comparisons have been made of the various results obtained in forward-speed impacts, forward-speed impacts with reverse wheel rotation, spin-up drop tests, and forward-speed impacts with wheel prerotation.

NACA RM L53E14a

A FLIGHT INVESTIGATION OF SOME EFFECTS OF AUTOMATIC CONTROL ON GUST LOADS. Chester B. Payne. July 1953. 18p. diagrs., tab. (NACA RM L53E14a)

The results of a limited flight investigation with a transport airplane to determine the effects of automatic control on gust loads indicate that the loads experienced by the test airplane when automatically controlled were less than those without automatic control. The magnitude of the difference between the loads with and without automatic control was roughly 7 percent. There was no apparent change in the effect of the autopilot on gust loads for a small increase in autopilot sensitivity.

NACA RM L53F12

THE CALCULATED AND EXPERIMENTAL INCREMENTAL LOADS AND MOMENTS PRODUCED BY SPLIT FLAPS OF VARIOUS SPANS AND SPANWISE LOCATIONS ON A 45° SWEPTBACK WING OF ASPECT RATIO 8. H. Neale Kelly. September 1953. 35p. diagrs., photo. (NACA RM L53F12)

Experimental data on the incremental lift and pitching moment produced in the linear angle-of-attack range by 20-percent-chord split flaps of various spans and positions on two 45° sweptback wings of aspect ratio 8.02 have been obtained at a Reynolds number of 4,000,000 and a Mach number of 0.19 by pressure-distribution tests in the Langley 19-foot pressure tunnel. The experimental data have been compared with calculated increments in span loading and pitching moment, and the probable causes of the deviations of the calculated values from the experimental are discussed.

THE FOLLOWING REPORTS HAVE BEEN DECLASSIFIED FROM RESTRICTED TO UNCLASSIFIED, 12/14/53.

NACA RM A8A21

THE EFFECTIVENESS AT HIGH SPEEDS OF A 10-PERCENT-CHORD PLAIN TRAILING-EDGE FLAP ON THE NACA 65-210 AIRFOIL SECTION. Richard J. Ilk. June 14, 1948. 26p. diagrs., tab. (NACA RM A8A21)

This report contains the results of a high-speed wind-tunnel investigation of the effectiveness of a 10-percent-chord plain flap on the NACA 65-210 airfoil section. The results include an indication of the lift-producing characteristics and the effectiveness of the 10-percent-chord flap. From a comparison of the characteristics of the 10-percent-chord flap with those of a 20-percent-chord flap, it was concluded that, although a reduction in flap-chord ratio from 0.20 to 0.10 lessens the severity of the effectiveness loss at supercritical speeds, the 20-percent-chord flap is more effective throughout the entire range of Mach numbers from 0.3 to 0.875.

NACA RM A8D07

INVESTIGATION OF A THIN WING OF ASPECT RATIO 4 IN THE AMES 12-FOOT PRESSURE WIND TUNNEL. I - CHARACTERISTICS OF A PLAIN WING. Ben H. Johnson, Jr. June 2, 1948. 37p. diagrs., photo. (NACA RM A8D07)

This report presents results of tests of a semispan model of an unswept wing having an aspect ratio of 4, a taper ratio of 0.5, and a 4.5-percent-thick diamond profile. The effects of rounding the profile ridge were also investigated. The Reynolds number was varied from 2,000,000 to 10,190,000 at 0.20 Mach number, and the Mach Number was varied from 0.20 to 0.94 at Reynolds numbers below 3,000,000. No excessive movement of the aerodynamic center was observed up to a Mach number of 0.94. The boundary layer separated near the ridge at low Reynolds numbers, but rounding the ridge diminished this separation, increased the lift-drag ratio, and decreased the minimum drag.

NACA RM A8D20

AERODYNAMIC STUDY OF A WING-FUSELAGE COMBINATION EMPLOYING A WING SWEPT BACK 63°. SUBSONIC MACH AND REYNOLDS NUMBER EFFECTS ON THE CHARACTERISTICS OF THE WING AND ON THE EFFECTIVENESS OF AN ELEVON. Robert M. Reynolds and Donald W. Smith. October 11, 1948. 56p. diagrs., photos., tab. (NACA RM A8D20)

This report presents results of tests of a semispan model of a wing having its leading edge swept back 63°, an aspect ratio of 3.5, a taper ratio of 0.25, zero twist, and the NACA 64A006 profile parallel to the airstream. The effectiveness of an elevon as a longitudinal control was investigated. Aerodynamic characteristics of the model are presented for a range of Mach numbers from 0.18 to 0.925 at Reynolds numbers of 2.35 to 3.55 million and for a range of Reynolds numbers from 2.35 to 10 million at 0.18 Mach number.

NACA RM A8E21

TESTS OF A TRIANGULAR WING OF ASPECT RATIO 2 IN THE AMES 12-FOOT PRESSURE WIND TUNNEL. III - THE EFFECTIVENESS AND HINGE MOMENTS OF A SKEWED WING-TIP FLAP. Carl D. Kolbe and Bruce E. Tinling. September 21, 1948. 30p. diagrs., photo. (NACA RM A8E21)

Results of wind-tunnel tests of a semispan model of a triangular wing of aspect ratio 2 with a skewed wing-tip flap are presented. Lift, drag, pitching-moment, and hinge-moment data are included for subsonic Mach numbers up to 0.95. The flap showed extremely high hinge moments and low effectiveness as a longitudinal control. Although less affected by compressibility, this flap is indicated to be inferior to a constant-chord flap when applied to this triangular wing.

NACA RM A8F15

INVESTIGATION OF A THIN WING OF ASPECT RATIO 4 IN THE AMES 12-FOOT PRESSURE WIND TUNNEL. II - THE EFFECT OF CONSTANT-CHORD LEADING- AND TRAILING-EDGE FLAPS ON THE LOW-SPEED CHARACTERISTICS OF THE WING. Ben H. Johnson, Jr. and Angelo Bandettini. October 18, 1948. 42p. diagrs., photos., tabs. (NACA RM A8F15)

Results of tests at low speeds of a thin unswept wing equipped with a constant-chord leading-edge plain flap and a constant-chord trailing-edge flap of either the plain or split type are presented at Reynolds numbers from 3,000,000 to 10,000,000. The maximum lift coefficient obtained by an optimum deflection of these flaps in combination was 1.45 compared to 0.74 for the plain wing with all flaps neutral.

NACA RM A8K19

INVESTIGATION OF A THIN WING OF ASPECT RATIO 4 IN THE AMES 12-FOOT PRESSURE WIND TUNNEL. IV - THE EFFECT OF A CONSTANT-CHORD LEADING-EDGE FLAP AT HIGH SUBSONIC SPEEDS. Ben H. Johnson, Jr. and Verlin D. Reed. January 20, 1949. 30p. diagrs., photo. (NACA RM A8K19)

The report presents results of tests at Mach numbers from 0.20 to 0.94 of a thin straight wing of aspect ratio 4, having a full-span, constant-chord, leading-edge flap. The wing profile was a modified diamond having a thickness ratio of 0.042. The investigation was made at a constant Reynolds number of 2,000,000. Deflection of the leading-edge flap produced an increase in maximum lift-drag ratio and an increase in the lift coefficient for maximum lift-drag ratio for all Mach numbers below 0.94. At a Mach number of 0.94, deflection of the flap resulted in a decrease of the maximum lift-drag ratio.

NACA RM A8L20

INVESTIGATION OF A THIN STRAIGHT WING OF ASPECT RATIO 4 BY THE NACA WING-FLOW METHOD. LIFT AND PITCHING-MOMENT CHARACTERISTICS OF THE WING ALONE. George A. Rathert, Jr., Carl M. Hanson and L. Stewart Rolls. February 14, 1949. 37p. diagrs., photos. (NACA RM A8L20)

This report presents measurements of the lift and pitching-moment characteristics of a straight wing of aspect ratio 4, taper ratio 0.5, having a symmetrical double-wedge airfoil section with a maximum thickness of 4.4-percent chord. The tests were conducted in the Mach number range 0.51 to 1.20, Reynolds numbers 380,000 to 660,000, by the NACA wing-flow method. The results are compared with theory and with wind-tunnel tests of a similar model. It is indicated that in the Mach number range 0.82 to 1.00 the model surface, profile, and test Reynolds number all would be very important considerations in any attempt to study or predict full-scale characteristics from small-model tests.

NACA RM A9A24

A PRELIMINARY EXPERIMENTAL INVESTIGATION OF A SUBMERGED CASCADE INLET. R. Duane Christiani and Lauros M. Randall. March 25, 1949. 29p. diagrs., photos., 3 tabs. (NACA RM A9A24)

Results are presented of an experimental investigation of a submerged air inlet incorporating a cascade of airfoils for turning and diffusing the entering air. The geometric variables investigated included ramp plan form, ramp angle, cascade-axis angle, cascade-blade angle, solidity ratio, and the angle of the duct center line aft of the cascade of airfoils. The effects of these variables on the ram-pressure recoveries for the inlet are shown.

NACA RM A9B28

WIND-TUNNEL INVESTIGATION OF TRANSONIC AILERON FLUTTER. Albert L. Erickson and Robert L. Mannes. June 9, 1949. 55p. diagrs., photos., tab. (NACA RM A9B28)

A new type of aileron flutter is shown to exist in the transonic speed range. This flutter is characterized by the fact that only one degree of mechanical freedom is required.

NACA RM A9D08

A FLIGHT INVESTIGATION OF THE EFFECT OF FLAP DEFLECTION ON HIGH-SPEED LONGITUDINAL-CONTROL CHARACTERISTICS. Maurice D. White, Melvin Sadoff, Lawrence A. Clousing and George E. Cooper. June 30, 1949. 28p. diagrs., photos., tab. (NACA RM A9D08)

Flight tests were conducted on two airplanes to study the effect of wing flap deflection on longitudinal stability and control characteristics at supercritical speeds. Negative flap deflection was beneficial in one case but not in the other. The relative effects on longitudinal stability and control of the variation with Mach number of angle of attack, airplane tail-off pitching moment, downwash and dynamic pressure at the tail, and aileron floating angle are presented. Attempts to predict the supercritical characteristics resulting from deflecting the flaps were made, but the results were inconsistent.

NACA RM A9G20

A PRELIMINARY INVESTIGATION OF THE USEFULNESS OF CAMBER IN OBTAINING FAVORABLE AIRFOIL-SECTION DRAG CHARACTERISTICS AT SUPERCRITICAL SPEEDS. Gerald E. Nitzberg, Stewart M. Crandall and Perry P. Polentz. October 7, 1949. 24p. diagrs. (NACA RM A9G20)

The possibility of employing camber to obtain an airfoil section which, at moderate lift coefficients and supercritical speeds, has drag coefficients significantly lower than those of the corresponding uncambered section is demonstrated. The measured high-speed section characteristics of an example, which appeared promising on the basis of calculations of drag-divergence Mach number, are presented.

NACA RM A9J26

THE EFFECT OF ACCELERATING A HYPOTHETICAL AIRCRAFT THROUGH THE TRANSONIC RANGE WITH CONTROLS FIXED. Howard F. Matthews. April 4, 1950. 30p. diagrs., tab. (NACA RM A9J26)

Mach number histories of the motion experienced by a hypothetical, small, straight-wing aircraft in accelerating at various rates through an assumed controls-fixed pitch-down balance change in the transonic range obtained by a differential analyzer are presented. The effect of longitudinal acceleration on the maximum change in normal acceleration is discussed. It is shown that the Mach number variation of the angle of attack for static balance determines to a great extent the degree of the effect of longitudinal acceleration on the normal acceleration. Two approximate analytical solutions of the longitudinal equations of motion are developed and are shown to compare favorably with the differential-analyzer solutions.

NACA RM A9K01

AN ANALYSIS OF THE FORCES AND PRESSURE DISTRIBUTION ON A WING WITH THE LEADING EDGE SWEPT BACK 37.25°. George G. Edwards and Frederick W. Boltz. March 30, 1950. 102p. diagrs., photos., 2 tabs. (NACA RM A9K01)

Results of wind-tunnel tests are presented for a semi-span model of a wing having the leading edge swept back 37.25°, aspect ratio 6, taper ratio 0.5, zero twist, and NACA 64_1-212 sections normal to the quarter-chord line of these sections. Lift, drag, pitching moment, and pressure-distribution data were obtained for a range of Mach numbers from 0.18 to 0.94, at a Reynolds number of 2,000,000. Similar data were obtained for Reynolds numbers of 1,100,000, 3,000,000, and with roughness applied to the wing (at a Reynolds number of 2,000,000). An analysis is made to correlate the changes in pressure distribution over the wing with the changes in the total forces.

NACA RM E8A27

ICE PROTECTION OF TURBOJET ENGINES BY INERTIA SEPARATION OF WATER. I - ALTERNATE-DUCT SYSTEM. Uwe von Glahn. May 28, 1948. 77p. diagrs., photos., 3 tabs. (NACA RM E8A27)

Aerodynamic and icing investigations of internal water-inertia separation inlets designed to prevent automatically entrance of large quantities of water into a turbojet engine in icing conditions was conducted on a one-half scale model. A simplified analytical approach to the design of internal water-inertia separation inlets is included. Results show that in order to be effective in preventing screen and guide-vane icing for an inlet of this type, a ram-pressure recovery of 75 percent was attained at design inlet-velocity ratio in an icing condition. For nonicing operation, ram-pressure recovery is comparable to direct-ram inlet.

NACA RM E8A28

ICE PROTECTION OF TURBOJET ENGINES BY INERTIA SEPARATION OF WATER. II - SINGLE-OFFSET-DUCT SYSTEM. Uwe von Glahn. June 8, 1948. 11p. diagrs., photos. (NACA RM E8A28)

Investigation of a single-offset-duct system designed to prevent entrance of water into a turbojet engine was conducted on a half-scale nacelle model. An investigation was made to determine ram-pressure recovery and radial velocity profiles at the compressor section and icing characteristics of such a duct system. At a design inlet velocity of 0.77, the maximum ram-pressure recovery attained with effective water-separating inlet was 77 percent, which is considerably less than attainable with a direct-ram inlet. Continuous heating of the accessory-housing surface would be required for inlets that have a small ice storage space.

NACA RM E8A29

ICE PROTECTION OF TURBOJET ENGINES BY INERTIA SEPARATION OF WATER. III - ANNULAR SUBMERGED INLETS. Uwe von Glahn. June 8, 1948. 21p. diagrs., photos., tab. (NACA RM E8A29)

Aerodynamic and icing studies were conducted on a one-half-scale model of an annular submerged inlet for use with axial-flow turbojet engines. Pressure recoveries, screen radial-velocity profiles, circumferential mass-flow variations, and icing characteristics were determined at the compressor inlet. In order to be effective in maintaining water-free induction air, the inlet gap must be extremely small and ram-pressure recoveries consequently are low, the highest achieved being 65 percent at inlet-velocity ratio of 0.86. All inlets exhibited considerable screen icing. Severe mass-flow shifts occurred at angles of attack.

NACA RM E8B27

ANALYSIS OF PARAMETERS FOR THRUST CONTROL OF A TURBOJET ENGINE EQUIPPED WITH AIR-INLET THROTTLE AND VARIABLE-AREA EXHAUST NOZZLE. Aaron S. Boksenbom and Melvin S. Feder. August 10, 1948. 62p. diagrs. (NACA RM E8B27)

By means of an analysis developed in this report, characteristics of a typical turbojet engine equipped with an air-inlet throttle, a variable-area exhaust nozzle, or with a combination of the two were predicted and control-parameter curves were chosen from which such control systems can be designed. The thrust control characteristics of a turbojet engine could be substantially improved by the addition to the conventional control system of either an air-inlet throttle, a variable-area exhaust nozzle, or a combination of the two.

NACA RM E8C09

EFFECT OF INLET-AIR PARAMETERS ON COMBUSTION LIMIT AND FLAME LENGTH IN 8-INCH DIAMETER RAM-JET COMBUSTION CHAMBER. A. J. Cervenka and R. C. Miller. July 22, 1948. 24p. diagrs. (NACA RM E8C09)

The effect of inlet-air parameters on combustion limit and flame length was determined for an 8-inch-diameter ram-jet combustion chamber. For a given combustion-chamber length, combustion efficiency increased with increasing inlet-air temperature or decreasing inlet-air velocity and pressure. Flame length increased with increasing fuel-air ratio, inlet-air pressure, inlet-air velocity, and decreasing inlet-air temperature.

NACA RM E8C18

PRELIMINARY RESULTS OF NATURAL ICING OF AN AXIAL-FLOW TURBOJET ENGINE. Loren W. Acker. August 6, 1948. 16p. diagrs., photos. (NACA RM E8C18)

A flight investigation in natural icing conditions was conducted to determine effect of ice formations on performance of an axial-flow turbojet engine. Re-

sults are presented for a flight in which the icing rate varied from 5.1 to 2.1 inches per hour. During 45 minutes in icing, tail-pipe temperature increased from 761° to 1065° F and jet thrust decreased from 1234 to 910 pounds. Ice penetrated to the second-stage stator blades.

NACA RM E8D13

EXPERIMENTAL INVESTIGATION OF HOT-GAS BLEEDBACK FOR ICE PROTECTION OF TURBO-JET ENGINES. I - NACELLE WITH OFFSET AIR INLET. Edmund E. Callaghan, Robert S. Ruggeri and Richard P. Krebs. July 9, 1948. 22p. diagrs. (NACA RM E8D13)

Investigations were conducted on a two-thirds-scale model of a turbojet-engine nacelle to provide icing protection for the engine, protective screen, and accessory housing by the introduction of hot gases into the inlet-air stream. The hot gas was injected into the inlet-air stream from a series of orifice holes around the inlet. Results indicate that if a minimum kinetic temperature of 32° F is maintained throughout the screen, adequate ice protection will be obtained for the entire installation.

NACA RM E8F01a

NATURAL ICING OF AN AXIAL-FLOW TURBOJET ENGINE IN FLIGHT FOR A SINGLE ICING CONDITION. Loren W. Acker. August 12, 1948. 16p. diagrs., photos. (NACA RM E8F01a)

A flight investigation in natural icing conditions was conducted to determine the effect of ice formations on performance of axial-flow turbojet engines. Results are presented for a flight in which liquid-water content varied from 0.077 to 0.490 gram per cubic meter. During 60 minutes in icing, tail-pipe temperature increased from 865° to 965° F and the jet thrust decreased from 1950 to 1700 pounds. The engine was satisfactorily accelerated to take-off power near the end of the icing period.

NACA RM E8J25b

ANALYSIS OF EFFECTS OF INLET PRESSURE LOSSES ON PERFORMANCE OF AXIAL-FLOW TYPE TURBOJET ENGINE. Newell D. Sanders and John Palasics. November 24, 1948. 39p. diagrs. (NACA RM E8J25b)

The effects of inlet pressure losses on the net thrust and specific fuel consumption for an axial-flow type turbojet engine have been determined. At low altitudes and flight Mach numbers, a 10-percent loss in inlet total pressure will result in a 14-percent loss in net thrust and a 15-percent increase in specific fuel consumption, and at high altitudes and flight Mach numbers a 10-percent inlet total-pressure loss produces a 22-percent loss in net thrust and an increase of 16 percent in specific fuel consumption.

NACA RM E8J25c

INLET ICING AND EFFECTIVENESS OF HOT-GAS BLEEDBACK FOR ICE PROTECTION OF TURBO-JET ENGINE. William A. Fleming and Martin J. Saari. November 26, 1948. 37p. diagrs., photos. (NACA RM E8J25c)

A method of protecting the inlet of a turbojet engine from ice was studied in the NACA Cleveland altitude wind tunnel whereby hot gas was bled from the turbine inlet and injected into the induction system ahead of the compressor. At ambient-air temperatures of 25° to 30° F, the hot-gas bleedback system removed ice from the compressor inlet in 3 to 5 minutes; however, at ambient temperatures of about 0° F, ice formed on the compressor inlet very slowly below 11,000 rpm with the hot-gas bleedback system in operation.

NACA RM E9B23

EFFECT OF HOT-GAS BLEEDBACK ICE PREVENTION ON PERFORMANCE OF A TURBOJET ENGINE WITH FIXED-AREA TAIL-PIPE NOZZLE. Robert O. Dietz, Jr. and Richard P. Krebs. May 16, 1949. 26p. diagrs. (NACA RM E9B23)

An analytical investigation was conducted to show that the inlet of a turbojet engine can be protected from ice accretions by bleeding hot gases from other locations within the engine to the inlet without undue loss in thrust. Bleedback from the combustion chamber was preferable to tail-pipe bleedback because the pressure was greater, less bleedback was required, and smaller thrust losses resulted. The thrust available at take-off from an engine protected against icing conditions in temperatures as low as -40° F with liquid-water contents as high as 2.5 grams per cubic meter exceeded the thrust available from the same engine in an ambient-air temperature of 100° F.

NACA RM E9C16

EXPERIMENTAL INVESTIGATION OF HOT-GAS BLEEDBACK FOR ICE PROTECTION OF TURBO-JET ENGINES. II - NACELLE WITH LONG STRAIGHT AIR INLET. Edmund E. Callaghan and Robert S. Ruggeri. May 26, 1949. 34p. diagrs., photo. (NACA RM E9C16)

Investigations were conducted on a two-thirds-scale model of a turbojet-engine nacelle to provide basic design criterions for hot-gas bleedback systems. The hot gas was injected into the inlet-air stream from a series of orifices around the inlet. General rules for obtaining a satisfactory orifice configuration are presented. Satisfactory agreement between calculated and measured heat requirements was obtained.

NACA RM E9E06

ANALYSIS AND PRELIMINARY INVESTIGATION OF EDDY-CURRENT HEATING FOR ICING PROTECTION OF AXIAL-FLOW-COMPRESSOR BLADES. Thomas Dallas and C. Ellisman. August 8, 1949. 66p. diagrs., photos., tab. (NACA RM E9E06)

An analysis and a preliminary experimental investigation of the use of eddy currents for heating the blades of an axial-flow compressor of a turbojet engine as a means of ice protection is presented. Steinmetz's analysis of eddy currents in flat plates is extended and formulas are derived that permit calculations of currents, voltages, flux distribution, and power when operation is not limited to conditions of constant permeability. The application of eddy-current heating appears to be feasible for the generation of power densities required for icing protection of axial-flow-compressor blades.

NACA RM E9E12

EXPERIMENTAL INVESTIGATION OF HOT-GAS BLEEDBACK FOR ICE PROTECTION OF TURBOJET ENGINES. III - NACELLE WITH SHORT STRAIGHT AIR INLET. Robert S. Ruggeri and Edmund E. Callaghan. August 4, 1949. 24p. diagrs., photo. (NACA RM E9E12)

An aerodynamic and icing investigation was conducted on a two-thirds-scale model of a turbojet-engine nacelle utilizing a hot-gas bleedback system for ice prevention. The optimum temperature distribution inside the model was obtained at a bleedback of 4.9 percent for a gas temperature of 1000° F and was independent of tunnel velocity. Icing protection for the accessory housing could not be attained at bleedbacks less than 6.0 percent for a gas temperature of 1000° F. Satisfactory agreement between measured and calculated heat requirements for icing conditions was obtained.

NACA RM E9I27

ALTITUDE-CHAMBER PERFORMANCE OF BRITISH ROLLS-ROYCE NENE II ENGINE. II - 18.41-INCH-DIAMETER JET NOZZLE. J. C. Armstrong, H. D. Wilsted and K. R. Vincent. October 26, 1949. 55p. diagrs., 2 tabs. (NACA RM E9I27)

An altitude-chamber investigation of British Rolls-Royce Nene II turbojet engine was conducted over range of altitudes from sea level to 60,000 feet and ram-pressure ratios from 1.00 to 3.50, using 18.41-inch-diameter jet nozzle. The 18.41-inch-diameter jet nozzle showed a small decrease in net-thrust specific fuel consumption from the standard 18.75-inch-diameter jet nozzle at cruise conditions.

NACA RM E9K25a

TRANSIENT OPERATING CHARACTERISTICS OF A TURBOJET ENGINE WHEN SUBJECTED TO STEP CHANGES IN FUEL FLOW. Arthur H. Bell and J. Elmo Farmer. February 20, 1950. 45p. diagrs., photos., 2 tabs. (NACA RM E9K25a)

An investigation was conducted on a typical centrifugal compressor type turbojet engine to determine operating characteristics during changes in engine speed resulting from approximate step changes in fuel flow. The data show the variation with time of engine speed, thrust, fuel flow, and critical gas and material temperatures as caused by sudden changes in fuel flow. Results show that the gas temperature at the tail-cone exit indicated the approximate turbine blade temperature during periods of acceleration and deceleration and that the time required for rotor speed to reach equilibrium was approximately the same for accelerations and decelerations of the same magnitude for the same range of speeds.

NACA RM L8A30a

A COMPILATION OF THE PRESSURES MEASURED ON A WING AND AILERON WITH VARIOUS AMOUNTS OF SWEEP IN THE LANGLEY 8-FOOT HIGH-SPEED TUNNEL. Richard T. Whitcomb. April 13, 1948. 84p. diagrs., 78 tabs. (NACA RM L8A30a)

A compilation is made in tabular form of all the pressures measured on a thin high-aspect-ratio wing and aileron with no sweep and with 30° and 45° of sweepback and sweepforward at high subsonic Mach numbers in the Langley 8-foot high-speed tunnel.

NACA RM L8C11

LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS AT TRANSONIC SPEEDS OF A SEMISPAN AIRPLANE MODEL HAVING A 45° SWEPTBACK WING AND TAIL AS OBTAINED BY THE TRANSONIC-BUMP METHOD. M. Leroy Spearman. June 30, 1948. 21p. diagrs., photo., tab. (NACA RM L8C11)

Tests were made using the transonic-bump method to determine the stability and control characteristics in the transonic range of a semispan airplane model having a 45° sweptback wing and tail. The lift, drag, and pitching-moment coefficients for two stabilizer settings were obtained at various angles of attack through a Mach number range from 0.50 to 1.23.

NACA RM L8C12

AN INVESTIGATION OF THE DOWNWASH BEHIND A HIGH-ASPECT-RATIO WING WITH VARIOUS AMOUNTS OF SWEEP IN THE LANGLEY 8-FOOT HIGH-SPEED TUNNEL. Richard T. Whitcomb. May 11, 1948. 25p. diagrs., 2 tabs. (NACA RM L8C12)

Downwash angles have been measured at vertical positions at the probable tail location behind a high-aspect-ratio wing with an NACA 65-210 section with no sweep and 30° and 45° of sweepback and sweepforward in conjunction with a fuselage at Mach numbers up to 0.96. Presented are the variations of downwash angles with normal-force coefficient and Mach number.

NACA RM L8C15

LANGLEY FULL-SCALE-TUNNEL INVESTIGATION OF THE CHARACTERISTICS IN YAW OF A TRAPEZOIDAL WING OF ASPECT RATIO 4 WITH CIRCULAR-ARC AIRFOIL SECTIONS. Ralph W. May, Jr. and George L. Stevens. August 30, 1948. 19p. diagrs., photos. (NACA RM L8C15)

Results are given of an investigation at an approximate Reynolds number of 4,100,000 and Mach number

of 0.07 to determine the characteristics in yaw of a trapezoidal wing of aspect ratio 4 with circular-arc airfoil sections and 0.20-chord rear and drooped-nose flaps. Measurements of the lift, the lateral force, the rolling moment, and the yawing moment of five configurations were made through a range of angle of attack at several yaw angles ranging from approximately -6° to 18°.

NACA RM L8D06

EFFECT OF HIGH-LIFT DEVICES ON THE LONGITUDINAL AND LATERAL CHARACTERISTICS OF A 45° SWEPTBACK WING WITH SYMMETRICAL CIRCULAR-ARC SECTIONS. Eugene R. Guryansky and Stanley Lipson. October 1, 1948. 45p. diagrs., photo. (NACA RM L8D06)

An investigation was made in the Langley full-scale tunnel at a Reynolds number of 4.5×10^6 of the longitudinal characteristics of several leading-edge and trailing-edge flap configurations and the lateral characteristics of one flapped configuration of a 45° sweptback wing having symmetrical circular-arc sections, aspect ratio 3.5, and taper ratio 0.5. Investigation included tests of chordwise fences with and without a rounded leading-edge modification installed on the outer semispan of the wing.

NACA RM L8D14

PRELIMINARY CORRELATION OF THE EFFECT OF COMPRESSIBILITY ON THE LOCATION OF THE SECTION AERODYNAMIC CENTER AT SUBCRITICAL SPEEDS. Edward C. Polhamus. November 3, 1948. 7p. diagr., tab. (NACA RM L8D14)

A correlation of available two-dimensional airfoil data to determine the effects of compressibility on the location of the section aerodynamic center at low lift coefficients has been made. The results indicate that large forward or rearward movements of the aerodynamic center with Mach number are possible. It appears that thickness ratio is an important parameter controlling the variation with Mach number.

NACA RM L8D30

EFFECT OF LEADING-EDGE HIGH-LIFT DEVICES AND SPLIT FLAPS ON THE MAXIMUM-LIFT AND LATERAL CHARACTERISTICS OF A RECTANGULAR WING OF ASPECT RATIO 3.4 WITH CIRCULAR-ARC AIRFOIL SECTIONS AT REYNOLDS NUMBERS FROM 2.9×10^6 TO 8.4×10^6. Roy H. Lange and Ralph W. May, Jr. November 10, 1948. 70p. diagrs., photos. (NACA RM L8D30)

Results are presented of an investigation at high Reynolds numbers and low Mach numbers in the Langley full-scale tunnel to determine the effects of leading-edge high-lift devices and split flaps on the maximum-lift and lateral characteristics of a rectangular wing of aspect ratio 3.4 with circular-arc airfoil sections. Measurements were made of the static-aerodynamic characteristics in pitch and in yaw of the basic wing and of the wing with several leading-edge high-lift devices and 0.20-chord split flaps deflected alone and in combination with one another. Scale effects were investigated at Reynolds numbers ranging from 2.9×10^6 to 8.4×10^6.

NACA RM L8F16

LOW-SPEED PRESSURE DISTRIBUTIONS OVER THE DROOPED-NOSE FLAP OF A 42° SWEPTBACK WING WITH CIRCULAR-ARC AIRFOIL SECTIONS AT A REYNOLDS NUMBER OF 5.3×10^6. Stanley H. Spooner and Robert L. Woods. September 23, 1948. 28p. diagrs., tab. (NACA RM L8F16)

Pressure distributions over the drooped-nose flap of a 42° sweptback wing having circular-arc airfoil sections are presented for several angles of attack. The drooped-nose-flap normal-force and hinge-moment coefficients are determined. The effects of nose-flap deflection and span and of half-span trailing-edge split flaps are shown. The Reynolds number and Mach number of the investigation were 5.3×10^6 and 0.11, respectively.

NACA RM L8F17

INVESTIGATION OF FLOW CONDITIONS AND THE NATURE OF THE WALL-CONSTRICTION EFFECT NEAR AND AT CHOKING BY MEANS OF THE HYDRAULIC ANALOGY. Clarence W. Matthews and Ray H. Wright. September 1, 1948. 62p. diagrs. (NACA RM L8F17)

Field surveys are presented of subcritical, supercritical, and choking flow about several airfoils at zero lift in a water channel. A qualitative study is made of the effects of the channel walls on supercritical flow about the airfoils, of the development of the choking condition from supercritical flow, and of the effects of airfoil characteristics on the choking stream Mach number. The experimental wall-interference results are compared with results obtained by theoretical calculations.

NACA RM L8F29

AN INVESTIGATION AT LOW SPEED OF A 51.3° SWEPTBACK SEMISPAN WING WITH A RAKED TIP AND WITH 16.7-PERCENT-CHORD AILERONS HAVING THREE SPANS AND THREE TRAILING-EDGE ANGLES. Jack Fischel and Leslie E. Schneiter. July 21, 1948. 52p. diagrs. photos., 2 tabs. (NACA RM L8F29)

Contains results and discussion of aerodynamic and lateral-control investigation at low speed of a 51.3° sweptback semispan wing with a raked tip and with 16.7-percent-chord sealed plain ailerons having spans of 34, 66, and 93 percent of the span of a full-span aileron, each with trailing-edge angles of 6°, 14°, and 25°. Lift and lateral-control data were obtained throughout a large angle-of-attack range. Spanwise variations of rolling-moment and hinge-moment parameters, as well as the effects of the aileron trailing-edge angles, were determined from the aileron configurations tested.

NACA RM L8G05

FULL-SCALE INVESTIGATION OF AN EQUILATERAL TRIANGULAR WING HAVING 10-PERCENT-THICK BICONVEX AIRFOIL SECTIONS. Edward F. Whittle, Jr. and J. Calvin Lovell. September 30, 1948. 32p. diagrs., photos. (NACA RM L8G05)

Contains the results of an investigation made at a Reynolds number of 6.0×10^6 to determine the low-speed characteristics of a wing having triangular plan form, 60° of sweepback at the leading edge, and 10-percent-thick biconvex airfoil sections. The investigation consisted of the determination of the effects on the stalling and static longitudinal characteristics of semispan and full-span leading-edge and trailing-edge flaps and the effects on the static lateral stability characteristics of a vertical fin.

NACA RM L8G22

DOWNWASH, SIDEWASH, AND WAKE SURVEYS BEHIND A 42° SWEPTBACK WING AT A REYNOLDS NUMBER OF 6.8×10^6 WITH AND WITHOUT A SIMULATED GROUND. G. Chester Furlong and Thomas V. Bollech. December 13, 1948. 77p. diagrs., photos., tab. (NACA RM L8G22)

An investigation, with and without a simulated ground, has been conducted to provide flow inclination and wake data behind a 42° sweptback wing. Tests were made for two model configurations; namely, the plain wing and the wing with inboard trailing-edge split flaps and outboard leading-edge flaps deflected. Contour charts of downwash, sidewash, and dynamic-pressure ratio at two longitudinal stations behind the wing (2.0 and 2.8 mean aerodynamic chords) are presented. Integrations have been made to obtain variations of average downwash and dynamic-pressure ratio with angle of attack. The possibility of extending the lifting-line method r) used for calculating the downwash behind unswept wings to the case of a sweptback wing has been briefly investigated.

NACA RM L8H20

AN INVESTIGATION AT LOW SPEED OF A 51.3° SWEPTBACK SEMISPAN WING EQUIPPED WITH 16.7-PERCENT-CHORD PLAIN FLAPS AND AILERONS HAVING VARIOUS SPANS AND THREE TRAILING-EDGE ANGLES. Jack Fischel and Leslie E. Schneiter. November 12, 1948. 81p. diagrs., photo., 2 tabs. (NACA RM L8H20)

Contains results and discussion of an aerodynamic investigation at low speed of a 51.3° sweptback semispan wing equipped with 16.7-percent-chord plain flaps and ailerons having various spans, spanwise locations, and trailing-edge angles. Variation of the lift and lateral-control data with flap or aileron span and spanwise location were determined through a large angle-of-attack range. The effects of aileron trailing-edge angle and the aerodynamic characteristics of a spoiler-aileron configuration on the wing were also determined.

NACA RM L8I03

THE EFFECTS OF HIGH-LIFT DEVICES ON THE LOW-SPEED STABILITY CHARACTERISTICS OF A TAPERED 37.5° SWEPTBACK WING OF ASPECT RATIO 3 IN STRAIGHT AND ROLLING FLOW. M. J. Queijo and Jacob H. Lichtenstein. November 9, 1948. 27p. diagrs., photo., tab. (NACA RM L8I03)

Contains results of tunnel tests to determine effects of various combinations of split flaps, slats, and nose slats on the stability characteristics of a tapered 37.5° sweptback wing of aspect ratio 3 in straight and rolling flow.

NACA RM L8I30

TRANSONIC-FLUTTER INVESTIGATION OF WINGS ATTACHED TO TWO LOW-ACCELERATION ROCKET-PROPELLED VEHICLES. Reginald R. Lundstrom, William T. Lauten, Jr. and Ellwyn E. Angle. November 23, 1948. 24p. diagrs., photos., 3 tabs. (NACA RM L8I30)

Two low-acceleration transonic-flutter vehicles were launched and flown. The first carried two test wings, one of which fluttered at $M = 0.92$ at a frequency of 61.4 cycles per second. The reference flutter speed determined from two-dimensional theory for an unswept wing in incompressible flow is conservative when compared to the experimental flutter speed. The second vehicle carried two test wings, one of which failed at $M = 0.71$ because of a low-frequency divergent oscillation. Since this failure was not caused by conventional flexure-tors on flutter, no comparison with a reference flutter speed can be made.

NACA RM L8J11

INITIAL EXPERIMENTS ON FLUTTER OF UNSWEPT CANTILEVER WINGS AT MACH NUMBER 1.3. W. J. Tuovila, John E. Baker and Arthur A. Regier. January 6, 1949. 23p. diagrs., photos., 2 tabs. (NACA RM L8J11)

This paper contains experimental data for the bending torsion flutter of unswept cantilever wings at Mach number 1.3. Comparison with the theory of flutter at supersonic speeds indicates that the theory is applicable in predicting cantilever-wing flutter. These preliminary experiments consider also various overall effects of center-of-gravity location, elastic-axis location, mass-density parameter, section shape, and some wing-tip moments of inertia.

NACA RM L8K12

LATERAL-CONTROL INVESTIGATION ON A 37° SWEPTBACK WING OF ASPECT RATIO 6 AT A REYNOLDS NUMBER OF 6,800,000. Robert R. Graham and William Koven. January 27, 1949. 58p. diagrs., photo. (NACA RM L8K12)

Lateral-control devices including an aileron, a plain spoiler at two chordwise locations, and a step

spoiler were investigated. The effects of stall control and high-lift devices including a leading-edge flap, slat, and drooped leading edge and split and double slotted trailing-edge flaps on the lateral control characteristics were also investigated. Force and moment data are presented for all the devices and in addition hinge-moment and balance compartment pressure coefficients are presented for the aileron.

NACA RM L8L01

ANALYTICAL CONSIDERATIONS REGARDING A CONTROL-SURFACE BALANCE ARRANGEMENT FOR SUBSONIC AND SUPERSONIC FLIGHT. Thomas A. Toll and Glenn H. Adair. January 10, 1949. 20p. diagrs. (NACA RM L8L01)

Presents results of a simplified analysis to indicate the possibility of utilizing the principle of the sealed internal balance to reduce control-surface hinge moments at both subsonic and supersonic speeds. Certain design considerations and possible advantages of such a balance are discussed.

NACA RM L8L29

LOW-SPEED STATIC-STABILITY AND ROLLING CHARACTERISTICS OF LOW-ASPECT-RATIO WINGS OF TRIANGULAR AND MODIFIED TRIANGULAR PLAN FORMS. Byron M. Jaquet and Jack D. Brewer. March 29, 1949. 44p. diagrs., photos., tab. (NACA RM L8L29)

Presents results of an investigation conducted in the Langley stability tunnel to determine effects of changes in profile and aspect ratio on the low-speed static-stability and rolling characteristics of triangular wings. The investigation was extended to determine the effects of adding fins to the upper surface and of cutting portions from the tips of a triangular wing to form low-aspect-ratio tapered wings. Results are compared with available swept-wing theory and triangular-wing theory.

NACA RM L9B25a

COMPARISON OF SEMISPAN DATA OBTAINED IN THE LANGLEY TWO-DIMENSIONAL LOW-TURBULENCE PRESSURE TUNNEL AND FULL-SPAN DATA OBTAINED IN THE LANGLEY 19-FOOT PRESSURE TUNNEL FOR A WING WITH 40° SWEEPBACK OF THE 0.27-CHORD LINE. Jones F. Cahill. April 22, 1949. 33p. diagrs., photo. (NACA RM L9B25a)

Results obtained in this investigation show that data obtained from semispan-wing tests in the Langley two-dimensional low-turbulence pressure tunnel may be expected to be in good agreement with data obtained from full-span tests of the wing alone except for unusually sensitive configurations where the lift distribution is such that small disturbances may cause a radical change in the location of the original stall or in the manner in which the stall progresses.

NACA RM L9B25b

CONTINUATION OF WING FLUTTER INVESTIGATION IN THE TRANSONIC RANGE AND PRESENTATION OF A LIMITED SUMMARY OF FLUTTER DATA. William T. Lauten, Jr. and J. G. Barmby. April 21, 1949. 21p. diagrs., photos., 2 tabs. (NACA RM L9B25b)

Results of four unswept flutter airfoils attached to two freely falling bodies are reported. One airfoil fluttered at a transonic Mach number of 1.17. Flutter frequency and phasing were recorded. A limited summary of experimental subsonic and supersonic flutter data is included and a critical flutter region is defined.

NACA RM L9E18

EFFECTS OF VARIOUS OUTBOARD AND CENTRAL FINS ON LOW-SPEED STATIC-STABILITY AND ROLLING CHARACTERISTICS OF A TRIANGULAR-WING MODEL. Byron M. Jaquet and Jack D. Brewer. June 29, 1949. 60p. diagrs., photos., 2 tabs. (NACA RM L9E18)

Results of an investigation conducted in Langley stability tunnel to determine effects of various outboard and central-fin arrangements on low-speed static-stability and rolling characteristics of a triangular-wing model are presented. One of the purposes was the determination of the fin configuration to provide good directional stability throughout the lift-coefficient range.

NACA RM L9F24

EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF SWEEPBACK ON THE FLUTTER OF A UNIFORM CANTILEVER WING WITH A VARIABLE LOCATED CONCENTRATED MASS. Herbert C. Nelson and John E. Tomassoni. August 31, 1949. 33p. diagrs., tab. (NACA RM L9F24)

An experimental investigation of the effect of sweepback on the flutter characteristics of an untapered cantilever wing carrying a concentrated weight is reported. The investigation covered sweepback angles of 0°, 45°, and 60°. The weight used in the investigation was approximately 14 percent heavier than the wing. The data presented may be used in conjunction with analytical methods of predicting flutter to indicate the validity of the methods used.

NACA RM L9H17

LOW-SPEED STATIC LONGITUDINAL STABILITY CHARACTERISTICS OF A CANARD MODEL HAVING A 60° TRIANGULAR WING AND HORIZONTAL TAIL. William R. Bates. November 9, 1949. 16p. diagrs., tab. (NACA RM L9H17)

Contains results of force tests and flow surveys made in the Langley free-flight tunnel to determine the stability and control characteristics of a canard model having a 60° triangular plan-form wing and horizontal tail. Tests were made with the horizontal tail used as a fixed-nose elevator or floating freely at various tab deflections.

NACA RM L9H18

LATERAL-CONTROL INVESTIGATION AT A REYNOLDS NUMBER OF 5,300,000 OF A WING OF ASPECT RATIO 5.8 SWEPTFORWARD 32° AT THE LEADING EDGE. Robert R. Graham. February 7, 1950. 44p. diagrs., photo. (NACA RM L9H18)

Lateral-control devices, including an aileron and plain and step spoilers, were investigated. The effects of an inboard leading-edge flap and a trailing-edge double-slotted flap on the lateral-control characteristics were also investigated. Force and moment data are presented for all the devices and, in addition, hinge-moment, normal-force, and balance-compartment-pressure coefficients are presented for the aileron.

NACA RM L9J07

LOW-SPEED PRESSURE-DISTRIBUTION AND FLOW INVESTIGATION FOR A LARGE PITCH AND YAW RANGE OF THREE LOW-ASPECT-RATIO POINTED WINGS HAVING LEADING EDGE SWEPT BACK 60° AND BICONVEX SECTIONS. Ralph W. May, Jr. and John G. Hawes. November 18, 1949. 109p. diagrs., photos., tab. (NACA RM L9J07)

Low-speed pressure distributions and flow characteristics through a yaw range of 0° to 35° and an angle-of-attack range through the stall are presented for three small-scale low-aspect ratio pointed wings having 10-percent-thick biconvex sections, 60° sweptback leading edge, and 0°, 30°, and -30° trailing-edge sweep. Also given are section lift coefficients and centers of pressure at zero yaw, and wing spanwise load distributions, force, and moment coefficients throughout the yaw range. A correlation is established between the pressure distributions and the vortex flow characteristics.

NACA RM L9J21a

EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF ROOT RESTRAINT ON THE FLUTTER OF A SWEPTBACK, UNIFORM, CANTILEVER WING WITH A VARIABLE LOCATED CONCENTRATED MASS. John E. Tomassoni and Herbert C. Nelson. March 31, 1950. 36p. diagrs., tab. (NACA RM L9J21a)

An experimental subsonic flutter investigation of the effect of root restraint on sweptback, uniform, cantilever wings carrying a concentrated weight is reported. The results pertain only to wings with relatively large length-to-chord ratios where the restrained root is a small portion of the whole wing.

NACA RM L9K04

LOW-SPEED INVESTIGATION OF THE AERODYNAMIC LOADS ON THE DROOP-NOSE FLAP OF A WING WITH LEADING EDGE SWEPT BACK 47.5° AND HAVING SYMMETRICAL CIRCULAR-ARC AIRFOIL SECTIONS AT A REYNOLDS NUMBER OF 4.3×10^6. Edward F. Whittle, Jr. and Marvin P. Fink. January 16, 1950. 34p. diagrs., 3 tabs. (NACA RM L9K04)

The results of an investigation of the pressure distribution over the full-span droop-nose flap of a wing with the leading edge swept back 47.5° and having symmetrical circular-arc airfoil sections are presented in this paper. The configurations tested included the basic configuration, the full-span droop-nose flap deflected 10°, 20°, 30°, and 40°, the semi-span plain flap deflected 40°, and both flaps deflected 40°. The investigation was conducted in the Langley full-scale tunnel at a Reynolds number of 4.3×10^6 and a Mach number of 0.07.

NACA RM L9K28a

PRELIMINARY EXPERIMENTS ON FORCES AND MOMENTS OF AN OSCILLATING WING AT HIGH-SUBSONIC SPEEDS. S. A. Clevenson and E. Widmayer, Jr. February 20, 1950. 28p. diagrs., tab. (NACA RM L9K28a)

Experimental results of lifts and moments about the quarter chord of an oscillating wing at high-subsonic Mach numbers are presented. A comparison of the experimental magnitude of the lift vector with the theory as given by Dietze showed good agreement. Comparisons of the moments and the quadrature component of lift with theory indicated that some refinements in the testing technique are necessary for the experimental determination of these quantities in the transonic range.

NACA RM L9L09a

THE EFFECT OF AILERON SPAN AND SPANWISE LOCATION ON THE LOW-SPEED LATERAL CONTROL CHARACTERISTICS OF AN UNTAPERED WING OF ASPECT RATIO 2.09 AND 45° SWEEPBACK. Rodger L. Naeseth and William M. O'Hare. February 10, 1950. 20p. diagrs. (NACA RM L9L09a)

Presents results of a low-speed wind-tunnel investigation of the effects of span and spanwise location of 0.25-chord flap-type ailerons on the lateral control characteristics of an untapered complete wing of aspect ratio 2.09 and 45° sweepback. The tests were made at a Reynolds number of 3,100,000.

NACA RM L9L13

ANALYSIS OF V-g DATA OBTAINED FROM SEVERAL NAVAL AIRPLANES. James O. Thornton. July 7, 1950. 28p. diagrs., 4 tabs. (NACA RM L9L13)

V-g records obtained with the F8F-1, SB2C-5, and F6F-5 airplanes from 1945 to 1949 are analyzed statistically to give the frequency of maximum loads and airspeeds made in bombing, gunnery, dive pull-outs, and simulated attacks. Composite V-g diagrams are shown for the F4U-4 and TBM-3 airplanes.

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA TN 3050

A PHOTOGRAPHIC METHOD FOR DETERMINING VERTICAL VELOCITIES OF AIRCRAFT IMMEDIATELY PRIOR TO LANDING. Emanuel Rind. January 1954. 23p. diagrs., photos. (NACA TN 3050)

A photographic method which has been successfully used for obtaining statistical data on vertical velocities of land-based aircraft immediately prior to landing contact is described. A long-focal-length (40-inch) lens is used. No instrument installation on the aircraft or interference with airport operation is required. A relatively simple data reduction is employed.

NACA TN 3059

ELASTIC BUCKLING UNDER COMBINED STRESSES OF FLAT PLATES WITH INTEGRAL WAFFLE-LIKE STIFFENING. Norris F. Dow, L. Ross Levin and John L. Troutman. January 1954. 19p. diagrs., photos., tab. (NACA TN 3059)

Theory and experiment were compared and found in good agreement for the elastic buckling under combined stresses of long flat plates with integral waffle-like stiffening in a variety of configurations. For such flat plates, 45° waffle stiffening was found to be the most effective of the configurations for the proportions considered over the widest range of combinations of compression and shear.

NACA TN 3064

DATA ON THE COMPRESSIVE STRENGTH OF SKIN-STRINGER PANELS OF VARIOUS MATERIALS. Norris F. Dow, William A. Hickman and B. Walter Rosen. January 1954. 49p. diagrs., photo., 7 tabs. (NACA TN 3064)

Flat skin-stringer compression panels of stainless steel, mild steel, titanium, copper, four aluminum alloys, and a magnesium alloy were tested. The results show the effect of variations in yield stress, Young's modulus, and both yield stress and Young's modulus for constant yield strain on the buckling, and load-shortening characteristics of the panels.

NACA TN 3113

ANALYSIS OF STRAIGHT MULTICELL WINGS ON CAL-TECH ANALOG COMPUTER. Stanley U. Benscoter and Richard H. MacNeal, California Institute of Technology. January 1954. 79p. diagrs., 4 tabs. (NACA TN 3113)

Using the Cal-Tech analog computer, structural analyses have been made for four straight multicell wings. Wings with aspect ratios of 2 and 4 with rectangular and biconvex cross sections have been considered. The wings are supported rigidly along two lines at the faces of the fuselage. Concentrated loads are applied at the intersection points of the ribs and spars. The effects of shearing strains in the ribs and spars are included. Deflections and all internal force quantities have been recorded as well as vibration modes and frequencies.

NACA TN 3116

CORRELATIONS INVOLVING PRESSURE FLUCTUATIONS IN HOMOGENEOUS TURBULENCE. Mahinder S. Uberoi, Johns Hopkins University. January 1954. 61p. diagrs., 2 tabs. (NACA TN 3116)

It is shown that the correlation of fluctuating static pressure (in an incompressible and homogeneous turbulence) with any fluctuating quantity in the flow field can be expressed in terms of the correlation of the same quantity with two or more components of the velocity. The correlations of pressure with itself and of pressure with two velocity components are investigated in detail for the case of isotropic turbulence. A postulated relation between the fourth-order and second-order correlations is investigated. The consequences of this relation are compared with the measurements of the fourth-order correlations. The root-mean-square pressure and pressure gradients are computed from second-order correlation for a range of turbulence Reynolds numbers. Since the pressure gradient is related to diffusion of marked particles from a source, the computed pressure-gradient level is compared with that calculated from a set of diffusion measurements. The triple correlation equation and plausible hypotheses relating higher order correlations with second-order correlation are examined for the possibility of getting a determinate set of equations for isotropic turbulence.

NACA TN 3118

DESIGN DATA FOR MULTIPOST-STIFFENED WINGS IN BENDING. Roger A. Anderson, Aldie E. Johnson, Jr. and Thomas W. Wilder, III. January 1954. 31p. diagrs., 3 tabs. (NACA TN 3118)

The results of a computational program are presented which give numerical values of the stiffnesses required of the various components of a multipost-stiffened wing to achieve desired buckling-stress values under bending loads. Two arrangements of the posts are considered, upright posts and posts used as diagonals of a Warren truss. This work extends and summarizes the calculations presented in NACA RM L52K10a.

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NACA TN 3119

STATIC PROPERTIES AND RESISTANCE CHARACTERISTICS OF A FAMILY OF SEAPLANE HULLS HAVING VARYING LENGTH-BEAM RATIO. Arthur W. Carter and David R. Woodward. January 1954. 38p. diagrs., photo., 3 tabs. (NACA TN 3119)

The principal results of the investigation of the static properties of a family of seaplane hulls are presented in charts from which draft, trim, and upsetting moment may be obtained for wide ranges of load, center-of-gravity location, and angle of roll. Charts are presented for the determination of resistance and trimming moment for length-beam ratios of 6 and 15.

NACA TN 3120

SPAN LOAD DISTRIBUTIONS RESULTING FROM CONSTANT VERTICAL ACCELERATION FOR THIN SWEPTBACK TAPERED WINGS WITH STREAMWISE TIPS. SUPERSONIC LEADING AND TRAILING EDGES. Isabella J. Cole and Kenneth Margolis. January 1954. 62p. diagrs., 2 tabs. (NACA TN 3120)

On the basis of the linearized supersonic-flow theory, equations for the span load distribution resulting from constant vertical acceleration (i.e., linear angle-of-attack variation with time) are derived for a series of thin sweptback tapered wings with streamwise tips. The analysis is valid, in general, at Mach numbers for which the wing leading and trailing edges are supersonic. Computational results are presented in the form of generalized design curves which permit fairly rapid estimation of the load distribution for broad ranges of the parameters aspect ratio, taper ratio, leading-edge sweepback, and Mach number.

NACA TN 3121

SOME EFFECTS OF ASPECT RATIO AND TAIL LENGTH ON THE CONTRIBUTION OF A VERTICAL TAIL TO UNSTEADY LATERAL DAMPING AND DIRECTIONAL STABILITY OF A MODEL OSCILLATING CONTINUOUSLY IN YAW. Lewis R. Fisher. January 1954. 49p. diagrs., photos., 6 tabs. (NACA TN 3121)

A fuselage—vertical-tail combination with tails of two aspect ratios, each of which was tested at four fuselage tail lengths, was oscillated in yaw through a range of reduced-frequency parameter corresponding to the lateral motions of airplanes. The phase lag of the tail force was measured during oscillation and converted to damping in yaw to determine the effects of varying these parameters. A complementary theoretical analysis based on the finite-span theory of Biot and Boehnlein is made on the effects of tail length and aspect ratio on the unsteady lateral damping and directional stability.

NACA TN 3122

EXPERIMENTAL INVESTIGATION AT A MACH NUMBER OF 2.41 OF AVERAGE SKIN-FRICTION COEFFICIENTS AND VELOCITY PROFILES FOR LAMINAR AND TURBULENT BOUNDARY LAYERS AND AN ASSESSMENT OF PROBE EFFECTS. Robert M. O'Donnell. January 1954. 38p. diagrs., photos. (NACA TN 3122)

Average skin-friction coefficients for laminar and turbulent flows were measured on a hollow cylinder at a Mach number of 2.41 and over a Reynolds number range from 0.06×10^6 to 0.95×10^6 per inch. Comparisons with various laminar- and turbulent-boundary-layer theories are presented, together with an assessment of probe effects.

NACA TN 3124

A METHOD FOR ESTIMATING THE EFFECT OF TURBULENT VELOCITY FLUCTUATIONS IN THE BOUNDARY LAYER ON DIFFUSER TOTAL-PRESSURE-LOSS MEASUREMENTS. Jerome Persh and Bruce M. Bailey. January 1954. 16p. diagrs. (NACA TN 3124)

A method has been devised for estimating the effect of turbulent velocity fluctuations on diffuser total-pressure-loss measurements. In the development of this method, continuity of flow is stipulated, and it is assumed that the inlet conditions and the diffuser dimensions are accurately known, that the flow is symmetrical, and that the velocity outside the boundary layer at the downstream measuring stations is not measurably influenced by turbulent velocity fluctuations. Only the case of a conical diffuser with incompressible flow is considered, although the procedure may be easily modified to include compressible-flow considerations.

NACA TN 3131

ON THE KERNEL FUNCTION OF THE INTEGRAL EQUATION RELATING THE LIFT AND DOWNWASH DISTRIBUTIONS OF OSCILLATING FINITE WINGS IN SUBSONIC FLOW. Charles E. Watkins, Harry L. Runyan and Donald S. Woolston. January 1954. 44p. (NACA TN 3131)

The kernel function of an integral equation relating the downwash to the lift distribution of a finite wing oscillating in subsonic compressible flow is treated. The kernel is reduced to a form which is amenable to calculations and the types of singularities are shown. As a check, it is shown that the kernel for the three-dimensional case reduces exactly to the known kernel for the two-dimensional case. In addition, results for the special cases of Mach number of 0 (incompressible case) and frequency of 0 (steady case) are given.

NACA TN 3132

FATIGUE TESTS AT STRESSES PRODUCING FAILURE IN 2 TO 10,000 CYCLES. 24S-T3 AND 75S-T6 ALUMINUM-ALLOY SHEET SPECIMENS WITH A THEORETICAL STRESS-CONCENTRATION FACTOR OF 4.0 SUBJECTED TO COMPLETELY REVERSED AXIAL LOAD. Herbert F. Hardrath and Walter Illg. January 1954. 14p. diagrs., photo., 2 tabs. (NACA TN 3132)

Notched specimens made of 24S-T3 and 75S-T6 aluminum-alloy sheet material, with theoretical stress-concentration factors equal to 4.0, were subjected to completely reversed axial loads. Failures occurred in less than 50 cycles at two-thirds of the static tensile strength and in as few as 2 cycles when the applied load was near the static strength of the specimen. The S-N curves were found to be concave upward for almost the complete range of fatigue lives; a reversal of curvature occurred at about 10

cycles of load. The fatigue strengths were equivalent for specimens made of each of the two materials and tested at stresses below 25 ksi; above that stress the 75S-T6 specimens had the greater fatigue strength. Compared on the basis of percent of ultimate tensile strength, the 24S-T3 specimens were stronger at all stress levels. Test techniques and special test apparatus are described.

NACA TN 3133

THE FREE-STREAM BOUNDARIES OF TURBULENT FLOWS. Stanley Corrsin and Alan L. Kistler, Johns Hopkins University. January 1954. 109p. diagrs., photos. (NACA TN 3133)

An experimental and theoretical study has been made of the instantaneously sharp and irregular front which separates turbulent fluid from contiguous "nonturbulent" fluid at a free-stream boundary. The overall behavior of the front is described statistically in terms of its wrinkle-amplitude growth and its lateral propagation relative to the fluid as functions of downstream coordinate. It is proposed and justified that the front actually consists of a very thin fluid layer in which direct viscous forces transmit mean and fluctuating vorticity to previously nonturbulent fluid. Outside this "laminar superlayer" there is presumably a field of irrotational velocity fluctuations (the "nonturbulent" flow) with constant mean velocity. Theoretical analysis based on this physical picture gives results which are in plausible agreement with experimental results for three turbulent shear flows.

NACA TN 3136

CREEP BENDING AND BUCKLING OF LINEARLY VISCOELASTIC COLUMNS. Joseph Kempner, Polytechnic Institute of Brooklyn. January 1954. 22p. diagrs. (NACA TN 3136)

The general dynamic equation of creep bending of a beam loaded laterally and axially was derived for a linearly viscoelastic material whose mechanical properties can be characterized by four parameters. The material can exhibit instantaneous and retarded elasticity as well as pure flow. The equation was used to determine creep characteristics of a beam in pure bending and a column with an initially sinusoidally deformed axis. The results showed that creep deflection characteristics of the beam are identical to the creep strain characteristics of a bar under simple tension or compression. For compressive end loads less than the Euler load, the column exhibited creep deflections which increase continuously with time and approach infinity only as time approaches infinity.

NACA TN 3137

CREEP BENDING AND BUCKLING OF NONLINEARLY VISCOELASTIC COLUMNS. Joseph Kempner, Polytechnic Institute of Brooklyn. January 1954. 27p. diagrs., 3 tabs. (NACA TN 3137)

Differential equations of bending of an idealized H-section beam column were derived for a nonlinearly viscoelastic material whose mechanical properties are analogous to a model consisting of a linear spring in series with a nonlinear dashpot whose strain rate is proportional to a power of the applied stress. The equations were used to obtain the creep-bending deflections of a beam in pure bending and of a column with initial sinusoidal deviation from straightness. The results for the simple beam showed that the deflections vary linearly with time. The results for the column, with the assumption that the original shape was maintained, showed the existence of a finite critical time at which the deflections become indefinitely large. The critical time decreases rapidly with increasing axial compression and column inaccuracy.

NACA TN 3138

CREEP BUCKLING OF COLUMNS. Joseph Kempner and Sharad A. Patel, Polytechnic Institute of Brooklyn. January 1954. 24p. diagrs., 2 tabs. (NACA TN 3138)

Formulas are presented for the determination of the creep deflection-time characteristics of an initially curved idealized H-section column. These results were obtained from closed-form solutions of the differential equation of bending (derived in NACA TN 3137) of a beam column whose creep properties are of a nonlinearly viscoelastic nature. The critical time (the time required for infinite deflections to develop) established by these solutions is tabulated and plotted for a wide range of the parameters involved.

NACA TN 3139

TIME-DEPENDENT BUCKLING OF A UNIFORMLY HEATED COLUMN. Nathan Ness, Polytechnic Institute of Brooklyn. January 1954. 18p. diagrs. (NACA TN 3139)

A theoretical investigation is presented of the time-temperature- dependent buckling of a pin-jointed constant-section column, whose initial curvature is defined by a half-sine wave when the material is linearly viscoelastic and is heated uniformly along the column at a prescribed time rate. It was found that the deviations from straightness increase with time and become indefinitely large when heating reduces the Young's modulus of the material to the value at which the applied load is the Euler load of the column. When the column is heated very rapidly this critical time represents its limit of usefulness. When heating takes place less rapidly the deflections cause bending stresses exceeding the yield stress of the material at a time considerably smaller than the critical time.

NACA TN 3157

METHOD FOR CALCULATION OF COMPRESSIBLE LAMINAR BOUNDARY LAYER WITH AXIAL PRESSURE GRADIENT AND HEAT TRANSFER. Paul A. Libby and Morris Morduchow, Polytechnic Institute of Brooklyn. January 1954. 44p. diagrs. (NACA TN 3157)

A rapid and sufficiently accurate method, for most practical purposes, of determining laminar-boundary-layer characteristics in flow with a given free-stream Mach number and given velocity distribution at the edge of the boundary layer is presented. The method can be easily applied to flow with zero pressure gradient for any (constant) Prandtl number of the order of unity and any given temperature distribution along the wall. For flow in an axial pressure gradient, the method can be applied for a Prandtl number of unity and any given uniform wall temperature.

NACA RM E53J07

MEASUREMENT OF HEAT-TRANSFER AND FRICTION COEFFICIENTS FOR FLOW OF AIR IN NONCIRCULAR DUCTS AT HIGH SURFACE TEMPERATURES. Warren H. Lowdermilk, Walter F. Weiland, Jr. and John N. B. Livingood. January 1954. 26p. diagrs. (NACA RM E53J07)

Measurements of average heat-transfer and friction coefficients were obtained with air flowing through electrically heated ducts having square, rectangular (aspect ratio, 5), and triangular cross sections for a range of surface temperature from 540° to 1780° R and Reynolds number from 1000 to 330,000. The results indicate that the effect of heat flux on correlations of the average heat-transfer and friction coefficients is similar to that obtained for circular tubes in a previous investigation and was nearly eliminated by evaluating the physical properties and density of the air at a film temperature halfway between the average surface and fluid bulk temperatures. With the Nusselt and Reynolds numbers based on the hydraulic diameter of the ducts, the data for the noncircular ducts could be represented by the same equations obtained in the previous investigation for circular tubes. Correlation of the average difference between the surface corner and midwall temperatures for the square duct was in agreement with predicted values from a previous analysis. However, for the rectangular and triangular ducts, the measured corner temperature was greater by approximately 20 and 35 percent, respectively, than the values predicted by analysis.

NACA TM 1364

THE PLANE PROBLEM OF THE FLAPPING WING. (Das ebene problem des schlagenden flugels). Walter Birnbaum. January 1954. 38p. diagrs., tab. (NACA TM 1364. Trans. from Zeitschrift für augewandte Mathematik und Mechanik, v.4, no.4, August 1924, p.277-292).

A theoretical study, based on vortex theory as applied to the linearized equations of motion, is made of the air forces on wings of infinite aspect ratio in incompressible flow. Expressions for forces and moments associated with steady harmonic oscillations in vertical translation and pitching of wings are derived in the form of power series in terms of a reduced frequency parameter. Use is made of the derived forces first to treat the problem of propulsion due to wing flapping and second to determine theoretical flutter speeds of some simple spring mounted configurations.

BRITISH REPORTS

N-28052*

Royal Aircraft Establishment (Gt. Brit.)
SOME NOTES ON THE DESIGN AND PERFORMANCE OF A THERMAL WATER CONTENT METER FOR USE IN CLOUDS. J. Rudman and F. J. Bigg. September 1953. 33p. diagrs., photos. (RAE Tech. Note Mech. Eng. 145)

Various methods of measuring the liquid water content of clouds are briefly reviewed and their probable applications pointed out. It is concluded that the best type of indicator for use primarily as a warning instrument in conditions of icing is one of a thermal type. An instrument is described which consists of two small heated cylinders, one exposed and the other in a sheltered position. Free water caught on the exposed cylinder produces a temperature difference, relative to the sheltered one, which is used as a measure of free water content. A theoretical analysis of the performance of this type of instrument shows that it is likely to be satisfactory as a warning device but only good for accurate measurement over a limited range of water concentrations, unless a resetting process is used.

N-28053*

Royal Aircraft Establishment (Gt. Brit.)
THE ABSORPTIOMETRIC DETERMINATION OF MAGNESIUM IN TITANIUM METAL. A. Bacon. September 1953. 27p. diagrs., 11 tabs. (RAE Tech. Note Met. 177)

Magnesium is separated in alkaline solutions, using hydrogen peroxide to prevent precipitation of the titanium. The magnesia is redissolved in standard acid and determined on the "Spekker" using Eriochrome Cyanine as the color reagent. Magnesium values are given for several samples of "Kroll" titanium.

N-28054*

Royal Aircraft Establishment (Gt. Brit.)
CORROSION, STRESS-CORROSION AND FATIGUE TESTS ON AN ALUMINIUM ALLOY HAVING A HIGH YOUNG'S MODULUS. G. Meikle, C. Braithwaite and M. S. Binning. September 1953. 7p. diagr., 2 tabs. (RAE Tech. Note Met. 180)

Corrosion tests have been made on an aluminum alloy containing 10.5 percent silicon and other elements to produce a high "E" value. The corrosion resistance of the alloy was not good, having lost about 17 percent of the proof stress and about 30 percent of the U. T. S. in 12 months' exposure to sea water spray. The stress corrosion resistance of the alloy was not very good. High fatigue results showed that improvement was imparted to the solution treated material but not to be fully heat-treated alloy by polishing. Reverse bend fatigue tests also showed an improvement by polishing the solution treated alloy but no improvement by polishing the fully heat-treated material.

N-28055*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF HEATING SOME ALUMINIUM ALLOYS FOR SHORT PERIODS UP TO 340°C. September 1953. 10p. diagrs., 3 tabs. (RAE Tech. Note Met. 181)

Samples of 20 S.W.G. (0.036 in.) sheets of DTD.610, DTD.546, and DTD.687 were heated at 200°, 250°, 300°, and 340° C for periods from 5 seconds to 32 minutes. The loss in strength of DTD.610 and DTD.546 at 200° C is negligible but becomes appreciable as the temperature is increased. DTD.687 loses strength at 200° C even with very short periods of heating. When heated at 340° C, resolution occurs in DTD.687 which, on subsequent natural ageing, offsets the loss of strength due to softening at 340° C.

N-28057*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) THE PERFORMANCE OF A MULTI-ENGINE HELICOPTER FOLLOWING FAILURE OF ONE ENGINE DURING TAKE-OFF OR LANDING. A. L. Oliver. October 30, 1953. 15p. diagrs., tab. (AAEE/Res/277)

A theoretical analysis is made of the performance of multiengine helicopters following failure of one engine in take-off and landing from the type of site proposed for civil operation in built-up areas. The performance of a twin engine helicopter of similar class to the Bristol 173 appears to be just adequate for safe operation from such a site but the nicety of handling judgment involved in return landings may make the performance difficult to achieve. A take-off technique allowing climb-away after engine failure at any stage is preferable but this is not possible for the twin engine machine within the space available. It is possible if the twin engines are replaced by four of the same effective total power but only if a turning climb-away is made after engine failure. A helicopter with sufficient performance for a straight climb-away can in general hover with one engine inoperative.

N-28058*

Royal Aircraft Establishment (Gt. Brit.)
A METHOD OF APPROXIMATE NUMERICAL SOLUTION OF NON-LINEAR DIFFERENTIAL EQUATIONS OF THE FORM, $\ddot{x} + f_1(\dot{x}, x) + f_2(x) = 0$.
G. S. Green and H. G. Cuming. September 1953. 16p. diagrs., tab. (RAE Tech. Note GW 277)

A method is suggested for deriving numerically the essential characteristics of the oscillatory motion whose nonlinear differential equation is of the form $\ddot{x} + f_1(\dot{x}, x) + f_2(x) = 0$. An example of the application of the method to a particular case is given.

N-28099*

Aeronautical Research Council (Gt. Brit.)
ACTUATOR DISC APPLIED TO WALL BOUNDARY LAYERS IN CASCADES. W. R. Hawthorne and J. H. Horlock. December 22, 1952. 32p. diagrs. (ARC 15,490; EA 270)

Using the actuator disk theory developed by Bragg and Hawthorne and Pinsley, a solution for the flow of a perfect fluid with initial velocity gradients through a moving cascade is found. The boundary-layer form factor at exit from the cascade is shown to be dependent upon the entry boundary-layer parameters, the exit air angle relative to the cascade, and the ratio of cascade blade speed to the main stream axial velocity at entry. A comparison is made between the values of these variables at which the cascade would stall, and those at which the flow might be expected to break away from the wall. The investigation is extended to consider a complete compressor stage.

N-28100*

Aeronautical Research Council (Gt. Brit.)
SOME ACTUATOR DISC THEORIES FOR THE FLOW OF AIR THROUGH AN AXIAL TURBO MACHINE. J. H. Horlock. December 22, 1952. 47p. diagrs., tab. (ARC 15,491; EA 271)

Using actuator disk theory, simplified methods are given for the solution of the direct problem of the incompressible flow of air through an axial flow turbomachine. Calculations based on these methods are compared with other approximate solutions to the flow through a model compressor stage.

N-28106*

Aeronautical Research Council (Gt. Brit.)
ON THE SOLUTION OF THE NAVIER-STOKES EQUATIONS FOR A TYPE OF STEADY RADIALLY-SYMMETRIC VISCOUS FLOW. S. C. R. Dennis. March 11, 1953. 13p. diagrs. (ARC 15,723; FM 1878)

The solution of the Navier-Stokes equations for the steady motion of a viscous fluid near an infinite rotating disk can be made to depend upon the solution of a pair of simultaneous nonlinear ordinary differential equations; the same equations govern the flow between two coaxial rotating disks. In this paper a method of solution is developed sufficiently to give some numerical results in a number of related cases. The results given are not necessarily unique, for in some cases the equations have been found to admit of more than one solution. Further solutions are not considered here, but it is hoped in a later paper to describe a method of obtaining them.

MISCELLANEOUS

NACA TN 1983

Errata No. 1 on "LONGITUDINAL FLYING QUALITIES OF SEVERAL SINGLE-ROTOR HELICOPTERS IN FORWARD FLIGHT." F. B. Gustafson, Kenneth B. Amer, C. R. Haig and J. P. Reeder. November 1949.

NACA TN 2590

Errata No. 2 on "CALCULATIONS ON THE FORCES AND MOMENTS FOR AN OSCILLATING WING-AILERON COMBINATION IN TWO-DIMENSIONAL POTENTIAL FLOW AT SONIC SPEED." Herbert C. Nelson and Julian H. Berman. January 1952.

UNPUBLISHED PAPERS

N-15407*

National Bureau of Standards.
THERMODYNAMIC PROPERTIES OF GASEOUS DIFLUORODICHLOROMETHANE (FREON-12). Joseph F. Masi. March 20, 1952. i, 19p. diagrs., tabs. (National Bureau of Standards. Rept. 1532)

Heat capacities of gaseous difluorodichloromethane (Freon-12) were measured with the flow calorimeter from the boiling point of CF_2C1_2 up to 90° C and at pressures up to 1.5 atmospheres. Tables of the heat capacity, enthalpy, entropy, and free energy function of the ideal gas have been calculated for temperatures from 200° to 1500° Kelvin.

N-27652*

National Bureau of Standards.
THE REPRESENTATION OF GAS PROPERTIES IN TERMS OF MOLECULAR CLUSTERS. Harold W. Woolley. March 1, 1952. ii, 13p. diagrs., tabs. (National Bureau of Standards. Rept. 1491)

This report presents a new and more adequate method for representing the actual thermodynamic properties of nonpolar gases, through the modification of the usual selection of force law parameters for the Lennard-Jones type of interaction potential. Instructions and generalized tables and charts are included which, together with existing tables of second and third virial coefficients, facilitate the fitting of experimental data for all nonpolar gases. Results are shown for A, N_2, CO, CO_2, CH_4, C_2H_4.

DECLASSIFIED NACA REPORTS

THE RECLASSIFICATION CHANGES LISTED IN THIS ISSUE COMPLETE THE ACTION REQUIRED BY EXECUTIVE ORDER NO. 10501 ON REPORTS INITIALLY ISSUED BY THE NACA AS RESTRICTED.

THE FOLLOWING REPORTS HAVE BEEN DECLASSIFIED FROM RESTRICTED TO UNCLASSIFIED, 12/14/53.

NACA RM 8C29

A RESTRICTED LIST OF AIRCRAFT MATERIALS RESEARCH PROJECTS. Sponsored by Government Agencies. May 4, 1948. 95p. (NACA RM 8C29)

This report contains a selected list of Government sponsored research projects on related aircraft materials in effect during the calendar year 1947. Information is contained on titles, description, sponsoring and conducting agencies.

NACA RM A7D10

THE DEVELOPMENT OF JET-ENGINE NACELLES FOR A HIGH-SPEED BOMBER DESIGN. Robert E. Dannenberg. August 29, 1947. 37p. diagrs., photos., tab. (NACA RM A7D10)

The results of an experimental investigation made for the purpose of developing suitable jet-engine nacelle designs for a high-speed medium bomber are presented. Two types of nacelles were investigated, the first enclosing two 4000-pound-thrust jet engines and a 65-inch-diameter landing wheel and the second enclosing a single 4000-pound-thrust jet engine. Both types of nacelles were tested in positions underslung beneath the wing and centrally located on the wing. The report summarizes the low-speed investigation and includes some results from the high-speed portion.

NACA RM A7I06

AN EXPERIMENTAL INVESTIGATION OF NACA SUBMERGED AIR INLETS ON A 1/5-SCALE MODEL OF A FIGHTER AIRPLANE. Donald E. Gault. December 5, 1947. 32p. diagrs., photos., 4 tabs. (NACA RM A7I06)

The results of an experimental investigation of an NACA submerged inlet system on a 1/5-scale model of a fighter airplane are presented. Duct system total pressure losses and pressure distributions over the lip and ramp were obtained. It is shown that the inlet location investigated is unsatisfactory.

NACA RM A7I26

PRELIMINARY RESULTS OF A FLIGHT INVESTIGATION TO DETERMINE THE EFFECT OF NEGATIVE FLAP DEFLECTION ON HIGH-SPEED LONGITUDINAL-CONTROL CHARACTERISTICS. Maurice D. White, Melvin Sadoff, Lawrence A. Clousing and George E. Cooper. December 16, 1947. 22p. diagrs., photos. (NACA RM A7I26)

Flight tests were conducted on two airplanes having wings of different airfoil section to determine the effect of deflecting the landing flaps upward on the high-speed longitudinal-control characteristics. For the airplane with the NACA 66-series airfoil, a decrease in the diving tendency at high Mach numbers resulted from a reduction in the variation of wing and tail angle of attack with Mach number with deflected flaps. For the airplane with the NACA 230-series airfoil, a change in the pitching moment of the airplane without the tail apparently offset the effect produced by the reduction of the angle-of-attack variation so that no appreciable improvement in diving tendencies resulted with deflected flaps.

NACA RM A7I30

AN EXPERIMENTAL INVESTIGATION OF THE DESIGN VARIABLES FOR NACA SUBMERGED DUCT ENTRANCES. Emmet A. Mossman and Lauros M. Randall. January 8, 1948. 59p. diagrs., 3 tabs. (NACA RM A7I30)

The effect of configuration modifications on the characteristics of NACA submerged duct entrances is presented. These tests were made with the duct inlet installed in the wall of an 8-inch by 36-inch wind channel. The modifications investigated were ramp plan form, ramp angle, width-to-depth ratio, ramp floor shape, deflectors and boundary-layer thickness.

NACA RM A7J13

AN ANALYSIS OF THE EFFECTS OF WING ASPECT RATIO AND TAIL LOCATION ON STATIC LONGITUDINAL STABILITY BELOW THE MACH NUMBER OF LIFT DIVERGENCE. John S. Axelson and J. Conrad Crown. January 9, 1948. 14p. diagrs. (NACA RM A7J13)

An analysis of the influence of wing aspect ratio and tail location on the effects of compressibility on static longitudinal stability indicates that the use of reduced wing aspect ratios or short tail lengths lead to serious reduction in high-speed stability below the Mach number of lift divergence.

NACA RM A7J22

HIGH-SPEED AERODYNAMIC CHARACTERISTICS OF A MODEL TAIL PLANE WITH MODIFIED NACA 65-010 SECTIONS AND 0° AND 45° SWEEPBACK. Joseph L. Anderson and Andrew Martin. January 12, 1948. 85p. diagrs., photo., 2 tabs. (NACA RM A7J22)

This report presents high-speed aerodynamic characteristics determined from wind-tunnel tests of a model tail plane having modified NACA 65-010 sections and a tapered plan form. Results are shown for the tail plane in an unswept and a 45° sweptback condition. For the unswept tail the Mach number of lift divergence was 0.80 while for the sweptback tail it was above 0.875. The report shows how the substitution of a 45° sweptback horizontal tail for an unswept tail affects the longitudinal stability and control forces of an airplane.

NACA RM A7J23

HIGH-SPEED AERODYNAMIC CHARACTERISTICS OF FOUR THIN NACA 63-SERIES AIRFOILS. Richard J. Ilk. December 31, 1947. 53p. diagrs., photo., tab. (NACA RM A7J23. Now issued as TN 2670)

This report contains the results of high-speed wind-tunnel tests made of the NACA 63-206, 63-208, 63-210, and 63-212 airfoil sections. The results indicate the effect of thickness on the aerodynamic characteristics of thin NACA 63-series airfoils. The data of these tests have been compared to similar data for corresponding NACA 64-series airfoils to show the effect of thickness distribution on the high-speed aerodynamic characteristics of NACA 6-series airfoils. It was concluded that, although the differences are small, the aerodynamic characteristics of thin NACA 64-series airfoils are more favorable for high-speed applications than those of comparable NACA 63-series airfoils.

NACA RM A7L02

A SUMMARY AND ANALYSIS OF WIND-TUNNEL DATA ON THE LIFT AND HINGE-MOMENT CHARACTERISTICS OF CONTROL SURFACES UP TO A MACH NUMBER OF 0.90. John A. Axelson. April 30, 1948. 43p. diagrs., tab. (NACA RM A7L02)

This report contains an extensive summary of wind-tunnel data showing the lift and hinge-moment characteristics of control surfaces up to a Mach number of 0.90. The many factors affecting C_{h_α}, C_{h_δ}, C_{L_α}, and C_{L_δ} are discussed, including sweep, airfoil section, aerodynamic balance, control surface profile, and trailing-edge angle.

NACA RM A8H12

HIGH-SPEED AERODYNAMIC CHARACTERISTICS OF A LATERAL-CONTROL MODEL. I - NACA 0012-64 SECTION WITH 20-PERCENT-CHORD PLAIN AILERON AND 0° AND 45° SWEEPBACK. Joseph L. Anderson and Walter J. Krumm. September 27, 1948. 28p. diagrs., photo., 2 tabs. (NACA RM A8H12)

Wind-tunnel tests were made to determine the aerodynamic and lateral-control characteristics of a semispan wing having the NACA 0012-64 section. The characteristics were determined through a large Mach number range for the wing unswept and swept back 45° and for a 20-percent-chord, plain, trailing-edge aileron. Results indicate an aileron overbalance and effectiveness reversal at high subsonic Mach numbers for the wing unswept but only an overbalance for the wing swept back 45°.

NACA RM A9G19

COMPARISON OF THE AERODYNAMIC CHARACTERISTICS OF THE NACA 0010 AND 0010-64 AIRFOIL SECTIONS AT HIGH SUBSONIC MACH NUMBERS. Perry P. Polentz. October 7, 1949. 23p. diagrs., tab. (NACA RM A9G19)

Section lift, drag, and pitching-moment characteristics of the NACA 0010 and NACA 0010-64 airfoil sections measured at Mach numbers up to 0.91 and Reynolds numbers between 1.0×10^6 and 1.9×10^6 are presented. Comparisons are made to determine the principal effects of varying the chordwise location of the maximum thickness.

NACA RM A9K22

EXPLORATORY INVESTIGATION OF THE EFFECT OF SKEWED PLAIN NOSE FLAPS ON THE LOW-SPEED CHARACTERISTICS OF A LARGE-SCALE TRIANGULAR-WING-FUSELAGE MODEL. Bradford H. Wick and David Graham. January 12, 1950. 12p. diagrs., photo. (NACA RM A9K22)

Presented are lift, drag, and pitching-moment data obtained from tests of a triangular-wing-fuselage combination with skewed nose flaps. The Reynolds numbers of the tests were 12.5 and 14.1 million (based on the wing mean aerodynamic chord). The semi plan form of the flaps was such that the flap chord varied from 0 percent wing chord at the model center line to 100 percent at about 91-percent wing semispan. It was concluded that skewed nose flaps of the investigated plan form are a promising means of delaying both the leading-edge separation and the tip stalling that occur on a thin, low-aspect-ratio triangular wing.

NACA RM A9L27

HIGH-SPEED AERODYNAMIC CHARACTERISTICS OF A LATERAL-CONTROL MODEL. II - MODIFIED NACA 0012-64 SECTION WITH A 26.6-PERCENT-CHORD, PLAIN, TRAILING-EDGE AILERON; WING UNSWEPT AND SWEPT BACK 45°. Walter J. Krumm and Joseph L. Anderson. March 15, 1950. 55p. diagrs., photo., 2 tabs. (NACA RM A9L27)

Wind-tunnel tests were made to determine the aerodynamic characteristics of a semispan model wing having a modified NACA 0012-64 section. The lateral-control characteristics for a 26.6-percent-chord, plain, trailing-edge aileron were determined for a Mach number range from 0.40 through 0.925 with the wing unswept and swept back 45°.

NACA RM E6I20

ALTITUDE-WIND-TUNNEL INVESTIGATIONS OF THRUST AUGMENTATION OF A TURBOJET ENGINE. I - PERFORMANCE WITH TAIL-PIPE BURNING. W. A. Fleming and R. O. Dietz. September 25, 1946. 56p. diagrs., photos. (NACA RM E6I20)

Engine thrust and fuel consumption were determined for a wide range of simulated flight conditions and tail-pipe fuel flows. The investigation was particularly directed toward evaluation of thrust augmentation for high-speed and high-altitude flight. The engine tail pipe was modified for the investigation to reduce the gas velocity at the inlet of the tail-pipe combustion chamber. The general trends of the experimental values were in agreement with values calculated from theoretical equations.

NACA RM E6K27

INVESTIGATION OF SHOCK DIFFUSERS AT MACH NUMBER 1.85. I - PROJECTING SINGLE-SHOCK CONES. W. E. Moeckel, J. F. Connors and A. H. Schroeder. June 17, 1947. 47p. diagrs., photos. (NACA RM E6K27)

Single-shock cones having angles of 20°, 30°, 40°, 50°, 60°, and 70° were tested with curved and straight diffuser-inlet sections. The variation of total-pressure recovery with tip projection and outlet area was investigated for each cone to determine optimum contraction ratios and shock locations. The effect of angle of attack was also investigated for several configurations. Maximum total-pressure recovery was obtained with the 50° cone using the straight inlet. The highest total-pressure recoveries were obtained with subsonic entrance flow.

NACA RM E6L13

INVESTIGATION OF SHOCK DIFFUSERS AT MACH NUMBER 1.85. II - PROJECTING DOUBLE-SHOCK CONES. W. E. Moeckel, J. F. Connors and A. H. Schroeder. June 17, 1947. 41p. diagrs., photos. (NACA RM E6L13)

The total-pressure recovery (at a Mach number of 1.85) of a shock diffuser having projecting cones designed to produce two oblique shocks ahead of the diffuser inlet was investigated. Four cones with different included angles were used. Each cone was investigated with a straight and with a curved diffuser-inlet section. The effect of angle of attack and the distribution of static and total pressures at the diffuser outlet were also investigated for the best configurations. The highest total-pressure recoveries were obtained with subsonic inlet flow. The results were compared with those obtained with single-shock cones.

NACA RM E6L27a

CHARACTERISTICS OF A HOT JET DISCHARGED FROM A JET-PROPULSION ENGINE. William A. Fleming. December 27, 1946. 20p. diagrs. (NACA RM E6L27a)

An investigation of a heated jet was conducted to provide information by which an engine could be so located in an airplane that no external surface is overheated by the jet. The temperature and the velocity on the axis of the jet and the diameter of the jet are presented nondimensionally as functions of the axial distance from the jet-nozzle outlet and the diameter of the jet at the vena contracta.

NACA RM E7B11h

COMPUTED TEMPERATURE DISTRIBUTION AND COOLING OF SOLID GAS-TURBINE BLADES. J. George Reuter and Carl Gazley, Jr. February 11, 1947. 13p. diagrs., tab. (NACA RM E7B11h)

Computations were made to determine the effects of gas temperature, blade-root temperature, blade thermal conductivity, and net gas-to-metal heat-transfer coefficient on the temperature distribution in a typical solid turbine blade.

NACA RM E7C12

ALTITUDE-WIND-TUNNEL INVESTIGATION OF THRUST AUGMENTATION OF A TURBOJET ENGINE. II - PERFORMANCE WITH WATER INJECTION AT COMPRESSOR INLET. Robert O. Dietz and William A. Fleming. May 19, 1947. 33p. diagrs. (NACA RM E7C12)

Engine performance at an engine speed of 7600 rpm was obtained over a wide range of water-air ratios at pressure altitudes of 5,000 and 20,000 feet and at a ram-pressure ratio corresponding to a flight Mach number of about 0.265. A fixed-area tail-pipe nozzle 16-3/8 inches in diameter was used for this investigation. Data are presented to show the effect of water injection on engine performance. A discussion of the effect of water injection on the pressure and temperature distribution at the compressor outlet of the turbojet engine is included.

NACA RM E7C26

THE USE OF PERFORATED INLETS FOR EFFICIENT SUPERSONIC DIFFUSION. John C. Evvard and John W. Blakey. June 25, 1947. 34p. diagrs., photo. (NACA RM E7C26. Now issued as RM E51B10)

The use of wall perforations on supersonic diffusers to avoid the internal contraction-ratio limitation is described. Experimental results at a Mach number of 1.85 on a preliminary model of a perforated diffuser having a geometric internal contraction ratio of 1.49 (the isentropic value) are presented. A theoretical discussion of the flow coefficients as well as the size and the spacing of the perforations is also included. At angles of attack of 0°, 3°, and 5°, total-pressure recoveries of 0.931, 0.920, and 0.906, respectively, were obtained.

NACA RM E7D22

A FUEL-DISTRIBUTION CONTROL FOR CONTINUOUS-FLOW MANIFOLD INJECTION ON RECIPROCATING ENGINES. Harold Gold and David M. Straight. June 6, 1947. 16p. diagrs., photos. (NACA RM E7D22)

A fuel-distribution control for continuous-flow manifold injection on reciprocating engines is described. A method of installation of the control on an engine is suggested.

NACA RM E7E12

PRELIMINARY INVESTIGATION OF EFFECTS OF GAMMA RADIATION ON AGE-HARDENING RATE OF AN ALUMINUM-COPPER ALLOY. J. Howard Kittel. June 20, 1947. 4p. diagr. (NACA RM E7E12)

A preliminary investigation was made to determine the effects of gamma radiation on the age-hardening rate of an aluminum-copper alloy at temperatures of 32° and 70° F. The gamma radiation from a 100-milligram radium source appeared to have no significant effect on the age-hardening rate of the alloy. A metallographic examination of the test specimens showed no microstructural changes that could be attributed to the gamma radiation.

NACA RM E7E13

PRELIMINARY INVESTIGATION OF EFFECTS OF ALPHA-PARTICLE BOMBARDMENT ON THE CREEP RATE OF ALUMINUM. J. Howard Kittel. July 3, 1947. 6p. diagrs. (NACA RM E7E13)

A preliminary investigation was made to determine the effects of alpha-particle bombardment on the creep rate of aluminum wire at 400° F. The alpha radiation from an 85-millicurie polonium source appeared to decrease slightly the creep rate of the aluminum. A metallographic examination of the creep specimens showed no microstructural changes that could be attributed to the alpha-particle bombardment.

NACA RM E7F10

ALTITUDE-WIND-TUNNEL INVESTIGATION OF THRUST AUGMENTATION OF A TURBOJET ENGINE. III - PERFORMANCE WITH TAIL-PIPE BURNING IN STANDARD-SIZE TAIL PIPE. William A. Fleming and Richard L. Golladay. August 11, 1947. 47p. diagrs., photos. (NACA RM E7F10)

Thrust augmentation of a turbojet engine by burning fuel in the tail pipe has been investigated in the NACA Cleveland altitude wind tunnel. The engine performance was determined at several simulated flight conditions throughout the range of tail-pipe fuel flows. A tail-pipe combustion chamber having the same external dimensions as the standard turbojet engine tail pipe was investigated to determine whether satisfactory operation could be obtained at high-speed and high-altitude flight conditions. Two different flame holders were used.

NACA RM E7F11

COMBUSTION-EFFICIENCY INVESTIGATION OF SPECIAL FUELS IN SINGLE TUBULAR-TYPE COMBUSTOR AT SIMULATED ALTITUDE CONDITIONS. Ralph T. Dittrich. August 15, 1947. 25p. diagrs., 2 tabs. (NACA RM E7F11)

Ten special straight-run distillate fuels were investigated. The distillates were obtained from various crude oils and consisted of hydrocarbon mixtures with distillation temperatures varying from 93° to 690° F. Three commercial fuels were also tested. The operating conditions simulated engine operation at an altitude of 40,000 feet at engine speeds of 7000 and 10,500 rpm. Under certain operating conditions the flame extended beyond the turbine position. The tests showed that as the distillation temperature of the fractions from the same crude increased, the combustion efficiency decreased.

NACA RM E7F12

FUEL INVESTIGATION IN A TUBULAR-TYPE COMBUSTOR OF A TURBOJET ENGINE AT SIMULATED ALTITUDE CONDITIONS. Adelbert O. Tischler and Ralph T. Dittrich. August 1, 1947. 41p. diagrs., photo., 2 tabs. (NACA RM E7F12)

A series of 11 fuels, which ranged in volatility from gasoline to Diesel oil and which included hydrocarbons of the paraffinic, naphthenic, olefinic, and aromatic types, was tested in a single tubular combustion chamber of a turbojet engine under inlet-air conditions that simulated engine operation at two engine speeds at an altitude of 40,000 feet. Tests were also conducted at two additional inlet-air conditions. Temperature-rise data at various fuel-air ratios were obtained for each set of air-flow conditions.

NACA RM E7G03

EXPERIMENTAL INVESTIGATION OF PERFORMANCE AND OPERATING CHARACTERISTICS OF A TAIL-PIPE BURNER FOR A TURBOJET ENGINE. David S. Gabriel, E. Vincent Martinson and Robert H. Essig. October 30, 1947. 29p. diagrs. (NACA RM E7G03)

Presents description and operating characteristics of 10 full-scale tail-pipe burners. The combustion and pressure-drop characteristics of most satisfactory burner were investigated. A tail-pipe burner was developed that operated satisfactorily over a range of fuel-air ratios with inlet conditions of gas temperature and velocity simulating those in a typical turbojet engine.

NACA RM E7I25a

AN ANALYSIS OF CONTROL REQUIREMENTS AND CONTROL PARAMETERS FOR DIRECT-COUPLED TURBOJET ENGINES. David Novik and Edward W. Otto. February 18, 1948. 50p. diagrs. (NACA RM E7I25a)

Presents discussion of control parameters for direct-coupled turbojet engine, based on analysis of steady-state operation, acceleration, and deceleration, and describes operation of a hypothetical control system.

NACA RM E7J19

EXPERIMENTAL INVESTIGATION OF THRUST AUGMENTATION OF 4000-POUND-THRUST CENTRIFUGAL-FLOW-TYPE TURBOJET ENGINE BY INJECTION OF WATER AND ALCOHOL AT COMPRESSOR INLETS. William L. Jones and Helmuth W. Engelman. May 14, 1948. 23p. diagrs. (NACA RM E7J19)

Contains curves and data to determine amount of thrust augmentation obtainable by injection of various water and alcohol mixtures at compressor inlets of a 4000-pound-thrust turbojet engine at standard NACA conditions. A maximum thrust augmentation of 26 percent was obtained by injection of 4.5 pounds per second of water and 2.0 pounds per second of alcohol.

NACA RM E7K14

EXPERIMENTAL INVESTIGATION OF THRUST AUGMENTATION OF AXIAL-FLOW-TYPE 4000-POUND-THRUST TURBOJET ENGINE BY WATER AND ALCOHOL INJECTION AT COMPRESSOR INLET. Burnett Baron, Harry W. Dowman and William C. Dackis. July 8, 1948. 41p. diagrs., photos. (NACA RM E7K14)

Reports on experimental investigation of thrust augmentation of axial-flow-type turbojet engine with a 4000-pound-thrust rating by means of water-alcohol injection at the compressor inlet. Augmentation was limited by centrifugal separation of liquid and air in the compressor and was sensitive to engine inlet-air temperature. A thrust augmentation of 15.4 percent was obtained with injection of 3 pounds per second of water alone at an inlet-air temperature of 548° F.

NACA RM E7L12

RELATION OF NOZZLE-BLADE AND TURBINE-BUCKET TEMPERATURES TO GAS TEMPERATURES IN A TURBOJET ENGINE. J. Elmo Farmer. April 30, 1948. 37p. diagrs., photos. (NACA RM E7L12)

Presents results of investigation to determine experimentally turbine-nozzle-blade and turbine-bucket temperatures in a turbojet engine and to correlate these temperatures with gas temperatures. Maximum indicated temperatures were about 1900° F for the nozzle blade and 1500° F for the turbine bucket. The maximum turbine-nozzle-blade temperature was 80° to 270° F higher than the calculated average turbine-inlet-gas temperature; the maximum turbine-bucket temperature was about 150° F less than the calculated average turbine-inlet-gas temperature.

NACA RM E7L16

ALTITUDE-WIND-TUNNEL INVESTIGATION OF THRUST AUGMENTATION OF A TURBOJET ENGINE. IV - PERFORMANCE WITH TAIL-PIPE BURNING AND WATER INJECTION. Robert O. Dietz, Jr., George Wishnek and John K. Kuenzig. June 15, 1948. 31p. diagrs., photo. (NACA RM E7L16)

Results of investigation of thrust augmentation of axial-flow-type turbojet engine by combination of tail-pipe burning and water injection are presented. Thrust increases obtainable with engine-inlet water injection reached a peak at a water-air ratio of 0.035 and decreased with larger amounts of injection; whereas thrust increases obtainable with combustion-chamber water injection increased as water-air ratio was raised throughout range of water-air ratios investigated. Greater maximum thrust increases were available with combustion-chamber water injection than with engine-inlet water injection. Thrust increases were accompanied by large increases in specific liquid consumption.

NACA RM E7L17

CONTROL DURING STARTING OF GAS-TURBINE ENGINES. Robert J. Koenig and Marcel Dandois. June 17, 1948. 39p. diagrs., photos. (NACA RM E7L17)

Reports on investigation of variables pertinent to the control of gas temperatures during starting of gas-turbine engines. Results indicate that poor control of gas temperatures during starting is caused by an accumulation of fuel in the engine before ignition and by excessive fuel-flow rates at the time of ignition. Prompt ignition was obtained by use of well atomized fuel sprays.

NACA RM E7L18

VIBRATION OF TURBINE BLADES IN A TURBOJET ENGINE DURING OPERATION. W. C. Morgan, R. H. Kemp and S. S. Manson. April 22, 1948. 17p. diagrs., photos. (NACA RM E7L18)

An experimental investigation was made to determine the vibration phenomena that occur in gas-turbine blades during service operation. Through the use of high-temperature strain gages, vibratory phenomena in turbine blades were observed and evaluated in terms of modes, frequencies, and stress range. The frequencies of the principal vibrations were found to be related to the number of nozzle blades and combustion chambers.

NACA RM E7L30

COMBUSTION-EFFICIENCY AND ALTITUDE-LIMIT INVESTIGATIONS OF FIVE FUELS IN AN ANNULAR TURBOJET COMBUSTOR. Jerrold D. Wear and Edmund R. Jonash. June 7, 1948. 19p. diagrs. (NACA RM E7L30)

Five fuels of various boiling temperatures and various hydrocarbon types were investigated in a jet-propulsion annular combustor of 10-3/8 inch diameter to determine the effect of boiling temperature and paraffinic and aromatic hydrocarbon types on combustion efficiency and altitude operational limit at three inlet-air conditions. The performance difference among the fuels was greatest at inlet-air conditions characterized by unstable combustion.

NACA RM E8A28a

BENCH AND ENGINE OPERATION OF A FUEL-DISTRIBUTION CONTROL. Harold Gold and Robert J. Koenig. June 14, 1948. 34p. diagrs., photos. (NACA RM E8A28a)

Presents application of a fuel-distribution-control method to actual gas-turbine engine operation. The control used was designed to equalize the flow to the 14 nozzles of a gas-turbine engine. The maximum measured deviation from perfect distribution during engine operation was 3.8 percent. It was shown that the control model is capable of maintaining this accuracy independently of changes in fuel-nozzle resistances from 0 up to 1.46 times the resistance of a normal engine fuel nozzle.

NACA RM E8C02a

EFFECT OF FUELS AND FUEL-NOZZLE CHARACTERISTICS ON PERFORMANCE OF AN ANNULAR COMBUSTOR AT SIMULATED ALTITUDE CONDITIONS. Richard J. McCafferty. September 28, 1948. 90p. diagrs., photos., tab. (NACA RM E8C02a)

The effect of fuels and fuel-nozzle characteristics on performance of an annular combustor at simulated altitude conditions was determined by operating with different fuels and fuel-nozzle sizes with the combustor inlet-air conditions each independently altered near the altitude operational limits. Results indicate that amount of difference in performance at altitude among different fuels is determined by hydrocarbon type and fuel boiling points. Reduction in fuel-nozzle size increased combustion efficiency at low heat-input values but produced lower temperature-rise limits.

NACA RM E8C08

A FUEL-DISTRIBUTION CONTROL FOR GAS-TURBINE ENGINES. Harold Gold and David M. Straight. June 14, 1948. 17p. diagrs., photos. (NACA RM E8C08)

A device to control the distribution of fuel to any number of discharge nozzles of a gas-turbine engine is presented. A model of the device controlled the flow to four discharge nozzles within 2 percent of perfect distribution over a wide range of fuel flows and was unaffected by uneven discharge-nozzle pressures.

NACA RM E8D12

INVESTIGATION OF HIGH-TEMPERATURE OPERATION OF LIQUID-COOLED GAS TURBINES. I - TURBINE WHEEL OF ALUMINUM ALLOY, A HIGH-CONDUCTIVITY NONSTRATEGIC MATERIAL. Harry Kottas and Bob W. Sheflin. July 22, 1948. 15p. diagrs., photos., tab. (NACA RM E8D12)

A liquid-cooled gas turbine with aluminum-alloy blades and disk was built to investigate the effect of liquid cooling and high-conductivity metals on limiting turbine-inlet gas temperature. The turbine was successfully operated at a speed of 19,000 rpm and an inlet gas temperature of 2100° F.

NACA RM E8D14

GAS-TURBINE-ENGINE OPERATION WITH VARIABLE-AREA FUEL NOZZLE. Harold Gold and David M. Straight. July 9, 1948. 47p. diagrs., photos. (NACA RM E8D14)

The characteristics of variable-area and fixed-area atomizing nozzles are discussed in relation to use in aircraft gas-turbine engines. A variable-area nozzle and a fuel-distribution control that were used in the operation of a gas-turbine engine are described. When the engine was equipped with variable area fuel nozzles, thrust specific fuel consumption in the lower half of the fuel-flow range was reduced, fuel pressures were lowered in the upper half of the fuel-flow range, and starting characteristics were improved.

NACA RM E8D23

PERFORMANCE OF SEVERAL AIR EJECTORS WITH CONICAL MIXING SECTIONS AND SMALL SECONDARY FLOW RATES. S. C. Huddleston, H. D. Wilsted and C. W. Ellis. July 19, 1948. 74p. diagrs. (NACA RM E8D23)

Experimental results presented are limited to investigations of conical-type mixing-section ejectors at ratios of mixing-section minimum diameter to primary-jet-nozzle diameter of 1.21, 1.10, and 1.00 using unheated air. Results were cross-plotted in charts to show the performance of all ejectors within the range of configurations investigated. For diameter ratios of 1.21 and 1.10, the spacing giving maximum airflow varied with diameter ratio but did not vary with primary and secondary pressure ratios. In general, the ejector had little effect on the primary nozzle thrust.

NACA RM E8D29

EFFECT OF MACH NUMBER ON PERFORMANCE OF AN AXIAL-FLOW COMPRESSOR ROTOR-BLADE ROW. Paul D. Dugan, John J. Mahoney and William A. Benser. September 28, 1948. 27p. diagrs., photo. (NACA RM E8D29)

An investigation was conducted to study the influence of high relative inlet Mach number on the performance of a highly loaded rotor blade row. A range of weight flow was investigated for equivalent tip speeds ranging from 300 to 915 feet per second, which correspond to relative inlet Mach numbers of 0.30 to 0.90 at the mean radius. At high Mach numbers, above 0.70, the blade-section-performance results of this investigation indicated good correlation with low-speed cascade results. The efficiency gradually decreased from 0.950 to 0.915 as the relative inlet Mach number increased from 0.30 to 0.82.

NACA RM E8E10

ANALYTICAL INVESTIGATION OF EFFECT OF WATER-COOLED TURBINE BLADES ON PERFORMANCE OF TURBINE-PROPELLER POWER PLANTS. William D. Bowman. August 16, 1948. 67p. diagrs. (NACA RM E8E10)

Performance of six turbine-propeller power plants, each having a multistage turbine equipped with water-cooled turbine blades and designed for maximum turbine inlet temperatures of 2000°, 2500°, 3000°, 4000°, and 4500° R, respectively, is calculated over a range of flight speeds from 200 to 600 miles per hour at altitudes from sea level to 35,000 feet. High temperature operation possible with water-cooled blades yields, at appropriate pressure ratios, performance gains that are not vitiated by losses incurred in cooling process. The heat-exchanger capacity and size are approximately 20 percent of that of a liquid-cooled piston engine of equal rated power.

NACA RM E8F04

DESIGN AND PERFORMANCE OF EXPERIMENTAL AXIAL-DISCHARGE MIXED-FLOW COMPRESSOR. I - IMPELLER DESIGN THEORY. Arthur W. Goldstein. August 12, 1948. 32p. diagrs. (NACA RM E8F04)

An axial-discharge centrifugal compressor, especially adapted for jet engines because of the large mass flow per unit frontal area, is described. General equations of relative fluid motion are developed to show assumptions involved and empirical character of simplifications. The best impeller was selected on basis of maximum air-flow capacity, which was 19.6 pounds per second for 14-inch diameter with tip speed of 1480 feet per second and pressure ratio of 3.5.

NACA RM E8F09

ALTITUDE-WIND-TUNNEL INVESTIGATION OF A 4000-POUND-THRUST AXIAL-FLOW TURBOJET ENGINE. I - PERFORMANCE AND WINDMILLING DRAG CHARACTERISTICS. William A. Fleming. August 3, 1948. 76p. diagrs., photos. (NACA RM E8F09)

Performance of a 4000-pound-thrust axial-flow turbojet engine was investigated at altitudes from 5000 to 40,000 feet and at ram pressure ratios from 1.02 to 1.86. The specific fuel consumption based on net thrust horsepower decreased rapidly with airspeed. Windmilling drag of the engine was relatively high and the inlet should be closed when the engine is inoperative in flight. The results show that an accurate calculation of the jet thrust of the engine can be made from measurements of the temperatures and pressures obtained from a survey across the jet-nozzle exit.

NACA RM E8F09a

ALTITUDE-WIND-TUNNEL INVESTIGATION OF A 4000-POUND-THRUST AXIAL-FLOW TURBOJET ENGINE. II - OPERATIONAL CHARACTERISTICS. William A. Fleming. August 6, 1948. 53p. diagrs., photos., 3 tabs. (NACA RM E8F09a)

Operational characteristics of a 4000-pound-thrust axial-flow turbojet engine were obtained at pressure altitudes from 5000 to 50,000 feet, ram pressure ratios from 1.00 to 1.86, and temperatures from 60° to -50° F. The effects of altitude and airspeed on such operational characteristics as combustion stability acceleration, starting, and fuel-control system were studied. The engine could be operated at full speed without serious burner unbalance at altitudes up to 50,000 feet. Acceleration of the engine was relatively slow and the time required for acceleration increased with altitude. The engine started normally and easily below 20,000 feet.

NACA RM E8F09b

ALTITUDE-WIND-TUNNEL INVESTIGATION OF A 4000-POUND-THRUST AXIAL-FLOW TURBOJET ENGINE. III - PERFORMANCE CHARACTERISTICS WITH THE HIGH-FLOW COMPRESSOR. William A. Fleming and Richard L. Golladay. August 5, 1948. 69p. diagrs., photos. (NACA RM E8F09b)

An investigation was conducted to determine the performance of a 4000-pound-thrust axial-flow turbojet engine with a high-flow compressor at altitudes from 5000 to 40,000 feet and ram pressure ratios from 1.00 to 1.82. Engine performance with high-flow and low-flow (standard) compressors is compared. Installation of a high-flow compressor in the engine in place of a low-flow compressor at a corrected engine speed of 7600 rpm and a ram pressure ratio of 1.40 gave an increase in corrected jet thrust of 11 percent, in corrected net thrust of 6.5 percent, in corrected fuel consumption of 14 percent, and in corrected airflow of 12 percent.

NACA RM E8F09c

ALTITUDE-WIND-TUNNEL INVESTIGATION OF A 4000-POUND-THRUST AXIAL-FLOW TURBOJET ENGINE. IV - ANALYSIS OF COMPRESSOR PERFORMANCE. Robert O. Dietz, Jr. and Frank L. Suozzi. August 5, 1948. 54p. diagrs., photos., tab. (NACA RM E8F09c)

Performance of two 11-stage axial-flow compressors operating in a 4000-pound-thrust axial-flow turbojet engine was investigated at simulated altitudes from 5000 to 40,000 feet, ram pressure ratios from 1.00 to 1.86, and compressor Mach numbers from 0.24 to 0.95. One was a standard compressor and the other, a similar compressor except that the blade angles of the rotor and stator blades were increased about 5° to obtain greater airflow. Maximum adiabatic efficiency for both compressors was about 85 percent. Increasing the blade angles 5° increased the airflow approximately 10 percent. Efficiency and pressure ratio at a given compressor Mach number were unaffected by changes in Reynolds number.

NACA RM E8F09d

ALTITUDE-WIND-TUNNEL INVESTIGATION OF A 4000-POUND-THRUST AXIAL-FLOW TURBOJET ENGINE. V - ANALYSIS OF TURBINE PERFORMANCE. Richard P. Krebs and Reece V. Hensley. August 4, 1948. 27p. diagrs., photo. (NACA RM E8F09d)

Performance characteristics of a turbine from a 4000-pound-thrust axial-flow turbojet engine were obtained at altitudes from 5000 to 40,000 feet and at ram pressure ratios from 1.01 to 1.77. Turbine efficiency was practically unaffected by changes in altitude or ram pressure ratio. The maximum efficiency obtained was about 82 percent.

NACA RM E8F17

PERFORMANCE INVESTIGATION OF CAN-TYPE COMBUSTOR. I - INSTRUMENTATION, ALTITUDE OPERATIONAL LIMITS AND COMBUSTION EFFICIENCY. Eugene V. Zettle and William P. Cook. September 16, 1948. 21p. diagrs., photo., tab. (NACA RM E8F17)

Investigation of single can-type combustor of turbojet engine was conducted to determine altitude operational limits with two fuels, combustion efficiencies at various altitudes and engine speeds, combustor-outlet temperature distribution, and combustor total-pressure drop. Limits with AN-F-32 fuel were approximately 60,000 feet for engine speed of 6000 rpm and 38,000 feet for engine speed of 4000 rpm. Altitude operational limits with AN-F-32 fuel are higher over largest part of engine-speed range than with AN-F-28 fuel.

NACA RM E8F29

OPERATING TEMPERATURES OF I-40-5 TURBOJET ENGINE BURNER LINERS AND THE EFFECT OF TEMPERATURE VARIATION ON BURNER-LINER SERVICE LIFE. H. D. Wilsted, Robert T. Duffy and Ralph E. Grey. August 23, 1948. 25p. diagrs., photos. (NACA RM E8F29)

The metal temperature and the temperature distribution in an I-40-5 turbojet engine were determined over the operating range of engine speeds using thermocouples welded to the outer surface of the burner liner. A ceramic-coated thermocouple was used throughout the investigation. Burner-liner temperatures increased at an increasing rate with engine speed; the highest temperature recorded was 1500° F. Temperature gradients were as large as 700° F per inch. The high local temperature gradients were apparently the cause of short burner-liner service life.

NACA RM E8G02

INVESTIGATION OF THE I-40 JET-PROPULSION ENGINE IN THE CLEVELAND ALTITUDE WIND TUNNEL. I - PERFORMANCE AND WINDMILLING DRAG CHARACTERISTICS. Stanley L. Gendler and William K. Koffel. August 24, 1948. 75p. diagrs., photos. (NACA RM E8G02)

An altitude-wind-tunnel investigation of the performance and windmilling characteristics of an I-40 jet-propulsion engine was conducted over a range of simulated flight conditions to determine the effects of altitude and ram pressure ratio. The use of generalizing factors for estimating altitude performance of the engine gave only fair results. Specific fuel consumption based on net thrust horsepower showed no effect of altitude but decreased with increasing ram pressure ratio at an engine speed of 11,500 rpm.

NACA RM E8G02a

INVESTIGATION OF THE I-40 JET-PROPULSION ENGINE IN THE CLEVELAND ALTITUDE WIND TUNNEL. II - ANALYSIS OF COMPRESSOR PERFORMANCE CHARACTERISTICS. Robert O. Dietz, Jr. and Robert M. Geisenheyner. August 26, 1948. 28p. diagrs., photos. (NACA RM E8G02a)

Performance characteristics of a centrifugal compressor operating as an integral part of a jet propulsion engine were obtained for a range of compressor Mach numbers from 0.72 to 1.46, ram pressure ratios from 0.98 to 1.76, and simulated altitudes from 10,000 to 40,000 feet. From results obtained over a wide range of altitudes, it was determined that the compressor performance is primarily dependent on the compressor-inlet Mach number. Variations of Reynolds number of the air at the compressor inlet had little effect on compressor performance.

NACA RM E8G02b

INVESTIGATION OF THE I-40 JET-PROPULSION ENGINE IN THE CLEVELAND ALTITUDE WIND TUNNEL. III - ANALYSIS OF TURBINE PERFORMANCE AND EFFECT OF TAIL-PIPE DESIGN ON ENGINE PERFORMANCE. Richard P. Krebs and Frederick C. Foshag. August 26, 1948. 27p. diagrs., photo. (NACA RM E8G02b)

Performance characteristics of a turbine operating as an integral part of a jet-propulsion engine were determined for a range of simulated altitudes from 10,000 to 40,000 feet and ram pressure ratios from 0.98 to 1.76. A comparison of engine performance with three different tail pipes is also presented. Turbine efficiency was unaffected by changes in altitude or the tail-pipe designs but varied with changes in ram pressure ratio. The most satisfactory engine performance was obtained with a constant-diameter tail pipe having a short nozzle at the outlet.

NACA RM E8G02c

INVESTIGATION OF THE I-40 JET-PROPULSION ENGINE IN THE CLEVELAND ALTITUDE WIND TUNNEL. IV - ANALYSIS OF COMBUSTION-CHAMBER PERFORMANCE. Reece V. Hensley. August 25, 1948. 34p. diagrs. (NACA RM E8G02c)

Combustion-chamber performance characteristics have been determined from an I-40 jet-propulsion engine over a range of simulated altitudes and ram pressure ratios. Combustion efficiency varied directly with ram pressure ratio and engine speed and varied inversely with altitude. Percentage losses in total pressure were appreciably affected by changes in altitude or ram pressure ratio up to a value of 1.3.

NACA RM E8G02d

INVESTIGATION OF THE I-40 JET-PROPULSION ENGINE IN THE CLEVELAND ALTITUDE WIND TUNNEL. V - OPERATIONAL CHARACTERISTICS. Richard L. Golladay and Stanley L. Gendler. August 25, 1948. 71p. diagrs., photos., 6 tabs. (NACA RM E8G02d)

Operational characteristics of a jet-propulsion engine determined at pressure altitudes from 10,000 to 50,000 feet and ram pressure ratios from 1.00 to 1.76 include effects of altitude and airspeed on operating speed range, starting, windmilling, acceleration, speed regulation, cooling, and vibration of the standard and modified engines. Maximum engine speed was obtainable at all altitudes and airspeeds with each fuel-control system investigated. The maximum idling speed was raised by increases in altitude and airspeed. Ignition at 30,000 feet was difficult. Windmilling starts were not successful. The engine speed was held constant during simulated dives and climbs at constant throttle position.

NACA RM E8H11

THEORETICAL COMPARISON OF SEVERAL METHODS OF THRUST AUGMENTATION FOR TURBOJET ENGINES. Eldon W. Hall and E. Clinton Wilcox. October 27, 1948. 40p. diagrs. (NACA RM E8H11. Now issued as Rept. 992)

Performance of several methods of thrust augmentation for turbojet engines was calculated for flight Mach numbers from 0 to 2.5 and for altitudes of sea level and 35,332 feet. The methods investigated were tail-pipe burning, water injection at compressor inlet, combination of tail-pipe burning and water injection, bleedoff, and rocket assist. Results indicated that tail-pipe burning plus water injection was best for large amounts of thrust augmentation and tail-pipe burning was best for smaller amounts inasmuch as these methods have the lowest ratio of augmented-to-normal total liquid consumption for a given thrust increase.

NACA RM E8H12

DETERMINATION OF AVERAGE HEAT-TRANSFER COEFFICIENTS FOR A CASCADE OF SYMMETRICAL IMPULSE TURBINE BLADES. I - HEAT TRANSFER FROM BLADES TO COLD AIR. Gene L. Meyer. 41p. diagrs., photos. (NACA RM E8H12)

A cascade of symmetrical impulse turbine blades was investigated to determine average surface heat-transfer coefficients. The results were correlated with other cascade data for impulse blades and are presented in dimensionless form. Heat-transfer coefficients based on an effective gas temperature were independent of Mach number.

NACA RM E8I03

EFFECT OF PRESSURE RATIO AND INLET PRESSURE ON PERFORMANCE OF EXPERIMENTAL GAS TURBINE AT INLET TEMPERATURE OF 800° R. Robert C. Kohl and Robert G. Larkin. November 22, 1948. 7p. diagrs. (NACA RM E8I03)

An experimental gas turbine was operated over a range of blade-jet speed ratios, total pressure ratios, and inlet total pressures at a constant inlet temperature of 800° R. Peak over-all efficiencies were obtained at blade-jet speed ratios from 0.525 to 0.575 for all runs. The variation in peak efficiency with inlet pressure and pressure ratio was of small magnitude for the conditions investigated.

NACA RM E8I21

SOME EFFECTS OF STATOR CONE ANGLE AND BLADE-TIP LEAKAGE ON 40-PERCENT-REACTION TURBINE HAVING ROTOR-BLADE CAPS. Robert E. English, Robert J. McCready and John S. McCarthy. March 23, 1949. 28p. diagrs., photo. (NACA RM E8I21)

A turbine having 40-percent reaction and rotor-blade caps, which form a continuous rotating cylindrical shroud, was operated with two stators having cone angles of 70° and 0° and with two stationary shrouds—a labyrinth, no-leakage shroud and a cylindrical shroud. With the 0°-cone-angle stator, the efficiency was 0.04 higher than with the 70°-cone-angle stator. Replacing the labyrinth shroud with the cylindrical shroud having a radial clearance 0.016 of the blade height produced no measurable change in efficiency.

NACA RM E8J22

VIBRATION SURVEY OF BLADES IN 10-STAGE AXIAL-FLOW COMPRESSOR. I - STATIC INVESTIGATION. Andre J. Meyer, Jr. and Howard F. Calvert. January 31, 1949. 34p. diagrs., photos., 2 tabs. (NACA RM E8J22)

Natural frequencies were measured in the blading of a 10-stage axial-flow compressor and these frequencies were compared with possible exciting forces. Node shapes of higher modes of vibration were determined from sand patterns in an attempt to correlate the position of high-stress points for the various modes with the location of actual failures in the seventh- and tenth-stage blades. Critical-speed diagrams were plotted to show possible cause of failures.

NACA RM E8J22a

VIBRATION SURVEY OF BLADES IN 10-STAGE AXIAL-FLOW COMPRESSOR. II - DYNAMIC INVESTIGATION. Andre J. Meyer, Jr. and Howard F. Calvert. January 31, 1949. 25p. diagrs., photos. (NACA RM E8J22a)

Vibratory stresses were measured in the first five stages by the use of strain gages mounted on the blades of a 10-stage axial-flow compressor. Effects of surge and of changes in pressure ratio on amplitude of blade vibrations were investigated. Good correlation was obtained between first bending-mode frequencies that were dynamically measured and those that were calculated by correcting static measurements to account for the effects of centrifugal force.

NACA RM E8J22b

VIBRATION SURVEY OF BLADES IN 10-STAGE AXIAL-FLOW COMPRESSOR. III - PRELIMINARY ENGINE INVESTIGATION. Andre J. Meyer, Jr. and Howard F. Calvert. January 31, 1949. 23p. diagrs., photo. (NACA RM E8J22b)

Vibratory stresses were measured in the blading of a 10-stage axial-flow compressor under operating conditions. Curves are presented showing maximum allowable vibratory stress for a given speed, change of damping coefficient with mounting of a strain gage at base of blade, effect of rotor speed on blade natural frequency, and effect of order of the first bending-mode vibration on stress. For all stages, the lower the order of vibration the higher the stress but no destructive vibrations were detected.

NACA RM E8J25

ALTITUDE-WIND-TUNNEL INVESTIGATION OF OPERATIONAL CHARACTERISTICS OF WESTINGHOUSE X24C-4B AXIAL-FLOW TURBOJET ENGINE. W. Kent Hawkins and Carl L. Meyer. November 23, 1948. 39p. diagrs., photos. (NACA RM E8J25)

Operating characteristics of Westinghouse X24C-4B axial-flow turbojet engine presented include: Operable engine-speed range at altitude, acceleration and deceleration, altitude and flight-Mach-number compensation of governor, lubrication-system performance, and starting characteristics. Operable range of engine speeds was limited at high altitudes and low flight Mach numbers. Accelerations and decelerations at altitudes above 25,000 feet were limited by combustion blow-out. Altitude and flight-Mach-number compensation of governor was good at high engine speeds and starting characteristics of one engine configuration were very unsatisfactory.

NACA RM E8J25a

ALTITUDE-WIND-TUNNEL INVESTIGATION OF PERFORMANCE AND WINDMILLING DRAG CHARACTERISTICS OF WESTINGHOUSE X24C-4B AXIAL-FLOW TURBOJET ENGINE. Carl L. Meyer and Harry E. Bloomer. November 23, 1948. 60p. diagrs., photo. (NACA RM E8J25a)

An altitude-wind-tunnel investigation of the performance and windmilling drag characteristics of an original and a modified turbojet engine was conducted over a range of simulated flight conditions. Performance variables depending upon fuel consumption that are obtained from data at one altitude cannot be used to predict these variables at other altitudes; however, thrust and air-flow values can be predicted for a limited range of altitudes from data taken at one altitude. The maximum net thrust of the modified engine was 3 to 20 percent greater than that of the original engine. The windmilling engine speed and drag of the two engines were comparable.

NACA RM E8J25d

INVESTIGATION OF PERFORMANCE OF TURBOJET ENGINE WITH CONSTANT- AND VARIABLE-AREA EXHAUST NOZZLES. Lewis E. Wallner. November 26, 1948. 43p. diagrs., photos., tab. (NACA RM E8J25d)

Presents performance of turbojet engine with constant- and variable-area exhaust nozzles at simulated altitudes from 5000 to 45,000 feet and simulated flight Mach numbers from 0.12 to 0.94. The efficiency of the variable-area nozzle investigated was 1.5 to 8 percent lower than the efficiency of the constant-area nozzle. As a result, lower thrusts and specific fuel consumptions were obtained with the variable-area nozzle as compared to the constant-area nozzle.

NACA RM E8J25e

ALTITUDE-WIND-TUNNEL INVESTIGATION OF TAIL-PIPE BURNING WITH A WESTINGHOUSE X24C-4B AXIAL-FLOW TURBOJET ENGINE. William A. Fleming and Lewis E. Wallner. December 13, 1948. 56p. diagrs., photos., tab. (NACA RM E8J25e)

Thrust augmentation of a 3000-pound-thrust axial-flow type turbojet engine by burning fuel in the tail pipe has been investigated in the NACA Cleveland altitude wind tunnel. The highest net-thrust increase obtained in the investigation was 86 percent with a net thrust specific fuel consumption of 2.91 and a total fuel-air ratio of 0.0523. The highest combustion efficiencies obtained with each of the four configurations investigated ranged from 0.71 to 0.96.

NACA RM E8J28

ALTITUDE-WIND-TUNNEL INVESTIGATION OF WESTINGHOUSE 19B-2, 19B-8, AND 19XB-1 JET-PROPULSION ENGINES. I - OPERATIONAL CHARACTERISTICS. William A. Fleming. 21p. diagrs., photos. (NACA RM E8J28)

Operational characteristics of the 19B-2, 19B-8, and 19XB-1 turbojet engines discussed include effects of altitude and airspeed on operating range, combustion stability, starting, acceleration, and functioning of fuel-control system. Operation of 19B engines above an altitude of 17,000 feet was limited because of combustion blow-out; operational range of the 19XB-1 engine was slightly better than that of 19B engines. Starting characteristics of the 19XB-1 engine were satisfactory but 19B engines did not start consistently.

NACA RM E8J28a

ALTITUDE-WIND-TUNNEL INVESTIGATION OF WESTINGHOUSE 19B-2, 19B-8, AND 19XB-1 JET-PROPULSION ENGINES. II - ANALYSIS OF TURBINE PERFORMANCE OF 19B-8 ENGINE. Richard P. Krebs and Frank L. Suozzi. November 24, 1948. 27p. diagrs., photos. (NACA RM E8J28a)

The performance of the turbine of the 19B-8 turbojet engine was determined from an investigation of the complete engine in the altitude wind tunnel over a range of simulated flight conditions. The effects of altitude, flight Mach number, and tail-cone position on turbine performance are discussed. Turbine efficiency was unaffected by changes in altitude up to 15,000 feet but was a function of tail-cone position and flight Mach number.

NACA RM E8J28b

ALTITUDE-WIND-TUNNEL INVESTIGATION OF WESTINGHOUSE 19B-2, 19B-8, AND 19XB-1 JET-PROPULSION ENGINES. III - PERFORMANCE AND WINDMILLING DRAG CHARACTERISTICS. William A. Fleming and Robert O. Dietz, Jr. November 26, 1948. 71p. diagrs., photos. (NACA RM E8J28b)

Performance of the 19B-8 and 19XB-1 turbojet engines and windmilling drag of the 19B-8 engine were determined in the altitude wind tunnel for a range of simulated flight conditions. Performance variables involving fuel consumption that are obtained from data at one altitude cannot be used to predict these variables at altitudes above 15,000 feet; thrust and air-flow values can be predicted for the range of altitudes investigated from data taken at one altitude. At similar operating conditions, corrected values of jet thrust and air flow were approximately the same for both engines.

NACA RM E8J28c

ALTITUDE-WIND-TUNNEL INVESTIGATION OF WESTINGHOUSE 19B-2, 19B-8, AND 19XB-1 JET-PROPULSION ENGINES. IV - ANALYSIS OF COMPRESSOR PERFORMANCE. Robert O. Dietz and John K. Kuenzig. November 26, 1948. 48p. diagrs., photos. (NACA RM E8J28c)

Performance of the compressors of the 19B-8 and 19XB-1 turbojet engines was determined from an investigation of the complete engines over a range of simulated flight conditions. For the range of compressor operation investigated, Reynolds number had no measurable effect on compressor performance. The operating lines of the 19B-8 compressor were on the low-air-flow side of the region of maximum efficiency. The pressure ratio of the 19XB-1 compressor was higher than that of the 19B-8 compressor.

NACA RM E8J28d

ALTITUDE-WIND-TUNNEL INVESTIGATION OF WESTINGHOUSE 19B-2, 19B-8, AND 19XB-1 JET-PROPULSION ENGINES. V - COMBUSTION-CHAMBER PERFORMANCE. Bemrose Boyd. November 26, 1948. 41p. diagrs., photo. (NACA RM E8J28d)

Combustion-chamber pressure losses of the 19B-2 and 19B-8 turbojet engines and combustion efficiencies of these two engines and the 19XB-1 turbojet engine are presented. Data were obtained from investigation of the complete engine over a range of simulated flight conditions. Maximum combustion efficiency was shifted to higher engine speeds by increasing altitude. Combustion efficiency was decreased at low engine speeds by increasing tunnel Mach number and was decreased at high engine speeds by extension of the tail cone.

NACA RM E8J29

SIMULATED ALTITUDE PERFORMANCE OF COMBUSTOR OF WESTINGHOUSE 19XB-1 JET-PROPULSION ENGINE. J. Howard Childs and Richard J. McCafferty. November 30, 1948. 44p. diagrs., photo., 2 tabs. (NACA RM E8J29)

A 19XB-1 combustor was operated under conditions simulating zero-ram operation of the 19XB-1 turbojet engine at various altitudes and engine speeds. The combustion efficiencies and the altitude operational limits were determined; data were also obtained on the character of the combustion, the pressure drop through the combustor, and the combustor outlet temperature and velocity profiles.

NACA RM E8K22

CARBON DEPOSITION OF 19 FUELS IN AN ANNULAR TURBOJET COMBUSTOR. Jerrold D. Wear and Edmund R. Jonash. February 3, 1949. 21p. diagrs., 2 tabs. (NACA RM E8K22)

Effects of fuel properties and change in simulated engine operating conditions on carbon deposition were evaluated in an annular turbojet combustor with a diameter of 10-3/8 inches. The fuels included hydrocarbons of the paraffinic, olefinic, and aromatic types as well as fuel mixtures. Carbon deposition increased with increase in boiling temperature of fuels of the same hydrocarbon type. Aromatic fuels deposited more carbon than the other types of fuel of the same boiling temperature. An empirical correlation of the carbon deposition and the boiling temperature and hydrogen-carbon weight ratio of the fuel was obtained.

NACA RM E8L02

COMPARISON OF FLIGHT PERFORMANCE OF AN-F-58 AND AN-F-32 FUELS IN J35 TURBOJET ENGINE. Loren W. Acker and Kenneth S. Kleinknecht. April 7, 1949. 15p. diagrs., photo., 2 tabs. (NACA RM E8L02)

Performance of fuels corresponding to specifications AN-F-58 and AN-F-32 was investigated in a J35 turbojet engine in flight. Comparatively, AN-F-58 fuel indicated slightly higher net thrust and fuel consumption, inferior blowout limits, and similar altitude starting characteristics and carbon deposits.

NACA RM E8L20a

ALTITUDE PERFORMANCE OF AN-F-58 FUELS IN J35-C-3 SINGLE COMBUSTOR. Edward G. Stricker and Warren D. Rayle. June 14, 1949. 21p. diagrs., 2 tabs. (NACA RM E8L20a)

Three fuel blends conforming to AN-F-58 specifications were tested in order to determine the influence of boiling temperatures and aromatic content on altitude performance in single combustor of 4000-pound-thrust turbojet engine. At simulated engine conditions from an altitude of 30,000 to an altitude of 60,000 feet and 85-percent rated engine speed, the three AN-F-58 fuels showed little difference in performance.

NACA RM E9B02

INVESTIGATION OF SEVERAL CLAMSHELL VARIABLE-AREA EXHAUST NOZZLES FOR TURBOJET ENGINES. Bruce T. Lundin. May 26, 1949. 52p. diagrs., photos. (NACA RM E9B02)

Efficiency of five different types of clamshell variable area exhaust nozzle for turbojet engines is compared with performance of various conventional fixed-area conical nozzles. Variable-area nozzles had satisfactory mechanical reliability even under afterburning conditions and three of the nozzles investigated provided jet thrust within 0 to 1-1/2 percent of that obtained with the fixed-area nozzles. Larger thrust losses for the other two nozzles were attributed principally to a nonplanar outlet configuration of the movable nozzle flaps.

NACA RM E9C15

TURBINE-ROTOR-BLADE DESIGNS BASED ON ONE-DIMENSIONAL-FLOW THEORY. I - PERFORMANCE OF SINGLE-STAGE TURBINE HAVING 40-PERCENT REACTION. Robert E. English and Cavour H. Hauser. June 10, 1949. 31p. diagrs., photo. (NACA RM E9C15)

The performance of the first of a family of turbine-rotor-blade designs is presented. The rotor blade was designed for a total-to-static pressure ratio of 4.00 and 40-percent reaction using one-dimensional-flow theory. Constant static pressure was assumed over the blade height at the entrance and the exit of each row of blades. The brake internal efficiency had a maximum value slightly greater than 0.84 and was equal to 0.82 at design conditions. For design conditions, the static pressure varied 5 percent over the blade height at the rotor exit.

NACA RM E9D01

EVALUATION OF PISTON-TYPE GAS-GENERATOR ENGINE FOR SUBSONIC TRANSPORT OPERATION. A. F. Lietzke and Hugh M. Henneberry. July 15, 1949. 29p. diagrs., tab. (NACA RM E9D01)

A piston-type gas-generator engine was evaluated by comparing performances of a transport airplane powered by this engine with an airplane having same characteristics powered by other types of engine. Turbojet, turbine-propeller, compound, and turbo-supercharged reciprocating engine were compared with gas-generator engine. Comparison is based on pay-load ton-miles per hour operation per ton take-off gross weight. Gas-generator engine was found to have a marked advantage over other engine types for long range at subsonic flight speeds. At short ranges no one engine showed great superiority, but the turbojet engine exhibits some advantages at high velocity.

NACA RM E9E16

EFFECT OF TEMPERATURE ON PERFORMANCE OF SEVERAL EJECTOR CONFIGURATIONS. H. D. Wilsted, S. C. Huddleston and C. W. Ellis. June 13, 1949. 27p. diagrs. (NACA RM E9E16)

An investigation was made to determine the effect of the primary-jet temperature on the performance of several ejector configurations. In general, for ejectors with short straight mixing lengths and short spacings, weight-flow ratio varies directly as the square root of ratio of total primary temperature to total secondary temperature. For ejectors with longer lengths and spacings, which pump greater weight flows through the secondary annulus, however, the pressure increase in the plane of the primary-nozzle exit decreases secondary weight flow so much that the temperature-ratio correction factor does not completely describe temperature effect on ejector performance.

NACA RM E9G01

PROPERTIES OF CERTAIN INTERMETALLICS AS RELATED TO ELEVATED-TEMPERATURE APPLICATIONS. I - MOLYBDENUM DISILICIDE. W. A. Maxwell. October 6, 1949. 27p. diagrs., 4 tabs. (NACA RM E9G01)

Methods were developed for the preparation, purification, and formation by pressing and sintering of molybdenum disilicide. The modulus-of-rupture strength and oxidation resistance at 2000° and 2400° F were studied as well as the general properties. Sintered molybdenum disilicide was found to have high comparative strength at 2400° F and to possess exceptional resistance to oxidation at high temperatures. The material deformed plastically at temperatures well below the melting point despite complete brittle behavior at room temperature.

NACA RM E9G08

ALTITUDE PERFORMANCE AND OPERATIONAL CHARACTERISTICS OF 29-INCH-DIAMETER TAIL-PIPE BURNER WITH SEVERAL FUEL SYSTEMS AND FLAME HOLDERS ON J35 TURBOJET ENGINE. E. William Conrad and William R. Prince. November 8, 1949. 50p. diagrs., photos., tab. (NACA RM E9G08)

An investigation of afterburning was conducted in the Lewis altitude wind tunnel using a full-scale turbojet engine to obtain information on afterburner design variables. Radial distribution and direction of injection of the tail-pipe fuel and several flame-holder types were studied. Direction of fuel injection had no effect on combustion efficiency; however, poor radial fuel distribution resulted in low combustion efficiencies. As altitude was increased, the decrease in peak combustion efficiency became more rapid as the blocking area of the flame holder was reduced. Problems of tail-pipe cooling and ignition are discussed and satisfactory solutions obtained.

NACA RM E9G13

CYCLIC ENGINE OPERATION OF CAST VITALLIUM TURBINE BLADES AT AN EXHAUST-CONE GAS TEMPERATURE OF 1440 ± 20° F. Charles Yaker and Floyd B. Garrett. September 19, 1949. 41p. diagrs., photos., 4 tabs. (NACA RM E9G13)

An investigation was conducted to study engine performance of cast Vitallium turbine blades at an estimated maximum blade temperature of 1600° F. The blades, mounted in a Timken 16-25-6 wheel, were subjected to 20-minute cycles consisting of approximately 5 minutes at idle and 15 minutes at rated speed. After 7-1/2 cycles (2 hr, 30 min), one

blade fractured due to fatigue, a large number of blades had intercrystalline cracks, and two blades had large transcrystalline cracks. Examination of broken and unbroken blades disclosed no correlation between blade failure and elongation as compared with grain size and hardness.

NACA RM E9G25

VIBRATIONAL MODES OF SEVERAL HOLLOW TURBINE BLADES AND OF SOLID TURBINE BLADE OF SIMILAR AERODYNAMIC DESIGN. R. H. Kemp and J. Shifman. October 3, 1949. 17p. diagrs., photos. (NACA RM E9G25)

Vibrational modes of several hollow turbine blades and a solid turbine blade of similar aerodynamic design were experimentally determined. Most of the observed vibrational modes of the hollow blades could be excited if the blades were operated in a conventional turbojet engine. A breathing effect was found in hollow blades at approximately 1230 cycles per second in which the blade walls moved toward each other and then away, producing stress concentrations at the leading and trailing edges. Little similarity in vibrational modes existed between the hollow blades and the solid blade. Approximately twice as many readily excited modes were found in the hollow blades as in the solid blade.

NACA RM E9I07

VIBRATION OF LOOSELY MOUNTED TURBINE BLADES DURING SERVICE OPERATION OF A TURBOJET ENGINE WITH CENTRIFUGAL COMPRESSOR AND STRAIGHT-FLOW COMBUSTION CHAMBERS. W. C. Morgan, R. H. Kemp and S. S. Manson. November 3, 1949. 18p. diagrs., photos. (NACA RM E9I07)

Vibration characteristics of loosely mounted turbine blades were determined during service operation of a turbojet engine. High-temperature strain gages were used to measure turbine-blade vibrations. Vibration occurred in first bending and first torsional modes; in addition, a small number of complex-mode vibrations was observed. Comparison was made between vibrations in loosely mounted blades and those observed during a previous investigation of similar blades tightly mounted in a turbine wheel. The comparison did not indicate that any considerable gain in damping was effected by the use of loosely mounted blades.

NACA RM E9I23

ALTITUDE-CHAMBER PERFORMANCE OF BRITISH ROLLS-ROYCE NENE II ENGINE. I - STANDARD 18.75-INCH-DIAMETER JET NOZZLE. Zelmar Barson and H. D. Wilsted. September 23, 1949. 58p. diagrs., 2 tabs. (NACA RM E9I23)

An altitude-chamber investigation of the British Rolls-Royce Nene II turbojet engine was conducted over a range of altitudes from sea level to 60,000 feet and ram-pressure ratios from 1.00 to 3.50. Decreasing compressor pressure ratio and efficiency at high altitude prevented prediction of engine performance parameters for altitudes above 20,000 feet from data obtained at any one altitude. Engine performance generalized to a single curve for ram-pressure ratio for all conditions when critical flow existed in the jet nozzle.

NACA RM E9K04

CORRELATION OF LABORATORY SMOKE TEST WITH CARBON DEPOSITION IN TURBOJET COMBUSTORS. Arthur M. Busch. February 3, 1950. 15p. diagrs., 3 tabs. (NACA RM E9K04)

A function of flame heights at the sooting point in a simple wick lamp and boiling point of 19 fuels was correlated with carbon deposition in a 10-3/8 inch annular turbojet combustor operating at a single set of conditions. Two similar investigations with different combustors, operating conditions, and nine different fuels yielded similar correlations. The simple wick lamp may be of value in the evaluation of turbojet fuels.

NACA RM E9L05

EFFECTS OF OBSTRUCTIONS IN COMPRESSOR INLET ON BLADE VIBRATION IN 10-STAGE AXIAL-FLOW COMPRESSOR. Andre J. Meyer, Jr., Howard F. Calvert and C. Robert Morse. February 13, 1950. 16p. diagrs. (NACA RM E9L05)

Resistance-wire strain gages were used to measure blade-vibration characteristics in 10-stage axial-flow compressor during normal jet-engine operation. Effects produced by obstructions in path of air flow entering compressor were also investigated. Aerodynamic damping of vibrating blades was evaluated. Results indicated that obstructions affected blade vibrations throughout compressor, that obstructions could be so located as to reduce some vibrations, and that aerodynamic damping accounted for about four-fifths of total dynamic blade damping.

NACA RM L6J09

HIGH-SPEED WIND-TUNNEL TESTS OF A 1/16-SCALE MODEL OF THE D-558 RESEARCH AIRPLANE. LIFT AND DRAG CHARACTERISTICS OF THE D-558-I AND VARIOUS WING AND TAIL CONFIGURATIONS. John B. Wright and Donald L. Loving. April 18, 1947. 43p. diagrs., 2 tabs. (NACA RM L6J09)

Test results indicated the airplane will have satisfactory lift and drag characteristics up to and including the design Mach number of 0.85. The swept-wing and low-aspect-ratio wing configurations showed pronounced improvement in maintaining lift throughout the Mach number range tested and in increasing critical Mach numbers to the order of 0.9.

NACA RM L6K08

RESUME OF WIND-TUNNEL DATA ON THE EFFECT OF EXTERNAL STORES ON STABILITY OF MODELS OF MILITARY AIRPLANES. H. Norman Silvers and Raymond D. Vogler. December 19, 1946. 7p. 2 tabs. (NACA RM L6K08)

A summary, in tabular form, is presented on the effect on static stability of tanks, torpedoes, bombs, and radar domes. The data obtained indicate that at Mach numbers below 0.4 the effects of external stores on static longitudinal stability were small but may not be negligible. Although data were meager for Mach numbers above 0.4, results indicated that wing-tip tanks which were well faired to the wing contour caused reasonably small changes in static longitudinal stability. The available data were insufficient to estimate the general effects of external stores on lateral stability.

NACA RM L6K08b

PRELIMINARY TESTS OF A BURNER FOR RAM-JET APPLICATIONS. Paul W. Huber. January 15, 1947. 14p. diagrs. (NACA RM L6K08b)

Preliminary tests of a small ram-jet burner have been made and tests of this burner indicate efficient combustion characteristics (combustion was 80 percent complete) and low aerodynamic losses at the conditions tested. The fact that the measured combustion was so nearly complete is due mainly to the method of fuel injection and to mixing of fuel and air before ignition. The pressure drop due to frictional losses at the burner at the inner passage of the ram jet is small, since the air is not greatly disturbed to obtain mixing and ignition.

NACA RM L6L19

THE EFFECT OF HIGH SOLIDITY ON PROPELLER CHARACTERISTICS AT HIGH FORWARD SPEEDS FROM WIND-TUNNEL TESTS OF THE NACA 4-(3)(06.3)-06 AND NACA 4-(3)(06.4)-09 TWO-BLADE PROPELLERS. James B. Delano. February 27, 1947. 50p. diagrs., photos. (NACA RM L6L19)

Two two-blade propellers were tested in the Langley 8-foot high-speed tunnel through a range of blade angle from 20° to 70° for free-stream Mach numbers from 0.165 to 0.725 to determine the effects of high solidity and compressibility on propeller characteristics.

NACA RM L6L27

EFFECTS OF A FUSELAGE AND VARIOUS HIGH-LIFT AND STALL-CONTROL FLAPS ON AERODYNAMIC CHARACTERISTICS IN PITCH OF AN NACA 64-SERIES 40° SWEPT-BACK WING. D. William Conner and Robert H. Neely. May 26, 1947. 40p. diagrs., photos., tab. (NACA RM L6L27)

Wind-tunnel tests were made to determine low-speed lift, drag, and pitching-moment characteristics. The wing had an aspect ratio of 4 and a taper ratio of 0.625. Low-, middle-, and high-wing-fuselage combinations were tested at Reynolds numbers of 3×10^6 and 8.1×10^6.

NACA RM L7C11

AERODYNAMIC CHARACTERISTICS OF A 45° SWEPT-BACK WING WITH ASPECT RATIO OF 3.5 AND NACA 2S-50(05)-50(05) AIRFOIL SECTIONS. Anthony J. Proterra. August 4, 1947. 21p. diagrs., photo. (NACA RM L7C11)

Scale effects were investigated at Reynolds numbers ranging from 2.1×10^6 to 8.0×10^6; the effects of yaw were investigated at a Reynolds number of 4.1×10^6. Results indicate that the wing has poor characteristics from low-speed considerations.

NACA RM L7C24a

INVESTIGATION OF INTAKE DUCTS FOR A HIGH-SPEED SUBSONIC JET-PROPELLED AIRPLANE. Herbert N. Cohen. April 23, 1947. 24p. diagrs., photos., tab. (NACA RM L7C24a)

Results of pressure-loss measurements are presented for full-scale models of two ducts under consideration for use in the induction system of an experimental jet-propelled airplane. Supplementary pressure-loss measurements were made on the better of the two ducts, designated duct II, first with carborundum grains in the duct inlet and then with a spoiler in order to obtain an indication of the importance of inlet roughness and surface discontinuities. Additional measurements were made of duct II incorporating a horizontal "splitter" vane which was under consideration for structural reasons.

NACA RM L7D03

AN INVESTIGATION OF THE LOW-SPEED CHARACTERISTICS OF TWO SHARP-EDGE SUPERSONIC INLETS DESIGNED FOR ESSENTIALLY EXTERNAL SUPERSONIC COMPRESSION. John S. Dennard. June 6, 1947. 32p. diagrs., photos. (NACA RM L7D03)

The investigation has been conducted at low airspeeds to obtain preliminary information concerning the surface-pressure, drag, and pressure recovery of such inlets. Surface-pressure measurements and surveys of the pressures in the internal and external flow were obtained at angles of attack of 0° and 6° for a wide range of inlet-velocity ratio.

NACA RM L7D14

AERODYNAMIC CHARACTERISTICS OF A 42° SWEPT-BACK WING WITH ASPECT RATIO 4 AND NACA 64_1-112 AIRFOIL SECTIONS AT REYNOLDS NUMBERS FROM 1,700,000 TO 9,500,000. Robert H. Neely and D. William Conner. May 23, 1947. 39p. diagrs., photos. (NACA RM L7D14)

Wind-tunnel tests were made to determine low-speed aerodynamic characteristics in pitch and in yaw at high Reynolds numbers. The characteristics in pitch were obtained over a Reynolds number range from 1.7×10^6 to 9.5×10^6 and the characteristics in yaw from 1.7×10^6 to 5.3×10^6.

NACA RM L7E12

FURTHER INVESTIGATION OF NACA 4-(5)(08)-03 TWO-BLADE PROPELLER AT HIGH FORWARD SPEEDS. Melvin M. Carmel and Harold L. Robinson. May 26, 1947. 46p. diagrs. (NACA RM L7E12)

Tests of an NACA two-blade propeller have been made in the Langley 8-foot high-speed tunnel for blade angles of 45° and 60° extending the Mach number range from that of previous tests of this propeller up to a forward Mach number of 0.913.

NACA RM L7E13

EFFECTS OF A FUSELAGE ON THE AERODYNAMIC CHARACTERISTICS OF A 42° SWEPTBACK WING AT REYNOLDS NUMBERS TO 8,000,000. Reino J. Salmi, D. William Conner and Robert R. Graham. June 10, 1947. 32p. diagrs., photos. (NACA RM L7E13)

Tests were made in pitch at Reynolds numbers of 3,040,000 and 8,090,000 and in yaw at Reynolds numbers of 1,720,000 and 5,300,000. The wing had an aspect ratio of 4, a taper ratio of 0.625 and NACA 64_1-112 airfoil sections. Tests were made with the wing in high-, low-, and midwing positions. Tests were made without flaps and with 18.4-percent-chord split flaps extending from 12.3 to 50 percent of the semispan. The presence of the fuselage had little effect on the values of the maximum lift coefficient and the slope of the lift curve, but caused a destabilizing shift in the rate of change of pitching moment with lift.

NACA RM L7E23

LOW-SPEED CHARACTERISTICS IN PITCH OF A 42° SWEPTBACK WING WITH ASPECT RATIO 3.9 AND CIRCULAR-ARC AIRFOIL SECTIONS. Robert H. Neely and William Koven. November 13, 1947. 42p. diagrs., photos., 2 tabs. (NACA RM L7E23)

Characteristics of basic wing were poor. The effects on the wing characteristics of extensible round-nose leading-edge flaps located on the outboard 70 percent of the semispan, and of a fuselage with fineness ratio 10.2 located in the low, middle, and high positions were investigated. Tests covered a range of Reynolds numbers from 3.09×10^6 to 9.60×10^6.

NACA RM L7E29

ESTIMATION OF RANGE OF STABILITY DERIVATIVES FOR CURRENT AND FUTURE PILOTLESS AIRCRAFT. Marvin Pitkin and Herman O. Ankenbruck. October 8, 1947. 22p. diagrs., tab. (NACA RM L7E29)

The estimated range of the aerodynamic and mass stability derivatives for airplanes and missiles is given primarily as an aid to designers of "flight tables" and "simulators."

NACA RM L7F04a

LOW-SPEED CHARACTERISTICS IN PITCH OF A 34° SWEPTFORWARD WING WITH CIRCULAR-ARC AIRFOIL SECTIONS. D. William Conner and Patrick A. Cancro. January 9, 1948, 35p. diagrs., photos. (NACA RM L7F04a)

Contains low-speed lift, drag, and pitching-moment characteristics of a 34° sweptforward wing with aspect ratio 3.9 and circular-arc airfoil sections tested with a fuselage and high-lift and stall-control devices. Adding a fuselage to the basic wing reduced the undesirable variations in pitching moment in the high-lift range. Adding full-span, extended, round-nose, leading-edge flaps to the midwing-fuselage combination increased the maximum lift coefficient to 1.30 without seriously decreasing the longitudinal stability. Combinations with half-span split flaps had unfavorable pitching-moment characteristics.

NACA RM L7F13

MEASUREMENTS OF AERODYNAMIC CHARACTERISTICS OF A 35° SWEPTBACK NACA 65-009 AIRFOIL MODEL WITH 1/4-CHORD PLAIN FLAP BY THE NACA WING-FLOW METHOD. Harold I. Johnson. August 5, 1947. 72p. diagrs., photos. (NACA RM L7F13)

As part of a general investigation of the stability and control characteristics of various airfoil-flap combinations in the transonic speed range, measurements were made by the NACA wing-flow method of the lift, pitching-moment, and hinge-moment characteristics of a 35° sweptback NACA 65-009 airfoil of aspect ratio 3.04, with a full-span 1/4-chord unsealed plain flap. The tests covered Mach numbers from 0.55 to 1.10, Reynolds numbers from about 500,000 to 1,300,000, angles of attack from -2° to 15°, and flap deflections from about -20° to 20°.

NACA RM L7F16

LANGLEY FULL-SCALE-TUNNEL INVESTIGATION OF MAXIMUM LIFT AND STABILITY CHARACTERISTICS OF AN AIRPLANE HAVING APPROXIMATELY TRIANGULAR PLAN FORM (DM-1 GLIDER). J. Calvin Lovell and Herbert A. Wilson, Jr. August 5, 1947. 44p. diagrs., photos., tab. (NACA RM L7F16)

This glider had an aspect ratio of 1.8 and 60° sweepback. The investigation consisted of the determination of the separate effects of the following modifications made to the glider on its maximum lift and stability characteristics: (a) installation of sharp leading edges over the inboard semispan of the wing, (b) removal of the vertical fin, (c) sealing of the elevon control-balance slots, (d) installation of redesigned thin vertical surfaces, (e) installation of faired sharp leading edges, and (f) installation of canopy.

NACA RM L7F19

PRELIMINARY INVESTIGATION OF SPOILER LATERAL CONTROL ON A 42° SWEPTBACK WING AT TRANSONIC SPEEDS. Leslie E. Schneiter and Howard L. Ziff. August 12, 1947. 13p. diagrs. (NACA RM L7F19)

This investigation was performed on a double-wedge type semispan wing by the NACA wing-flow method of testing. Above a Mach number of 0.6, the effectiveness of the spoiler in producing rolling moment at an angle of attack of 3° increased as a Mach number of 0.90 was approached. At Mach numbers greater than 0.90, the spoiler effectiveness decreased rapidly until a Mach number of 1.05 was attained, above which point the effectiveness increased slightly as speed was further increased.

NACA RM L7I24

AN ANALYSIS OF DUCTED-AIRFOIL RAM JETS FOR SUPERSONIC AIRCRAFT. Paul R. Hill and A. A. Gammal. July 7, 1948. 43p. diagrs. (NACA RM L7I24)

The effect of sweepback on the external aerodynamics of ducted airfoils with the leading edge ahead of the Mach cone is shown to be small. Possible total pressure recoveries are determined for two-dimensional wedge-type diffuser inlets in order to compute thrust and propulsive coefficients for a wide range of hydrocarbon fuel-air ratios. The possible range and acceleration performances are determined for aircraft with fineness ratio 10, parabolic body-of-revolution fuselages with both ducted wing and ducted tails of various sizes relative to the fuselage size.

NACA RM L7I30

YAW CHARACTERISTICS AND SIDEWASH ANGLES OF A 42° SWEPTBACK CIRCULAR-ARC WING WITH A FUSELAGE AND WITH LEADING-EDGE AND SPLIT FLAPS AT A REYNOLDS NUMBER OF 5,300,000. Reino J. Salmi and James E. Fitzpatrick. December 10, 1947. 38p. diagrs., photos., tab. (NACA RM L7I30)

Contains results of tests of a 42° sweptback wing at a Mach number of 0.11. The dihedral effect of the sharp-edged-airfoil wing became negative at moderate lift coefficients similar to low Reynolds number results of round-nosed airfoil wings. Flap deflection produced positive effective dihedral. The plain wing had neutral directional stability with flaps neutral but was stable with flaps deflected. Air-stream surveys of the sidewash angles of various wing fuselage combinations showed that maximum vertical-tail effectiveness would be obtained on a low-wing combination.

NACA RM L7J03

INVESTIGATION OF PRESSURE DISTRIBUTION OVER AN EXTENDED LEADING-EDGE FLAP ON A 42° SWEPTBACK WING. D. William Conner and Gerald V. Foster. December 19, 1947. 12p. diagrs. (NACA RM L7J03)

Pressure distributions over an extended leading-edge flap, mounted on a 42° sweptback wing and deflected 50°, are presented for several angles of attack. Results indicate that the flap normal-force coefficient increased almost linearly with angle of attack to a maximum value of 3.25. Peak negative pressures built up at the flap leading edge with angle of attack and caused the chordwise location of the flap center of pressure to be moved forward. For the high angle-of-attack range, the center of pressure ranged between 49 and 55 percent of the flap chord.

NACA RM L7J10

PRELIMINARY TESTS TO DETERMINE THE MAXIMUM LIFT OF WINGS AT SUPERSONIC SPEEDS. James J. Gallagher and James N. Mueller. December 11, 1947. 41p. diagrs., photos., 3 tabs. (NACA RM L7J10)

Contains a variety of wing plan forms of random thickness distribution which were tested at Mach numbers of 1.55, 1.90, and 2.32 at angles of attack ranging from zero up through the angle at which maximum lift occurred. In general, at these Mach numbers the value of maximum lift coefficient was approximately 1.05 ± 0.05; it appeared to be independent of plan form and decreased slightly with increasing Mach number. No discontinuities in lift occurred from zero angle of attack through maximum lift, which was attained at approximately 40° angle of attack. Lift-drag ratios at maximum lift were of the order of 1.0.

NACA RM L7K13

WIND-TUNNEL INVESTIGATION OF THE LOW-SPEED STABILITY AND CONTROL CHARACTERISTICS OF A MODEL WITH A SWEPTBACK VEE TAIL AND A SWEPTBACK WING. Edward C. Polhamus. May 25, 1948. 31p. diagrs. (NACA RM L7K13)

Tests were made in the Langley 300-mph 7- by 10-foot tunnel of a complete model with a sweptback vee tail and a sweptback wing to determine its low-speed stability and control characteristics. Tests were also made of the wing alone and of the wing in combination with the fuselage. Comparisons are made with the results of tests of the same tail panel with zero dihedral (horizontal tail) on the same wing-fuselage combination.

NACA RM L8B13

MEASUREMENT THROUGH THE SPEED OF SOUND OF STATIC PRESSURES ON THE REAR OF UNSWEPT AND SWEPTBACK CIRCULAR CYLINDERS AND ON THE REAR AND SIDES OF A WEDGE BY THE NACA WING-FLOW METHOD. Richard H. Sawyer and Fred L. Daum. July 21, 1948. 13p. diagrs., photos. (NACA RM L8B13)

Static-pressure measurements were made through the speed of sound by the NACA wing-flow method at the rear of two unswept circular cylinders of different length-diameter ratio and one 45° sweptback circular cylinder. Additional measurements were made at the rear and sides of a wedge. A Mach number range from about 0.7 to about 1.2 was covered in the tests.

NACA RM L8D23

TESTS OF THE NACA 64_1-012 AND 64_1A012 AIRFOILS AT HIGH SUBSONIC MACH NUMBERS. W. F. Lindsey and Milton D. Humphreys. July 9, 1948. 19p. diagrs., tab. (NACA RM L8D23)

An investigation of NACA 64_1-012 and 64_1A012 airfoils at Mach numbers between 0.35 and 0.89 and at low Reynolds numbers showed the effect of increasing the trailing-edge angle from 9° (NACA 64_1-012) to 14° (NACA 64_1A012).

NACA RM L8H25

STATIC LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A 52° SWEPTBACK WING OF ASPECT RATIO 2.88 AT REYNOLDS NUMBERS FROM 2,000,000 TO 11,000,000. James E. Fitzpatrick and Gerald V. Foster. November 16, 1948. 21p. diagrs., photo. (NACA RM L8H25)

Presents results of test of a 52° sweptback wing with aspect ratio of 2.88, taper ratio 0.625, and NACA 64_1-112 airfoil sections perpendicular to the 0.282-chord line for Reynolds number range of 2,000,000 to 11,000,000. Tests were made with and without half-span split flaps for both the smooth and rough conditions. The tests also included a study of the flow changes at moderate to high lift coefficients.

NACA RM L8H25a

STATIC TESTS OF FOUR TWO-BLADE NACA PROPELLERS DIFFERING IN CAMBER AND SOLIDITY. Robert J. Platt, Jr. December 2, 1948. 23p. diagrs., photo. (NACA RM L8H25a)

Contains static-test data on two-blade propellers of the NACA 4-(3)(08)-03, 4-(5)(08)-03, 4-(10)(08)-03, and 4-(3)(08)-045 designs at blade angles from 0° to 40°. Some earlier data are included which were obtained with the propellers fluttering.

NACA RM L8H30

INVESTIGATION OF THE EFFECT OF SWEEP ON THE FLUTTER OF CANTILEVER WINGS. J. G. Barmby, H. J. Cunningham and I. E. Garrick. November 15, 1948. 70p. diagrs., photo., 7 tabs. (NACA RM L8H30. Now issued as TN 2121; Rept. 1014)

An experimental and analytical investigation of the flutter of uniform, cantilever, sweptback wings is reported. The experiments employed groups of wings swept back by rotating and by shearing. The angle of sweep ranged from 0° to 60° and the Mach numbers extended to approximately 0.9. Comparison with experiment indicates that the analysis developed in the present paper is satisfactory for nearly uniform cantilever wings of moderate length-to-chord ratios.

NACA RM L8I17

A METHOD FOR CALCULATING FLOW FIELDS OF COWLINGS WITH KNOWN SURFACE-PRESSURE DISTRIBUTIONS. Robert W. Boswinkle, Jr. November 22, 1948. 23p. diagrs. (NACA RM L8I17)

Describes a way in which the data of three previous papers may be utilized to compute the incompressible flow fields of cowling-spinner combinations and open-nose inlets at zero incidence. The method consists of regarding the cowling surface as replaced by a ring vortex sheet whose strength at any point is equal to the local tangential velocity. The field of the ring vortex sheet is integrated to give the induced velocities of the body. An approximate method is given for cowlings at angles of attack. A comparison of calculated points with experimental data indicates that the method gives adequate accuracy for propeller design purposes. The application of the Prandtl-Glauert rule for compressible flow is given in detail.

NACA RM L8I24

SURFACE-PRESSURE DISTRIBUTIONS ON A SYSTEMATIC GROUP OF NACA 1-SERIES COWLINGS WITH AND WITHOUT SPINNERS. Robert W. Boswinkle, Jr. and Arvid L. Keith, Jr. November 30, 1948. 188p. diagrs., 3 tabs. (NACA RM L8I24)

Presents the static-pressure distributions on the tops of 79 NACA 1-series cowling-spinner combinations and 9 NACA 1-series open-nose cowlings over wide ranges of inlet-velocity ratio at angles of attack of 0°, 2°, 4°, and 6° for use in calculating the flow fields of such cowlings. This flow field information is useful in the design of propellers. Some effects of changes in the internal lip shape and of propeller operation on the surface pressures on the cowlings are shown.

NACA RM L8J01

INVESTIGATION OF HORN BALANCES ON A 45° SWEPTBACK HORIZONTAL TAIL SURFACE AT HIGH SUBSONIC SPEEDS. Harold S. Johnson and Robert F. Thompson. December 3, 1948. 63p. diagrs., photo., 2 tabs. (NACA RM L8J01)

A wind-tunnel investigation of horn balances on a 45° sweptback, semispan, horizontal tail surface was made to determine the effects of horn size and inboard-edge fairing at a Mach number of 0.30 and to determine the effects of compressibility up to a Mach number of 0.89. Presented are lift, drag, pitching-moment, and hinge-moment data and lift and hinge-moment parameters.

NACA RM L8K19

WIND-TUNNEL INVESTIGATION AT LOW SPEEDS OF VARIOUS PLUG-AILERON AND LIFT-FLAP CONFIGURATIONS ON A 42° SWEPTBACK SEMISPAN WING. Leslie E. Schneiter and James M. Watson. January 26, 1949. 45p. diagrs., photos. (NACA RM L8K19)

Contains results and discussion of a high-lift and lateral-control investigation at low speed on a 42° sweptback semispan-wing model. The lift characteristics of a full-span slotted flap at various deflections and positions of the flap nose, a partial-span slotted flap, and a partial-span Zap flap were determined in addition to a determination of the lateral-control characteristics of a plug-aileron configuration and various modifications thereof, and the characteristics of a partial-span plain aileron in both the flap-retracted and flap-deflected configurations.

NACA RM L8L06

AN INVESTIGATION OF THE CHARACTERISTICS OF THREE NACA 1-SERIES NOSE INLETS AT SUBCRITICAL AND SUPERCRITICAL MACH NUMBERS. Robert E. Pendley and Norman F. Smith. January 13, 1949. 38p. diagrs., photo. (NACA RM L8L06)

Results of measurements of pressure distribution and drag are presented for NACA 1-65-050, NACA 1-50-100, and NACA 1-40-200 nose inlets. Data were obtained at two fineness ratios and at Mach numbers up to 0.925 for a range of inlet-velocity ratio. An appreciable margin was measured between the critical Mach number and the Mach number at which a drag rise occurred. A sharp pressure peak raised at the inlet lip at low inlet-velocity ratios did not affect the Mach number for drag rise.

NACA RM L9A07

LOW-SPEED INVESTIGATION OF AILERON AND SPOILER CHARACTERISTICS OF A WING HAVING 42° SWEEPBACK OF THE LEADING EDGE AND CIRCULAR-ARC AIRFOIL SECTIONS AT REYNOLDS NUMBERS OF APPROXIMATELY 6.0×10^6. Stanley H. Spooner and Robert L. Woods. March 10, 1949. 58p. diagrs., photos. (NACA RM L9A07)

The lateral characteristics of an aileron and several spoiler arrangements on a 42° sweptback wing with symmetrical circular-arc airfoil sections and various high-lift and stall-control devices are shown. Includes aileron normal-force, hinge-moment, and balance-chamber pressure coefficients. The Reynolds number of the tests, which were conducted in the Langley 19-foot pressure tunnel, varied from 5.3×10^6 to 6.9×10^6 which corresponded to a Mach number range of 0.11 to 0.15.

NACA RM L9A18

PRESSURE-DISTRIBUTION MEASUREMENTS OVER AN EXTENSIBLE LEADING-EDGE FLAP ON TWO WINGS HAVING LEADING-EDGE SWEEP OF 42° AND 52°. Reino J. Salmi. March 7, 1949. 36p. diagrs., photos. (NACA RM L9A18)

Contains results of pressure-distribution measurements over a leading-edge flap on two wings having leading-edge sweep of 42° and 52° with NACA 64_1-112 sections. The 42° sweptback wing was of aspect ratio 4.01, taper ratio 0.625, equipped with half-span split flaps and was tested in combination with a circular fuselage at a Reynolds number of 5.12×10^6 and Mach number of 0.11. The 52° sweptback wing was of aspect ratio 2.88, taper ratio 0.625, equipped with half-span split flaps and a fence. The tests were made at a Reynolds number of 4.4×10^6 and Mach number of 0.08, and at various angles of yaw.

NACA RM L9F10

PRELIMINARY AERODYNAMIC INVESTIGATION OF THE EFFECT OF CAMBER ON A 60° DELTA WING WITH ROUND AND BEVELED LEADING EDGES. John M. Riebe and Joseph E. Fikes. August 16, 1949. 46p. diagrs., photos., tab. (NACA RM L9F10)

Contains the results of an investigation in the Langley 300-mph 7- by 10-foot wind tunnel to determine the effect of camber on lift-drag ratio and the longitudinal and lateral stability characteristics on a 60° delta wing at Reynolds numbers of 1.5×10^6 and 3.0×10^6. Angles of attack ranged from 0° to 40°; angles of yaw ranged from -4° to 20°. Camber was produced by full-span leading-edge flaps of round and beveled shapes deflected through a range of 0° to 60°.

NACA RM L9H09

PERFORMANCE CHARACTERISTICS OF TWO 6° AND TWO 12° DIFFUSERS AT HIGH FLOW RATES. William J. Nelson and Eileen G. Popp. October 19, 1949. 26p. diagrs. (NACA RM L9H09)

The aerodynamic characteristics of two circular-inlet and two annular-inlet diffusers of fixed area ratio (1.75) have been determined at inlet Mach numbers from 0.2 to the choked condition. The pressure-loss coefficient and diffuser effectiveness of each of these diffusers is shown to be essentially independent of Reynolds number in the subcritical-flow range; the performance falls off rapidly when sonic velocity is exceeded at any point in the system. Pressure distributions across both the inlet and exit and along the diffuser walls are presented. Inlet-boundary-layer profiles were also measured.

NACA RM L9H23

AN INVESTIGATION OF THE CHARACTERISTICS OF AN UNSWEPT WING OF ASPECT RATIO 4.01 IN THE LANGLEY 8-FOOT HIGH-SPEED TUNNEL. Ralph P. Bielat and Maurice S. Cahn. November 8, 1949. 32p. diagrs., 2 tabs. (NACA RM L9H23)

An investigation of the characteristics of a wing of aspect ratio 4.01 was conducted at high subsonic Mach numbers in the Langley 8-foot high-speed tunnel. The results of this investigation indicate that the severe changes in aerodynamic characteristics usually associated with wings of average or high aspect ratio were alleviated and were delayed to higher Mach numbers.

NACA RM L9J03

SURVEY OF TWO-DIMENSIONAL DATA ON PITCHING-MOMENT CHANGES NEAR MAXIMUM LIFT CAUSED BY DEFLECTION OF HIGH-LIFT DEVICES. Jerold M. Bidwell and Jones F. Cahill. December 2, 1949. 13p. diagrs., tab. (NACA RM L9J03)

The large pitching-moment increments associated with deflection of certain types of trailing-edge high-lift devices have made it difficult or impossible to obtain trim during landing and take-off. As an aid in the selection of high-lift devices, therefore, a survey has been made of two-dimensional data on the changes in pitching moment resulting from deflection at various types of high-lift devices. The types of high-lift devices investigated include extensible and nonextensible leading-edge and trailing-edge flaps and slats.

NACA RM E6J21

EXPERIMENTAL INVESTIGATION OF THRUST AUGMENTATION OF A TURBOJET ENGINE AT ZERO RAM BY MEANS OF TAIL-PIPE BURNING. Bruce T. Lundin, Harry W. Dowman and David S. Gabriel. January 6, 1947. 34p. diagrs., photos., tab. (NACA RM E6J21)

The performance of a turbojet engine equipped with a tailpipe burner designed by the NACA has been investigated at zero ram over a range of rotor speeds and tailpipe-burner fuel flows. The burner consisted essentially of an enlarged tailpipe incorporating fuel-spray nozzles and a flame holder. An adjustable-area exhaust nozzle is installed at the burner discharge.

THE FOLLOWING REPORTS HAVE BEEN DECLASSIFIED FROM CONFIDENTIAL TO UNCLASSIFIED, 1/8/54.

NACA RM A8A20

AN INVESTIGATION OF SUBMERGED AIR INLETS ON A 1/4-SCALE MODEL OF A TYPICAL FIGHTER-TYPE AIRPLANE. Noel K. Delany. June 2, 1948. 47p. diagrs., photos. (NACA RM A8A20)

Results are presented for ramp plan forms with parallel and with diverging walls and show the effect of the duct-entrance location (forward of the wing and over the wing), internal ducting efficiency, and deflectors. The air inlets having the ramps with diverging walls were satisfactory in both locations tested on the fuselage. The submerged air inlets with parallel ramp walls had lower ram pressure recoveries for the normal operating range. The ram pressure-recovery ratios measured at the inlets were higher for the forward location of the inlets than for the aft location.

NACA RM E7H27

INDIRECT METHODS FOR OBTAINING RAM-JET EXHAUST-GAS TEMPERATURE APPLIED TO FUEL-METERING CONTROL. Eugene Perchonok, William H. Sterbentz and Stanley H. Moore. January 14, 1948. 36p. diagrs. (NACA RM E7H27)

Presents development and experimental verification of analytical method that gives two independent means of obtaining total-temperature ratio across a ram jet or turbojet tail-pipe burner without direct measurement of final gas temperature. Proposes several total-temperature-ratio meter designs, which provide simple means of evaluating total-temperature ratio and also provide basis for ram-jet fuel-metering controls using total-temperature ratio as control variable.

NACA RM E8D30

VIBRATION SURVEY OF NACA 24-INCH SUPERSONIC AXIAL-FLOW COMPRESSOR. André J. Meyer, Jr. and Morgan P. Hanson. July 30, 1948. 45p. diagrs., photos. (NACA RM E8D30)

Vibration investigations were made of two blade cascades in wind tunnels and of blades operated in the NACA 24-inch supersonic compressor. The results showed that the blade vibrations were present at all tunnel and compressor air velocities and were influenced primarily by tunnel design, simulated centrifugal loading, surging angle of attack, and possible critical Mach numbers.

NACA RM E50I29a

INTERPRETATION OF BOUNDARY-LAYER PRESSURE-RAKE DATA IN FLOW WITH A DETACHED SHOCK. Roger W. Luidens and Robert T. Madden. December 22, 1950. 14p. diagrs., photos. (NACA RM E50I29a)

A procedure is presented for determining boundary-layer quantities from pressure-rake data, which includes the combined effects of viscous and shock losses. The analysis utilizes schlieren photographs of the shock configuration, the continuity of mass relationship, and the characteristic of the turbulent boundary layer that its outer edge is defined by a rapid change in the slope of the Mach number profile.

NACA RM L7A08

EFFECT OF NUMBER OF FINS ON THE DRAG OF A POINTED BODY OF REVOLUTION AT LOW SUPERSONIC VELOCITIES. N. Mastrocola. April 7, 1947. 10p. diagrs., photos. (NACA RM L7A08)

The interference drag increased with increased number of fins up to a Mach number of 1.35; above this value the effect is reversed. The magnitude of interference effects, for the bluff fin sections used in these tests, is such as to make these effects important in estimating the drag of a multifin tail group. The fin drag was found to be comparatively large and was attributed to the blunt leading edge and square trailing edge of the fin airfoil section.

The test data from flight tests of three- and five-fin bodies up to a Mach number of approximately 1.4 are given.

NACA RM L7B20

COMPARATIVE DRAG MEASUREMENTS AT TRANSONIC SPEEDS OF 6-PERCENT-THICK AIRFOILS OF SYMMETRICAL DOUBLE-WEDGE AND CIRCULAR-ARC SECTIONS FROM TESTS BY THE NACA WING-FLOW METHOD. Norman S. Silsby. April 8, 1947. 10p. diagrs. (NACA RM L7B20)

Both airfoils had a thickness of 6 percent of the chord, were of rectangular plan form, and had an aspect ratio of 4.0. The tests were run at M = 0.65 to 1.10. The results indicated that the principal difference in the drag characteristics of the two airfoils at zero lift is the earlier drag rise of the double-wedge section. Although the double-wedge airfoil had a somewhat higher drag throughout the Mach number range tested, the difference decreased with increasing Mach number after the onset of the drag rise of the circular-arc section, and at M = 1.10 the drag coefficient for the two airfoils was about the same.

NACA RM L7C05

DRAG CHARACTERISTICS OF RECTANGULAR AND SWEPT-BACK NACA 65-009 AIRFOILS HAVING VARIOUS ASPECT RATIOS AS DETERMINED BY FLIGHT TESTS AT SUPERSONIC SPEEDS. Warren A. Tucker and Robert L. Nelson. April 22, 1947. 15p. diagrs., photos. (NACA RM L7C05)

Wings of aspect ratios 3.8 to 5.0 were used at Mach numbers 1.0 to 1.3. The drag coefficient decreased as the sweepback angle increased, the rate of decrease being somewhat greater for the larger aspect ratios. For Mach numbers greater than a value somewhat less than that at which the Mach line lies along the leading edge, the drag coefficient decreased with a decrease in aspect ratio.

NACA RM L7K12

PRESSURE DISTRIBUTION OVER A SHARP-NOSE BODY OF REVOLUTION AT TRANSONIC SPEEDS BY THE NACA WING-FLOW METHOD. Edward C. B. Danforth and J. Ford Johnston. March 5, 1948. 25p. diagrs., photos. (NACA RM L7K12)

Contains pressure distributions by the NACA wing-flow method at Mach numbers between 0.70 and 1.05, over a sting-mounted body of revolution of circular-arc profile and fineness ratio 6. The measurements are compared with existing subsonic and supersonic theory where applicable. The manner in which transition occurs from the subsonic to the supersonic type of pressure distribution is shown with particular reference to the accompanying rapid increases in pressure drag.

NACA RM L8F23

A LIMIT PRESSURE COEFFICIENT AND AN ESTIMATION OF LIMIT FORCES ON AIRFOILS AT SUPERSONIC SPEEDS. John P. Mayer. August 23, 1948. 18p. diagrs. (NACA RM L8F23)

The results of an estimation of the limit forces on airfoils at supersonic speeds are presented. Computed values of the forces on two-dimensional wings are in good agreement with three-dimensional wind-tunnel data at high angles of attack where detached shock waves are present. A limit pressure coefficient attainable on an airfoil is given as based on experimental data. The empirical limit pressure coefficient corresponds to about 70 percent of the pressure coefficient for a vacuum.

NACA RM L8H06

PRESSURE DISTRIBUTIONS OVER A WING-FUSELAGE MODEL AT MACH NUMBERS OF 0.4 TO 0.99 AND AT 1.2. Clarence W. Matthews. November 3, 1948. 24p. diagrs. (NACA RM L8H06)

Pressure coefficients and Mach numbers are presented for the flow over a prolate spheroid and an NACA 65-010 wing section in the transonic Mach number range. The values over the prolate spheroid are compared with theoretical values. A study is made of the development of a supersonic flow pattern. Tunnel-wall-constriction effects at Mach numbers near unity are also considered.

NACA RM L8H31a

EFFECT OF STRUT-MOUNTED WING TANKS ON THE DRAG OF NACA RM-2 TEST VEHICLES IN FLIGHT AT TRANSONIC SPEEDS. Sidney R. Alexander. November 18, 1948. 13p. diagrs., photos. (NACA RM L8H31a)

Results of a free-flight investigation near zero lift of an NACA RM-2 drag research model equipped with strut-mounted wing tanks of fineness ratio 7.44 are presented for a Mach number range from about 0.7 to 1.1. The addition of the tanks and struts caused the drag rise to occur at a lower Mach number and produced a drag-coefficient increment of 0.075 at a Mach number of 0.72 which increased to 0.82 (the maximum increment obtained) at a Mach number of 1.06. Estimation indicates that the proximity of the struts and tanks may produce significant trim changes in the Mach number range investigated.

NACA RM L8L07a

FLIGHT INVESTIGATIONS AT LOW SUPERSONIC SPEEDS TO DETERMINE THE EFFECTIVENESS OF CONES AND A WEDGE IN REDUCING THE DRAG OF ROUND-NOSE BODIES AND AIRFOILS. Sidney R. Alexander. March 3, 1949. 15p. diagrs., photos. (NACA RM L8L07a)

It is clearly indicated from results and tests conducted at low supersonic speeds that a small cone placed ahead of a round-nose body can effectively reduce the drag of the basic body. The presence of a small wedge placed ahead of a round-nose airfoil did not appreciably affect the drag of the basic airfoil in the investigated Mach number range of M = 1.05 to 1.225.

NACA RM L9A12

AERODYNAMIC CHARACTERISTICS OF A 6-PERCENT-THICK SYMMETRICAL DOUBLE-WEDGE AIRFOIL AT TRANSONIC SPEEDS FROM TESTS BY THE NACA WING-FLOW METHOD. Lindsay J. Lina. March 4, 1949. 27p. diagrs. (NACA RM L9A12)

Tests were made in the transonic speed range by the NACA wing-flow method to investigate the lift, pitching-moment, and drag characteristics of a 6-percent-thick-chord symmetrical double-wedge airfoil having a rectangular plan form of aspect ratio 4.0. The tests covered a range of Mach numbers from 0.66 to 1.12.

NACA RM L9B17

EXPERIMENTAL DETERMINATION OF THE SUBSONIC PERFORMANCE OF A RAM-JET UNIT CONTAINING THIN-PLATE BURNERS. John R. Henry. June 29, 1949. 54p. diagrs., photos. (NACA RM L9B17)

A ram-jet unit containing a cluster of thin-plate burners in a semicircular combustion chamber was tested in Langley induction aerodynamics laboratory. Data were taken over a fuel-air-ratio range from 0 to 0.049, at combustion-chamber inlet velocities from 40 to 195 feet per second, and at simulated free-stream Mach numbers from 0.20 to 0.55. Combustion efficiencies from 56 to 72 percent were obtained. Combustion-chamber characteristics led to the conclusion that high-thrust-output operation would not be feasible. Thrust-coefficient estimates for supersonic flight are regarded as too low to be practical. Diffuser efficiencies of 99 percent were obtained.

NACA RM L9F02

FLIGHT INVESTIGATION AT HIGH-SUBSONIC, TRANSONIC, AND SUPERSONIC SPEEDS TO DETERMINE ZERO-LIFT DRAG OF BODIES OF REVOLUTION HAVING FINENESS RATIO OF 6.04 AND VARYING POSITIONS OF MAXIMUM DIAMETER. Ellis R. Katz. August 31, 1949. 17p. diagrs., photo. (NACA RM L9F02)

Flight investigation of rocket-powered models was performed at high-subsonic, transonic, and supersonic speeds to determine the zero-lift drag of fin-stabilized bodies of revolution differing only in position of maximum diameter. The bodies were of 6.04 fineness ratio and had cut-off sterns with equal base area for all models.

NACA RM L9H08

AN EMPIRICAL METHOD FOR ESTIMATING TRAILING-EDGE LOADS AT TRANSONIC SPEEDS. T. H. Skopinski. October 6, 1949. 43p. diagrs., tab. (NACA RM L9H08)

An empirical method for estimating trailing-edge loads and moments in the transonic region is presented. A comparison of the experimental trailing-edge normal-force and bending-moment coefficients obtained for 15 different NACA airfoil sections with those calculated by the proposed empirical method indicated that the method may be used as a guide when specific applicable experimental data are not available at the design stage.

NACA RM L9J11

PRELIMINARY INVESTIGATION OF A VARIABLE MASS-FLOW SUPERSONIC NOSE INLET. Clyde Hayes. December 13, 1949. 15p. diagrs., photos. (NACA RM L9J11)

A method employing an inflatable boot on the central-body surface has been analyzed for varying the mass flow of supersonic inlets having a circular cross section and a central body. The tests made at a Mach number of 2.70 show effects of such a method on the entering flow, mass flow, and pressure recovery.

NACA RM L52E29a

PRELIMINARY INVESTIGATION OF THE EFFECTS OF HEAT TRANSFER ON BOUNDARY-LAYER TRANSITION ON A PARABOLIC BODY OF REVOLUTION (NACA RM-10) AT A MACH NUMBER OF 1.61. K. R. Czarnecki and Archibald R. Sinclair. July 1952. 23p. diagrs., photos., tab. (NACA RM L52E29a)

This paper presents the results of a preliminary investigation of the effects of heat transfer on boundary-layer transition on a parabolic body of revolution (NACA RM-10) at Mach number of 1.61. This paper includes also a study of the effectiveness of cooling on boundary-layer transition with model surface roughened and a comparison of the results obtained in this investigation with other available theoretical and experimental data.

NACA RM L53B25

AN EXTENSION OF THE INVESTIGATION OF THE EFFECTS OF HEAT TRANSFER ON BOUNDARY-LAYER TRANSITION ON A PARABOLIC BODY OF REVOLUTION (NACA RM-10) AT A MACH NUMBER OF 1.61. K. R. Czarnecki and Archibald R. Sinclair. March 1953. 21p. diagrs., photo. (NACA RM L53B25)

This paper covers the extension of a previous investigation of the effects of heat transfer on boundary-layer transition to higher Reynolds numbers, to greater amounts of heating, and to a more extensive study of the effects of surface roughness and wind-tunnel flow disturbances. The tests were made at a Mach number of 1.6 and over a Reynolds number range from 2.5×10^6 to 35×10^6. A comparison is made between the experimental results and theory.

THE FOLLOWING REPORT HAS BEEN DECLASSIFIED FROM RESTRICTED, 12/11/53.

RM E50K02

THE FOLLOWING REPORTS HAVE BEEN DECLASSIFIED FROM RESTRICTED, 12/14/53.

RM E8E12
RM E8F14
RM E8H06

THE FOLLOWING REPORT HAS BEEN DECLASSIFIED FROM CONFIDENTIAL, 1/8/54.

RM L8F08

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA TN 3053

A NEW METHOD OF ANALYZING EXTREME-VALUE DATA. Julius Lieblein, National Bureau of Standards. January 1954. 88p. diagrs., 9 tabs. (NACA TN 3053)

A new method based on order statistics is presented for analyzing extreme-value data. The method of application is presented in detail and an actual example is worked out. The techniques described provide a simple means for estimating the necessary parameters, making predictions from the fitted curve, estimating the reliability, and evaluating the efficiency of the method in relation to methods now in use. Comparison with Gumbel's method of moments indicates that, although subject to certain limitations, the method of order statistics offers certain important advantages. The method is discussed in terms of application to gust loads, but it is also applicable to other fields in which extreme values occur.

NACA TN 3062

A FLIGHT INVESTIGATION OF THE PRACTICAL PROBLEMS ASSOCIATED WITH POROUS-LEADING-EDGE SUCTION. Paul A. Hunter and Harold I. Johnson. February 1954. 42p. diagrs., photos., 4 tabs. (NACA TN 3062)

This investigation was concerned with the effect of atmospheric dust and rain on the clogging of the porous leading edge, power requirements, and construction details. In the course of the investigation, the extent of porous area was varied to determine the effect on power requirements and maximum lift coefficients.

NACA TN 3065

PRESENT STATUS OF INFORMATION RELATIVE TO THE PREDICTION OF SHOCK-INDUCED BOUNDARY-LAYER SEPARATION. Roy H. Lange. February 1954. 16p. diagrs. (NACA TN 3065)

The present status of available information relative to the prediction of shock-induced boundary-layer separation is discussed. Experimental results showing the effects of Reynolds number and Mach number on the separation of both laminar and turbulent boundary layers are given and compared with results obtained by available methods for predicting separation. The flow phenomena associated with separation caused by forward-facing steps, wedges, and incident shock waves are discussed. Applications of the flat-plate data to problems of separation on spoilers, diffusers, and scoop inlets are indicated for turbulent boundary layers.

NACA TN 3066

EFFECT OF SURFACE ROUGHNESS OVER THE DOWNSTREAM REGION OF A 23° CONICAL DIFFUSER. Jerome Persh and Bruce M. Bailey. January 1954. 57p. diagrs., photo. (NACA TN 3066)

An experimental investigation was conducted to determine the effect of increasing the extent of surface roughness over the downstream region of a 23° conical diffuser with a 2:1 ratio of exit to inlet area and with a constant-area tailpipe approximately 3-1/2 inlet diameters in length. The inlet-boundary-layer thickness was of the order of 5 percent of the inlet diameter. The airflows used in this investigation cover an inlet Mach number range from about 0.10 to 0.40, corresponding to Reynolds numbers of approximately 1×10^6 to 4×10^6 based on inlet diameter. The surface roughening was accomplished by coating the surface of the diffuser with graded cork particles. Incremental bands of roughness were removed from the upstream end (a 1-inch-wide band being retained near the inlet to stabilize the flow) after each series of pressure measurements was made so that the variation of diffuser performance with percent of diffuser length roughened could be determined.

NACA TN 3068

COMPARISON OF MODEL AND FULL-SCALE SPIN RECOVERIES OBTAINED BY USE OF ROCKETS. Sanger M. Burk, Jr. and Frederick M. Healy. February 1954. 63p. diagrs., photos., 5 tabs. (NACA TN 3068)

An investigation of a 1/19-scale model of an unswept-wing trainer airplane was conducted in the Langley 20-foot free-spinning tunnel to determine the rocket spin-recovery characteristics of the model for comparison with available full-scale-airplane results. A rocket was attached to each wing tip to fire in a direction to apply an antispin yawing moment about the Z body axis. The rockets were fired individually and in combination.

NACA TN 3069

INCOMPRESSIBLE FLOW PAST A SINUSOIDAL WALL OF FINITE AMPLITUDE. Carl Kaplan. February 1954. 26p. diagrs., 2 tabs. (NACA TN 3069)

Plane incompressible flow past an infinitely long sinusoidal wall of any amplitude is considered in

the present paper. It was found that this problem could not be treated in the physical plane but had to be transferred to the plane of velocity potential and stream function. In this plane, the problem was not only successfully treated by the small disturbance iteration method but, moreover, its solution was rigorously expressed in the form of a nonlinear integral equation.

NACA TN 3095

THE AMES 10- BY 14-INCH SUPERSONIC WIND TUNNEL. A. J. Eggers, Jr. and George J. Nothwang. January 1954. 43p. diagrs., photos., tab. (NACA TN 3095)

The Ames 10- by 14-inch supersonic wind tunnel is described and pertinent features of the design and operation of the facility are included. The wind tunnel is capable of continuous operation at Mach numbers from 2.7 to 6.3 and Reynolds numbers from 1 million to 11 million per foot. Data on the characteristics of flow in the test section, including pressure and stream-angle distributions, are presented.

NACA TN 3098

DENSITY PROFILES OF SUBSONIC BOUNDARY LAYERS ON A FLAT PLATE DETERMINED BY X-RAY AND PRESSURE MEASUREMENTS. Ruth N. Weltmann and Perry W. Kuhns. February 1954. 30p. diagrs., photos. (NACA TN 3098)

Laminar, transitional, and turbulent boundary layers were investigated in a subsonic wind tunnel at Mach numbers of 0.55 and 0.78 at various Reynolds numbers and stations along a flat plate. Comparisons are made of the density profiles obtained with a total-pressure probe of small frontal opening and by means of an X-ray absorption method and, in a few cases, by using interferometer data. The limitations of the probe and X-ray methods are discussed. The decrease in mass flow in the tunnel due to the insertion of the pressure probe was found to affect the pressure measurements in the boundary layer. A mass-flow correction for the pressure data is suggested. The maximum difference between the mass-flow corrected pressure profiles and the radiation measurements was 0.8 percent in density ratio. No change in boundary-layer type from transitional to turbulent or from laminar to transitional was observed when the probe was inserted into the boundary layer.

NACA TN 3101

STUDY OF THREE-DIMENSIONAL INTERNAL FLOW DISTRIBUTION BASED ON MEASUREMENTS IN A 48-INCH RADIAL-INLET CENTRIFUGAL IMPELLER. Joseph T. Hamrick, John Mizisin and Donald J. Michel. February 1954. 64p. diagrs., photos. (NACA TN 3101)

A study of the loss and velocity distribution in a radial flow impeller was made. It is indicated that secondary flows within the boundary layer and leakage through the blade-to-shroud clearance space result in a concentration of low-energy air at approximately 80 percent of the passage width from the pressure face at the shroud. Comparison of the data from internal measurements made for the impeller of this investigation with hot-wire anemometer studies made at the outlet of a similar impeller indicates that much can be learned about the internal flow picture with hot-wire surveys alone.

NACA TN 3115

ANALYSIS OF SWEPTBACK WINGS ON CAL-TECH ANALOG COMPUTER. Richard H. MacNeal and Stanley U. Benscoter, California Institute of Technology. January 1954. 80p. diagrs., 5 tabs. (NACA TN 3115)

Using the Cal-Tech analog computer, structural analyses have been made of two 45° swept wings of aspect ratio 3. One of these has a constant depth and the other has a constant biconvex cross section in planes parallel to the airstream. The wings extend through the fuselage and are rigidly supported along two lines at the faces of the fuselage. Deflections and all internal forces have been calculated for concentrated static loads. Vibration modes are also presented. The effects of neglecting shearing strains in the ribs and spars and also of assuming the ribs to be rigid have been investigated by modifying the electric circuits to correspond to these simplifications.

NACA TN 3117

LUBRICANTS OF REDUCED FLAMMABILITY. Charles E. Frank, Donald E. Swarts and Kenneth T. Mecklenborg, University of Cincinnati. January 1954. 24p. diagrs., tab. (NACA TN 3117)

Determination of the change in spontaneous ignition temperature with composition for blends of hydrogenated polyisobutylene with typical ester, hydrocarbon, and polyether lubricants has shown that 40 percent hydrogenated polyisobutylene by volume raises the ignition temperature of these lubricants by 60° to 80° C. Preliminary stability tests indicated that the hydrogenated polyisobutylenes possess reasonable thermal stability, suffering a weight loss of about 3 percent after 10 hours at 195° C in an inert atmosphere. Introduction of oxygen accelerates this decomposition rate, but addition of phenyl-beta-naphthylamine reduced the loss to 1 or 2 percent. A practical method for synthesizing polyisobutylene largely in the lubricant molecular weight range has been developed.

NACA TN 3123

EFFECT OF VARIOUS ARRANGEMENTS OF TRIANGULAR LEDGES ON THE PERFORMANCE OF A 23° CONICAL DIFFUSER AT SUBSONIC MACH NUMBERS. Jerome Persh and Bruce M. Bailey. January 1954. 36p. diagrs. (NACA TN 3123)

An experimental investigation was conducted to determine the effect of rough and smooth triangular ledges, approximately one-tenth of the inlet boundary layer thickness in height, on the performance of a 23° conical diffuser with a 2:1 ratio of exit to inlet

area and with a constant-area tailpipe about 3-1/2 inlet diameters in length. The inlet boundary-layer thickness was of the order of 5 percent of the inlet diameter. The airflows used in this investigation covered an inlet Mach number range from about 0.10 to 0.40, corresponding to Reynolds numbers from approximately 1×10^6 to 4×10^6 based on inlet diameter. The rough ledges consisted of graded cork particles and the smooth ledges of balsa-wood strips of triangular cross section. The results of this investigation showed that, although the flow in the diffuser without ledges was very unstable, the presence of a roughness strip near the inlet, with or without additional ledges, assured stable flow. For the configurations investigated, the static-pressure recovery and total-pressure-loss coefficient were either unaffected or slightly impaired by the installation of ledges.

NACA TN 3125

A SIMPLE MECHANICAL ANALOGUE FOR STUDYING THE DYNAMIC STABILITY OF AIRCRAFT HAVING NONLINEAR MOMENT CHARACTERISTICS. Thomas N. Canning. February 1954. 18p. diagrs. (NACA TN 3125)

The analogy between a ball rolling on a suitably contoured surface and a pitching and yawing missile in free flight is developed. The analogue is checked experimentally for the case of linear moment characteristics. Several nonlinear cases are also treated experimentally. Results of ballistic-range firings are also included.

NACA TN 3134

A METHOD FOR ESTIMATING VARIATIONS IN THE ROOTS OF THE LATERAL-STABILITY QUARTIC DUE TO CHANGES IN MASS AND AERODYNAMIC PARAMETERS OF AN AIRPLANE. Ordway B. Gates, Jr. and C. H. Woodling. January 1954. 66p. diagrs., 4 tabs. (NACA TN 3134)

Expressions are presented from which can be calculated the rates of change of the roots of the lateral-stability quartic with respect to the mass and aerodynamic parameters of an airplane. Results obtained from these expressions are compared with the results of exact calculations. The expressions are shown to have a definite relationship to the amplitude coefficients of the lateral modes of motion subsequent to input moments or forces.

NACA TN 3135

INVESTIGATION OF MUTUAL INTERFERENCE EFFECTS OF SEVERAL VERTICAL-TAIL–FUSELAGE CONFIGURATIONS IN SIDESLIP. William H. Michael, Jr. January 1954. 35p. diagrs., photos., 3 tabs. (NACA TN 3135)

This report presents results of sideslip tests made on three circular-arc fuselages and nine unswept vertical tails to determine the mutual interference effects between fuselages and vertical tails. The analysis shows the primary factors affecting the magnitude of the interference effects and the relative magnitudes of the induced loadings on the fuselage and on the vertical tail. Some observations concerning the distribution of the induced loadings are made. Some theoretical calculations of the interference effect of a body on adjacent lifting surfaces are included and compared with the experimental results.

NACA TN 3140

USE OF AERODYNAMIC HEATING TO PROVIDE THRUST BY VAPORIZATION OF SURFACE COOLANTS. W. E. Moeckel. February 1954. 37p. diagrs. (NACA TN 3140)

The thrust and specific impulse obtainable by use of aerodynamic heating to vaporize aircraft surface coolants are determined as a function of Mach number for a variety of possible coolants. Use of hydrogen vaporization as an independent propulsion system yields specific impulses comparable with those of current rocket propellants at very high Mach numbers. For use as an auxiliary power source, coolant vaporization can produce specific impulses comparable with those of current rocket propellants at all Mach numbers.

NACA TN 3158

A SUBSTITUTE-STRINGER APPROACH FOR INCLUDING SHEAR-LAG EFFECTS IN BOX-BEAM VIBRATIONS. William W. Davenport and Edwin T. Kruszewski. January 1954. 23p. diagrs., tab. (NACA TN 3158)

The use of the substitute-stringer approach for including shear-lag in the calculation of transverse modes and frequencies of box beams is discussed. Various thin-walled hollow rectangular beams of uniform wall thickness are idealized by means of the substitute-stringer approach and the resulting frequencies of the idealized structures are compared with those of the original beams. The results indicate how the substitute-stringer idealization could be made in order to yield accurate representation of the shear-lag effect in dynamic analysis.

NACA TN 3159

FLIGHT INVESTIGATION AT LARGE ANGLES OF ATTACK OF THE STATIC-PRESSURE ERRORS OF A SERVICE PITOT-STATIC TUBE HAVING A MODIFIED ORIFICE CONFIGURATION. William Gracey and Elwood F. Scheithauer. February 1954. 25p. diagrs., photos. (NACA TN 3159)

The static-pressure errors of two essentially similar service pitot-static tubes and of three modified orifice arrangements on one of these tubes have been determined from flight tests over a range of angle of attack α of -15° to 45°, at Mach numbers from 0.20 to 0.68 and at Reynolds numbers from 0.9×10^5 to 2.7×10^5 (where Reynolds number is based on local velocity and the diameter of the tube). The tests showed that for Mach numbers from 0.20 to 0.68 and Reynolds numbers from 0.9×10^5 to 1.4×10^5, the static-pressure error will remain within 2 percent of the impact pressure q_c for $\alpha = -10^\circ$ to 30°. Because of pressure fluctuations

and rapidly increasing errors at $\alpha > 30^{\circ}$, the usefulness of the tube is limited to $\alpha < 30^{\circ}$.

NACA RM E53J08

CORRELATION OF ISOTHERMAL CONTOURS FORMED BY PENETRATION OF JET OF LIQUID AMMONIA DIRECTED NORMAL TO AN AIR STREAM. David B. Fenn. February 1954. 38p. diagrs., tab. (NACA RM E53J08)

An investigation was conducted to correlate the isothermal contour lines formed downstream of a single jet of liquid ammonia directed normal to an air stream. Criteria are presented to facilitate the design of jet-engine thrust-augmentation systems utilizing the injection of liquid ammonia to cool the air at the compressor inlet. From the correlation presented, it is possible to construct an isothermal contour map for a single orifice operating within the following range of conditions: air velocity, 112 to 329 feet per second; air density, 0.024 to 0.070 pound per cubic foot; air temperature, 534° to 770° R; ammonia jet velocity, 63 to 244 feet per second; ammonia temperature, 433° to 470° R; mixing distance, 4 to 24 inches; orifice diameter, 0.018 to 0.053 inch. It was verified that the construction of the isothermal contours formed by a multiorifice injection system may be determined by simply adding the temperature drops of the overlapping single-orifice contour maps determined from the correlation.

NACA RM E53K30

FLAME QUENCHING BY A VARIABLE-WIDTH RECTANGULAR-SLOT BURNER AS A FUNCTION OF PRESSURE FOR VARIOUS PROPANE-OXYGEN-NITROGEN MIXTURES. Abraham L. Berlad. January 1954. 42p. diagrs., 3 tabs. (NACA RM E53K30)

Flame quenching by a variable-width rectangular-slot burner as a function of pressure for various propane-oxygen-nitrogen mixtures was investigated. It was found that for cold gas temperatures of 27° C, pressures of 0.1 to 1.0 atmosphere, and volumetric oxygen fractions of the oxidant of 0.17, 0.21, 0.30, 0.50, and 0.70, the relation between pressure p and quenching distance d is approximately given by $d \propto p^{-r}$ with $r = 1$, for equivalence ratios approximately equal to one. The quenching equation of Simon and Belles was tested. For equivalence ratios less than or equal to unity, this equation may be used, together with one empirical constant, to predict the observed quenching distance within 4.2 percent. The equation in its present form does not appear to be suitable for values of the equivalence ratio greater than unity. A quantitative theoretical investigation has also been made of the error implicit in the assumption that flame quenching by plane parallel plates of infinite extent is equivalent to that of a rectangular burner. A curve is presented which relates the magnitude of this error to the length-to-width ratio of the rectangular burner.

NACA RM E53L01

EXPLOSION AND COMBUSTION PROPERTIES OF ALKYLSILANES. I - TEMPERATURE-COMPOSITION LIMITS OF EXPLOSION FOR METHYL-, DIMETHYL-, TRIMETHYL-, TETRAMETHYL-, AND VINYLSILANE AT ATMOSPHERIC PRESSURE. Rose L. Schalla and Glen E. McDonald. February 1954. 11p. diagrs. (NACA RM E53L01)

The explosion limits of five alkylsilanes were determined as a function of temperature and composition at a pressure of 1 atmosphere. Over a fuel concentration range of 2 to 10 percent, the lowest temperatures ($^{\circ}$C) below which explosion did not occur for the five fuels studied were: tetramethylsilane $(CH_3)_4Si$, 450°; trimethylsilane $(CH_3)_3SiH$, 310°; dimethylsilane $(CH_3)_2SiH_2$, 220°; methylsilane CH_3SiH_3, 130°; and vinylsilane $H_2C{=}CH\text{-}SiH_3$, 90°. Explosion limits for hydrocarbons analogous to these silanes fall in a temperature range of 500° to 600° C. Since the explosion temperatures of the alkylsilanes are lower than those of the hydrocarbons and since they decrease as hydrogen atoms are substituted for methyl groups, it was concluded that the Si-H bond is more readily susceptible to oxidation than the C-H bond.

NACA RM E53L08

EFFECT OF WATER ON CARBON MONOXIDE - OXYGEN FLAME VELOCITY. Glen E. McDonald. February 1954. 15p. diagrs., 2 tabs. (NACA RM E53L08)

The flame velocities were measured of 20 percent oxygen and 80 percent carbon monoxide mixtures containing either light water or heavy water. The flame velocity increased from 34.5 centimeters per second with no added water to about 104 centimeters per second for a 1.8 percent addition of light water and to 84 centimeters per second for an equal addition of heavy water. The addition of light water caused greater increases in flame velocity with equilibrium hydrogen-atom concentration than would be predicted by the Tanford and Pease square-root relation. The ratio of the flame velocity of a mixture containing light water to that of a mixture containing heavy water was found to be 1.4. This value is the same as the ratio of the reaction rate of hydrogen and oxygen to that of deuterium and oxygen. A ratio of reaction rates of 1.4 would also be required for the square-root law to give the observed ratio of flame-velocity changes.

NACA RM E53L14

VAPOR PRESSURES AND CALCULATED HEATS OF VAPORIZATION OF CONCENTRATED NITRIC ACID SOLUTIONS IN THE COMPOSITION RANGE 71 TO 89 PERCENT NITRIC ACID, 7 TO 20 PERCENT NITROGEN DIOXIDE, 1 TO 10 PERCENT WATER, AND IN THE TEMPERATURE RANGE 10° TO 60° C. A. B. McKeown and Frank E. Belles. February 1954. 20p. diagrs., 2 tabs. (NACA RM E53L14)

Total vapor pressures were measured for 16 acid mixtures of the ternary system nitric acid, nitrogen dioxide, and water within the temperature range 10° to 60° C and within the composition range 71 to 89 weight percent nitric acid, 7 to 20 weight percent nitrogen dioxide, and 1 to 10 weight percent water. Heats of vaporization were calculated from the vapor pressure measurements for each sample for the temperatures, 25°, 40°, and 60° C. The ullage of the apparatus used for the measurements was 0.46. Ternary diagrams showing isobars as a function of composition of the system were constructed from experimental and interpolated data for the temperatures 25°, 40°, 45°, and 60° C and are presented herein.

NACA TM 1356

EXPERIMENTAL DETERMINATION OF LOCAL AND MEAN COEFFICIENTS OF HEAT TRANSFER FOR TURBULENT FLOW IN PIPES. (Eksperimental'noe Opredelenie Lokal'nykh i Srednikh Koeffitsientov Teplootdachi Pri Turbulentnom Techenii Zhidkosti v Trubakh). I. T. Aladyev. February 1954. 18p. diagrs., 3 tabs. (NACA TM 1356. Trans. from Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, no. 11, 1951, p. 1669-1681).

Heat-transfer coefficients were determined for the flow of water through a heated pipe. The local heat-transfer coefficient was found to decrease along the length of the pipe up to a distance of about 40 diameters from the entrance. Equations are given for the local and mean heat-transfer coefficients as functions of the Reynolds number, Prandtl number, and length of the pipe in diameters.

BRITISH REPORTS

N-27001*

Royal Aircraft Establishment (Gt. Brit.)
CORROSION TESTS ON DIFFERENT CLADDING MATERIALS ON ALUMINIUM ALLOY SHEETS. C. Braithwaite. June 1953. 17p. photos., diagrs., 5 tabs. (RAE Tech. Note Met. 171)

The corrosion resistance of different claddings on Al-Zn-Mg and Al-Cu-Si-Mg core material was investigated after 2 years' exposure to sea water spray. The claddings were aluminum, manganese-aluminum, zinc-aluminum, and magnesium-silicon-aluminum.

N-28109*

Aeronautical Research Council (Gt. Brit.)
THE DETERMINATION OF TURBULENT SKIN FRICTION BY MEANS OF PITOT TUBES. J. H. Preston. March 31, 1953. 31p. diagrs. (ARC 15,758; FM 1883)

A simple method of determining local turbulent skin friction has been developed which utilizes a round pitot tube resting on the surface. Assuming the existence of a region near the surface in which conditions are functions only of the skin friction, the relevant physical constants of the fluid and a suitable length, a universal nondimensional relation is obtained for the difference between the total pressure recorded by the tube and the static pressure at the wall, in terms of the skin friction. This relation is independent of the pressure gradient and surface condition.

N-28249*

Royal Aircraft Establishment (Gt. Brit.)
THE CHEMISTRY OF SOME COMPLEX ZINC AND CADMIUM CHROME PIGMENTS. H. G. Cole and L. F. Le Brocq. September 1953. 35p. diagrs., photos., 8 tabs. (RAE Met. 75)

By means of pH curves obtained during the progressive addition of alkali to the dichromates of zinc and cadmium, conditions have been found for the formation of double alkali basic chromates of zinc and cadmium with sodium, potassium, and ammonium, and for the decomposition of these compounds by further action of alkali to basic zinc and cadmium chromates. The identity of each compound has been characterized by equation of formation, composition, X-ray diffraction pattern, and solubility. Many of these compounds are of commercial importance as paint pigments.

N-28250*

Royal Aircraft Establishment (Gt. Brit.)
THE INFLUENCE OF SUB-STRUCTURE ON THE SLIP OBSERVED IN PURE ALUMINIUM AND SOME ALUMINIUM ALLOYS. P. J. E. Forsyth and C. A. Stubbington. October 1953. 14p. diagrs., photos. (RAE Met. 76)

Observations have been made on the modifying effects of substructure on subsequent fatigue deformation both at room and subzero temperatures. Substructures produced by cold rolling altered completely the appearance of the deformation that occurred under subsequent fatigue stresses. A self-annealing process occurred in cold-rolled pure aluminum when subjected to cyclic stresses. It is concluded that fatigue stresses by virtue of their cyclic nature aid the polygonization process in pure aluminum and in certain aluminum alloys and may produce very sharply defined boundaries by a process of crystallite growth.

N-28251*

Royal Aircraft Establishment (Gt. Brit.)
THERMODYNAMIC CHARTS FOR THE DECOMPOSITION PRODUCTS OF 80% HYDROGEN PEROXIDE. Enid Carter. October 1953. 9p. diagrs. (RAE Tech. Note RPD 88)

Thermodynamic charts giving enthalpy, entropy, and specific volume have been constructed for the decomposition products of 80-percent hydrogen peroxide (HTP), for regions above and below the saturation line. The gas velocity and venturi nozzle area can be easily deduced from the enthalpy-specific volume chart by means of a rider scale, which is also enclosed with this note.

N-28255*

Royal Aircraft Establishment (Gt. Brit.)
AIRCRAFT STRUCTURAL RESEARCH: A CRITICAL SURVEY. D. Williams. October 1953. 7p. (RAE Structures 156)

This report is a reproduction for official use of the author's "feature article" in "Applied Mechanics Reviews" for August 1953. After reviewing the progress of structural research in recent years, it calls attention to some of the major problems that still challenge workers in this field.

N-28256*

Royal Aircraft Establishment (Gt. Brit.)
ON THE STRENGTH OF POLYCRYSTALLINE AND SINGLE CRYSTAL CORUNDUM. Elizabeth A. Jackman and J. P. Roberts. August 1953. 14p. diagrs., photos. (RAE Tech. Note Met. 172)

The strength in bend of polycrystalline and single crystal corundum was studied between room temperature and 1,300° C.

N-28257*

Royal Aircraft Establishment (Gt. Brit.)
A METHOD OF PRODUCING HARD SURFACES ON ALUMINIUM AND ITS ALLOYS BY ANODIC OXIDATION. E. G. Savage and E. G. F. Sampson. August 1953. 12p. diagrs., 3 tabs. (RAE Tech. Note Met. 173)

The potential value of relatively thick and hard oxide coatings on aluminum and aluminum alloys led to experiments to determine the conditions under which such coatings, 0.001 inch or more thick, could be produced. It was found that aluminum and a number of aluminum alloys could be successfully treated under one set of conditions in a cooled sulphuric acid electrolyte. Film thickness and abrasion tests were made on the anodised samples and an anodised shaft was run in a steel bearing with promising results. There should be many uses for hard anodised parts, particularly where lightness and wear-resistance are important and where point or line loading or high resistance to fatigue are not required. It is proposed to make a short series of Wöhler-type fatigue tests on hard-anodised material to specification D.T.D.364.

N-28258*

Royal Aircraft Establishment (Gt. Brit.)
FATIGUE TESTS ON SPECIMENS FROM ALUMINIUM ALLOY D.T.D.683 'Z' SECTION EXTRUSIONS. M. S. Binning and J. T. Ballett. September 1953. 17p. diagrs., 3 tabs. (RAE Tech. Note Met. 179)

Fatigue tests have been made on extruded 'Z' section stringers in high strength aluminum alloy D.T.D.683, to discover if a surface effect detrimental to fatigue strength is present, similar to that found in extruded stringers of aluminum alloy to D.T.D.364. Tests were made in fluctuating tension in high fatigue machines, to determine the effect of surface finish and stress raisers. It has been confirmed that a surface effect is present with D.T.D.683 extrusions. Polishing the extruded surface resulting in an increase of 30 percent in fatigue strength, bringing the fatigue/tensile strength ratio to the same order as that for polished bar to the same specification. When a stress raiser in the form of a hole is present, polishing has little effect but radiusing the edges of the hole increases the fatigue strength by 30 percent.

N-28259*

Royal Aircraft Establishment (Gt. Brit.)
THE KINETICS OF THE CHEMICAL REACTION BETWEEN A SOLID AND A GAS STREAM MOVING OVER IT. L. G. Carpenter. October 1953. 6p. (RAE Tech. Note Met. 182)

Based upon the kinetic theory of gases, a simple approximate treatment is given, which shows how the reaction rate is controlled by both chemical and diffusional resistance, and enables the relative importance of these terms to be calculated.

N-28260*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF HEAT AND MOISTURE ON THE TENSILE STRENGTH OF SURFACE-TREATED GLASS FIBRES. R. B. King and E. W. Russell. September 1953. 10p. 4 tabs. (RAE Tech. Note Chem. 1203)

The tensile strength after heat treatment of single high and low alkali glass fibers was examined. The influence of surface agents in reducing the attack of moisture on the glass was also studied. Permanent weakening was sustained with temperatures above 250° C. Of the surface finishes investigated, vinyl trichlorosilane was found to be the most effective. Most of the other treatments showed little or no improvement over control values.

N-28263*

Royal Aircraft Establishment (Gt. Brit.)
MODEL TESTING TECHNIQUE EMPLOYED IN THE R.A.E. SEAPLANE TANK. T. B. Owen, A. G. Kurn and A. G. Smith. September 1953. 87p. diagrs., photos., tab. (RAE Aero 2505)

A description is given of the various techniques evolved in recent years to provide model data as a basis for predicting the full-scale behavior of a seaplane. The apparatus available at the time of writing is described and also the methods of design and construction of the models used to measure water and air forces, and the dynamic behavior in pitch, heave, and yaw.

N-28265*

Aeronautical Research Council (Gt. Brit.)
THE BIOLOGY OF FLYING. REPORT OF A SYMPOSIUM HELD AT THE BRITISH ASSOCIATION MEETING IN BELFAST, SEPTEMBER, 1952. May 21, 1953. 15p. (ARC 15, 927; EP 240)

Papers are given on Civil Air Transport Problems by K. G. Bergin, Physiological Problems of High Performance Military Aircraft by W. K. Stewart, Skill and the Airman by W. E. Hick, and Engineering Problems of Conditioning Aircraft for Human Occupation and Control by D. G. A. Rendel.

N-28404*

Royal Aircraft Establishment (Gt. Brit.)
AN ELECTRONIC TRIP TO PREVENT OVERSPEEDING OF A TURBO-ALTERNATOR. D. S. Dean. November 1953. 8p. diagrs. (RAE Tech. Note RPD 91)

A circuit is described which will cut off the fuel supply to a turbine driven alternator when the output of the alternator reaches a predetermined frequency, and thus prevent damage to the unit due to overspeeding. The circuit also incorporates a manual emergency stop which may be operated at any turbine speed. The particular unit described has been designed to operate at any frequency between 2350 and 3000 cycles/second depending upon the setting chosen before the run. It will operate at the same frequency with any input between 2 and 150 volts and is unaffected by the harmonic content of the input signal. The setting is stable to within ±10 cycles/second over a period of weeks.

N-28405*

Royal Aircraft Establishment (Gt. Brit.)
TRANSIENT TEMPERATURE DISTRIBUTION IN AN INFINITE FLAT PLATE WITH RADIAL HEAT FLOW. S. W. Green. October 1953. 24p. diagrs. (RAE Tech. Note RPD 92)

The temperature distribution in an infinite flat plate originally at uniform temperature has been calculated for prescribed rates of heat transfer across the boundary of a circular hole in the plate. Heat transfer with constant heat-transfer coefficient from a source at constant temperature has been assumed, and the calculations have been made for a range of values of the heat-transfer coefficient.

N-28406*

National Gas Turbine Establishment (Gt. Brit.)
OUTLINED GENERAL TREATMENT OF THE CALCULATION OF WAVE EFFECTS DUE TO SMALL DISTURBANCES OF STEADY STABILISED BURNING. PART II. P. W. H. Howe. July 1953. 39p. diagrs., 2 tabs. (NGTE R. 135)

The reaction of a region of steady burning to small disturbances (for example, in the fuel supply) is considered. Equations are given for a law of burning such that the rate of change of entropy of a gas particle is proportional to the fuel concentration. It is established that there is a fairly close connection between the pressure pulses produced up to a certain time and extra energy released up to that time. If increased turbulence contributes to the extra heat, release "humped" pressure pulse profiles are obtained.

N-28409*

Marine Aircraft Experimental Establishment (Gt. Brit.) SOME NOTES ON THE CALCULATION OF PRESSURE PICK-UP SENSITIVITY AND THE CONDITIONS FOR MAXIMUM SENSITIVITY. J. K. Friswell. November 1953. 36p. diagrs. (MAEE F/Res/235)

A theoretical analysis is made of the sensitivity of a pressure pickup of the strain-gaged cantilever type and of the conditions for maximum sensitivity. Two different configurations are treated and the effect of tension in the diaphragm is also considered. An account is given of experiments carried out in order to verify the analysis and to observe the behavior outside the range of validity of the theory. Suggestions are made for practical pickup design based on both theory and experiment.

MISCELLANEOUS

NACA TN 2012

Addendum No. 1 on "RESULTS OF SHEAR FATIGUE TESTS OF JOINTS WITH 3/16-INCH-DIAMETER 24S-T31 RIVETS IN 0.064-INCH-THICK ALCLAD SHEET." Marshall Holt. February 1950.

N-29154

National Advisory Committee for Aeronautics.
LIST OF TECHNICAL MEMORANDUMS, 1947-1953. 1954. 8p. (NACA)

N-29155

National Advisory Committee for Aeronautics.
LIST OF TECHNICAL NOTES, 1947-1953. 1954. 147p. (NACA)

UNPUBLISHED PAPERS

N-6535*

National Bureau of Standards.
EFFECT OF HOT DIMPLING ON THE CORROSION OF ALUMINUM ALLOYS 75S-T6 AND ALCLAD 75S-T6. Fred M. Reinhart and Hugh B. Hix. February 27, 1951. 13p. photos., 2 tabs. (National Bureau of Standards)

This investigation was initiated to determine whether the hot dimpling of 75S-T6 and Alclad 75S-T6 aluminum alloys to accomodate A17S-T4, 100° countersunk rivets adversely effected the corrosion resistance of these materials.

N-27944*

National Bureau of Standards.
PROTECTIVE VALUE OF CHROMIUM PLATE ON TYPE 410 STAINLESS STEEL IN MARINE AND URBAN ATMOSPHERES AND IN TIDEWATER. Fred M. Reinhart and David B. Ballard. April 6, 1953. 12p. photos., tab. (National Bureau of Standards. Rept. 2406)

An investigation was conducted to determine whether chromium plated type 410 stainless steel could be substituted for type 316 stainless steel for some corrosive conditions in aircraft and whether chromium plating would increase the life of type 410 stainless steel. The chromium plate discolored and the underlying steel rusted within 3 months of exposure in urban and marine atmospheres and within 6 months in tidewater.

N-27946*

National Bureau of Standards.
CORROSION OF COMMERCIAL MAGNESIUM ALLOYS. Fred M. Reinhart. May 26, 1953. 25p. photos., 4 tabs. (National Bureau of Standards. Rept. 2519)

An investigation was conducted to determine the relative susceptibilities of all the commercially available magnesium alloys with different surface treatments, both painted and unpainted, to corrosion in marine atmosphere and tidewater environments. The surface coatings on all of the magnesium alloys failed within 24 months after exposure in the marine atmosphere. Paint afforded protection to the majority of the alloys for 12 months in the tidewater. The surface coatings served as good bases for paint for at least 24 months of exposure in the marine atmosphere.

N-27947*

National Bureau of Standards.
PROTECTIVE COATINGS FOR LOW CARBON STEEL. Fred M. Reinhart and David B. Ballard. December 2, 1952. 7p. photo. (National Bureau of Standards. Rept. 2087)

A project has been initiated to determine the protective value of cadmium plate, Dimetcote No. 2, Zincilate No. 100, and Zincilate No. 300 coatings on low carbon steel in urban and marine atmospheres and in tidewater. After 3 months exposure the Cadmium coating gave no signs of failure; the Dimetcote No. 2 showed indications of incipient failure in urban atmosphere only; Zincilate No. 100 showed beginning of failure in tidewater only; Zincilate No. 300 failed by blistering in tidewater. Rusting at the bottom of scratches through the coating occurred in all environments. This report covers one phase of a general investigation.

N-27948*

National Bureau of Standards.
ANODICALLY SURFACE TREATED AND PAINTED CAST MAGNESIUM ALLOY AZ63A-T6. Fred M. Reinhart. June 1, 1953. 13p. 2 tabs., photo. (National Bureau of Standards. Rept. 2533)

Results are given of a study of the effect of some variables associated with surface treatments such as composition of bath, time of treatment, conditions of electrolysis, surface pretreatments, and sealing treatments on the adhesion of paint and the protection afforded by the paint against corrosion in a marine atmosphere. The adhesion of different paint coatings to the anodically surface coated panels was excellent for 184 months of exposure in the marine atmosphere.

DECLASSIFIED NACA REPORTS

NACA RM 52F19

DEVELOPMENT OF METAL-BONDING ADHESIVE FPL-710 WITH IMPROVED HEAT-RESISTANT PROPERTIES. John M. Black and R. F. Blomquist, Forest Products Laboratory. July 8, 1952. 10p. 2 tabs. (NACA RM 52F19) (Declassified from Confidential, 1/22/54)

An adhesive, FPL-710, has been developed that produces higher strength at temperatures up to 600° F than heretofore obtained and possesses good resistance to aging at temperatures as high as 450° F. The adhesive also has acceptable resistance to creep and to immersion in various organic solvents. The preparation and recommended bonding procedures are described.

THE FOLLOWING REPORT
HAS BEEN DECLASSIFIED FROM
CONFIDENTIAL, 1/8/54.

RM L7I05

THE FOLLOWING REPORTS
HAVE BEEN DECLASSIFIED FROM
RESTRICTED, 12/14/53.

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ACR E6D05

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National Advisory Committee for Aeronautics

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Research Abstracts

NO. 59 MARCH 9, 1954

CURRENT NACA REPORTS

NACA Rept. 1123

A STUDY OF INVISCID FLOW ABOUT AIRFOILS AT HIGH SUPERSONIC SPEEDS. A. J. Eggers, Jr., Clarence A. Syvertson and Samuel Kraus. 1953. ii, 27p. diagrs., 6 tabs. (NACA Rept. 1123. Formerly TN 2646; TN 2729)

Steady flow about curved airfoils is investigated analytically, first assuming air behaves as an ideal gas, and then assuming it behaves as a thermally perfect, calorically imperfect gas. Conclusions are drawn from the study.

NACA TN 3063

EFFECTS OF WING POSITION AND FUSELAGE SIZE ON THE LOW-SPEED STATIC AND ROLLING STABILITY CHARACTERISTICS OF A DELTA WING MODEL. Alex Goodman and David F. Thomas, Jr. February 1954. 66p. diagrs., photos., 3 tabs. (NACA TN 3063)

Results are presented of an investigation made to determine the effects of wing position and fuselage size on the low-speed static and rolling stability characteristics of models having a triangular wing and vertical tail surfaces. Interference increments between the various components are evaluated, and the variation of the vertical-tail lift-curve slopes and the efficiency factors with angle of attack as affected by wing position and body size are presented. Tuft-grid pictures of the flow at the vertical tail as affected by wing-fuselage interference are also presented.

NACA TN 3106

AN EVALUATION OF THE SOAP-BUBBLE METHOD FOR BURNING VELOCITY MEASUREMENTS USING ETHYLENE-OXYGEN-NITROGEN AND METHANE-OXYGEN-NITROGEN MIXTURES. Dorothy M. Simon and Edgar L. Wong. February 1954. 30p. diagrs., photos., 5 tabs. (NACA TN 3106)

A nonaqueous soap-bubble method was used to measure the burning velocities of some ethylene-oxygen-nitrogen and methane-oxygen-nitrogen mixtures. Burning velocity calculations were based on high-speed schlieren motion-picture records of the flame growth and a theoretical expansion ratio. An upper limit in the spatial velocity in the range 2500 to 3500 centimeters per second due to the appearance of rough flames was found for the soap-bubble method. Soap-bubble burning velocity measurements were compared with measurements by other methods.

NACA RM 54A04

EFFECTS OF MOLECULAR WEIGHT ON CRAZING AND TENSILE PROPERTIES OF POLYMETHYL METHACRYLATE. I. Wolock, M. A. Sherman and B. M. Axilrod, National Bureau of Standards. February 1954. 11p. diagrs., tab. (NACA RM 54A04)

Tensile and crazing properties are reported for five cast polymethyl-methacrylate sheets in which the molecular weight of the resin was 90,000, 120,000, 200,000, 490,000, and 3,160,000, respectively. Both stress and stress-solvent crazing tests were conducted. The tensile strength and ultimate elongation were found to increase rapidly with increasing molecular weight at the lower molecular weights and to level off at molecular weights of approximately 200,000 and 500,000, respectively. There was no change in the modulus of elasticity over the range studied. The specimens with lowest molecular weight broke at low strains without crazing. The stress and strain at which crazing occurred increased with increasing molecular weights.

BRITISH REPORTS

N-28467*

Aeronautical Research Council (Gt. Brit.)
KINETIC TEMPERATURE OF WET SURFACES. A METHOD OF CALCULATING THE AMOUNT OF ALCOHOL REQUIRED TO PREVENT ICE, AND THE DERIVATION OF THE PSYCHROMETRIC EQUATION. J. K. Hardy. 1953. 13p. 2 tabs. (ARC R & M 2830. Formerly NACA WR A-8; NACA ARR 5G13)

A method is given for calculating the temperature of a surface wetted either by a pure liquid, such as water, or by a mixture, such as alcohol and water. The method is applied to the problem of protecting, by alcohol, propellers and the induction system of the engine against ice. The minimum quantity of alcohol required is calculated for a number of arbitrarily chosen conditions. The effect of evaporation of alcohol is shown by repeating the calculations for a nonvolatile fluid. The method can be applied to other problems in evaporation, for instance, to the evaporation of fuel in the induction system of the engine. The psychrometric equation, used in wet-bulb hygrometry, is deduced in its general form. The effect of kinetic heating is included in this equation.

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N-28468*

Aeronautical Research Council (Gt. Brit.)
OBSERVATIONS ON A THIN CAMBERED AEROFOIL BEYOND THE CRITICAL MACH NUMBER. E. W. E. Rogers. (Read before VIIth International Congress of Applied Mechanics, September 1948) 1953. 16p. diagrs., photos. (ARC R & M 2432. Formerly ARC 13,238; Perf. 685; FM 1455)

In the course of surface pressure measurements and wake traverses on an airfoil section of 10 percent thickness/chord ratio, tested at high subsonic speeds in the 20- by 8-inch (50.8 x 20.3 cm) high-speed wind tunnel of the National Physical Laboratory, it was discovered that at a particular incidence (3.7^{o}) an extensive region of supersonic velocity (M = 1.15) existed without the formation of a well-defined shock wave or a rise of drag. The drag coefficient, in fact, decreased markedly as the Mach number was raised from a low value, and this was accompanied by a rearward movement on the upper surface of the position of boundary-layer transition corresponding to a favorable change of the surface pressure gradient. The transition positions measured with the "china-clay" method are compared with those estimated from the observed drag coefficients. Direct-shadow photographs illustrate the development of the shock-wave pattern.

N-28469*

Aeronautical Research Council (Gt. Brit.)
A GENERAL TREATMENT OF STATIC LONGITUDINAL STABILITY WITH PROPELLERS, WITH APPLICATION TO SINGLE-ENGINED AIRCRAFT. E. Priestley. 1953. 20p. diagrs., 2 tabs. (ARC R & M 2732; ARC 7974. Formerly RAE Aero 1944)

A general method of treatment of stick-fixed static longitudinal stability with propellers is given, distortion and compressibility effects being neglected. Model full-throttle data on some single-engined fighters are analyzed for the flaps-up condition to establish a basis of estimation of effect of propeller on stability for this type of design. The general effect of propellers on maneuver point, more particularly the effect on $H_m - K_n$, is considered in an appendix.

N-28470*

Aeronautical Research Council (Gt. Brit.)
LOW-SPEED MEASUREMENTS OF THE PRESSURE DISTRIBUTION AT THE SURFACE OF A SWEPT-BACK WING. V. M. Falkner and Doris E. Lehrian. 1953. 36p. diagrs., photo., 27 tabs. (ARC R & M 2741. Formerly ARC 12,647; Perf. 588; S & C 2335)

Measurements were made at selected stations on a sweptback wing with and without body. The wing has 45° sweepback, aspect ratio of 3, and constant chord. The section was chosen to be suitable for work at low Reynolds number. This is the first part of a program on a sweptback wing to provide methods of calculating the pressure at the surface, as well as the general properties of wings. This report covers what is thought to be one of the worst types of discontinuity likely to require investigation (excluding deflected flaps); that is, sudden changes in direction of both leading and trailing edges of the wing.

N-28471*

Aeronautical Research Council (Gt. Brit.)
INTERIM REPORT ON V-G RECORDS ON HELICOPTERS. H. I. Birds. 1953. 5p. diagrs., photos. (ARC R & M 2746; ARC 12,327. Formerly AFEE Rept. Rota 5)

V-g records have been obtained during the past year on Hoverfly I helicopters. Some data have also been obtained on a Hoverfly II and a Sikorsky S.51. The V-g records on these aircraft were obtained mainly during test flying which included blind flying and some general flying. It was not possible to separate the flight accelerations from the landing accelerations, but these were small except in the case of engine-off landings which were the subject of separate tests.

N-28472*

Aeronautical Research Council (Gt. Brit.)
THE INITIAL BUCKLING OF A LONG AND SLIGHTLY BOWED PANEL UNDER COMBINED SHEAR AND NORMAL PRESSURE. E. H. Brown and H. G. Hopkins. 1953. 19p. diagrs., 4 tabs. (ARC R & M 2766; ARC 12,605. Formerly RAE Structures 42)

Recent American experimental work has suggested that the resistance to buckling of wing skin panels under compression or shear loads is improved by aerodynamic suction. A complete theoretical analysis of this problem is very difficult, because, compression load necessarily involves the consideration of post-buckling behavior. An approach is made in this report by considering the restricted problem of the initial buckling of a long, thin, and slightly bowed panel under combined shear and normal pressure. The theoretical values of the initial shear buckling stress which agree well with American experimental values, increase with both pressure and curvature; the wave length of the buckles also increases with pressure, but decreases with curvature. The difference between the buckling stresses for simply supported and clamped edges is considerable for a flat panel under shear alone but decreases rapidly with curvature and pressure, thus making the indeterminacy of practical edge conditions of less importance.

N-28473*

Aeronautical Research Council (Gt. Brit.)
TESTS ON A SWEPT-BACK WING AND BODY IN THE COMPRESSED AIR TUNNEL. C. Salter, C. J. W. Miles and H. M. Lee. 1953. 15p. diagrs., photos., 5 tabs. (ARC R & M 2738. Formerly ARC 13,155; Perf. 671)

The model was a sweptback wing of symmetrical section and a long cylindrical body. Aspect ratio of 2.39, taper ratio of 0.37, and sweepback of the quarter-chord of 42.5° gives the plan form of the wing. The wing was 8.6 percent thick at the root and 10 percent thick at the tip. Results are given of the lift, drag, and pitching moment for angles of attack up to 30°. A selection of flow pictures is reproduced.

N-28474*

Aeronautical Research Council (Gt. Brit.)
TWO-DIMENSIONAL AEROFOIL DESIGN IN COMPRESSIBLE FLOW. L. C. Woods. 1953. 19p. diagrs., 3 tabs. (ARC R & M 2731. Formerly ARC 12,922; FM 1412)

This paper deals with the following two-dimensional problem: "The design of an airfoil to give a specified velocity against chord curve at a given free-stream Mach number." A "relaxation" method is adopted, based on the differential equations for incompressible and compressible flow. An essential feature of the method is that the calculations are carried out in the (ϕ,ψ) or w-plane in which the airfoil is represented by a slit along $\psi = 0$. The square mesh in this plane is formed by the streamlines (ψ = constant), and equipotentials (ϕ = constant) for incompressible flow about the airfoil. The method is developed for a symmetrical airfoil at zero incidence, but the modifications necessary for the more general case are indicated. A worked example is given, from which some idea of the accuracy of the method can be gained. The compressible velocity distribution about a known airfoil was taken as the initial data. This airfoil was actually 12 percent thick at 30 percent of the chord distance from the leading edge. Using a mesh giving only 14 mesh points on the airfoil, we find that the calculations yield a 12.06 percent airfoil at 28.2 percent of the chord distance from the leading edge.

N-28475*

Aeronautical Research Council (Gt. Brit.)
TESTS ON A WHIRLWIND AIRCRAFT IN THE ROYAL AIRCRAFT ESTABLISHMENT 24-FT WIND TUNNEL. (Includes: MOMENTUM INVESTIGATIONS ON FUSELAGE-WING INTERFERENCE AND NACELLE DRAG) T. V. Somerville, R. R. Duddy and G. H. L. Buxton. 1953. 17p. diagrs., 8 tabs. (ARC R & M 2603. Formerly RAE BA Dept. Note LWT 30; RAE BA Dept. Note LWT 34)

Simple modifications were found to decrease the drag of the airplane. The drag analysis is not complete and is focused chiefly on the drag due to leaks, cooling, and excrescences. A complete record of the tests is given. Modifications which gave an appreciable saving in drag were sealing of leaks and gaps, fairing of exhaust cooling ducts, and fairing of main cooling inlet. The saving in drag corresponds to an increase in maximum speed of about 15 mph. A further saving of 0.8 pound can be obtained by sealing the cartridge chutes.

N-28476*

Aeronautical Research Council (Gt. Brit.)
THE INDUCED VELOCITY FIELD OF A ROTOR. K. W. Mangler and H. B. Squire. 1953. 16p. diagrs. (ARC R & M 2642; ARC 11,562; ARC 11,694. Formerly RAE Aero 2247; RAE Tech. Note Aero 1958)

A short account and the results of a theoretical investigation of the velocity field induced by a lifting rotor are given. The computation is based on the assumptions that the rotor is lightly loaded and that is has an infinite number of blades. This is applied to calculate the induced velocity distribution for disk incidences of 0°, 15°, 30°, 45°, and 90°. For the downwash at the rotor itself (the normal component of the induced velocity) the Fourier coefficients are given, as they are needed for the calculation of the blade motion.

N-28477*

Aeronautical Research Council (Gt. Brit.)
MEASUREMENTS OF THE AERODYNAMIC DERIVATIVES FOR A HORN-BALANCED ELEVATOR. N. C. Lambourne, A. Chinneck and D. B. Betts. 1953. 15p. diagrs., photos., 2 tabs. (ARC R & M 2653. Formerly ARC 12,085; 0.796)

This report gives the results of measurements by a forced oscillation method of the direct derivatives (aerodynamic stiffness and damping) for a horn-balanced elevator. The tests were made at low airspeeds on a complete wing-fuselage-tail model at 0° and 10° incidence in a wind tunnel. Some information was obtained on the effect of mean elevator angle on the derivatives when the model was at the high incidence. Measurements were also made with trailing-edge cords and transition wires in position. The experiments suggest that none of the above factors causes a reduction in damping, but the stiffness derivative was found to be considerably influenced by the elevator angle and by the presence of trailing-edge cords and transition wires. In general, the measured values are numerically considerably less than those calculated by simple strip theory using two-dimensional vortex sheet theory results.

N-28478*

Aeronautical Research Council (Gt. Brit.)
MULTIPLE-JET WHITE-SMOKE GENERATORS. C. Salter. 1953. 18p. diagrs., photos. (ARC R & M 2657. Formerly ARC 10,296; FM 1058; ARC 13,004; FM 1425)

Descriptions are given of equipment devised for the generation of fairly large quantities of an optically dense white smoke and special attention has been paid to the need for delivering this through long ducts or against an appreciable back-pressure. The smoke consists of very small particles of condensed paraffin vapor and is obtained by directing jets of cool air on to high-speed jets of the vapor issuing from very small orifices. The optimum outputs are about 6 cu ft (170 litres) and 8 cu ft (230 litres) per minute from No. 1 and No. 2 generators, respectively, but considerably larger quantities can be delivered

with a slight loss of opacity. Under normal operating conditions, the rate of use of paraffin is rather less than 2 cu in. (33 c.c.) (No. 1) and 3 cu in. (49 c.c.) (No. 2) per minute.

N-28549*

Aeronautical Research Council (Gt. Brit.)
THE MEASUREMENT OF HEAT TRANSFER AND SKIN FRICTION AT SUPERSONIC SPEEDS. PART IV. TESTS ON A FLAT PLATE AT M = 2.82. R. J. Monaghan and J. R. Cooke. 1953. 42p. diagrs., 3 tabs. (ARC CP 140)

This note gives the results of overall heat transfer and boundary-layer measurements made on a flat plate in a 5 inch square supersonic wind tunnel operating at M = 2.82 under atmospheric stagnation pressure conditions. The tests were made to extend the range of results previously obtained at M = 2.43 and used the same experimental equipment. In general, the results confirm those obtained at the lower Mach number and some general conclusions are now drawn concerning the structure and behavior of experimental laminar and turbulent compressible boundary layers on a flat plate.

N-28550*

Aeronautical Research Council (Gt. Brit.)
CURVES FOR ESTIMATING THE WAVE DRAG OF SOME BODIES OF REVOLUTION, BASED ON EXACT AND APPROXIMATE THEORIES. L. E. Fraenkel. 1953. 15p. diagrs. (ARC CP 136)

Curves are presented for estimating the wave drag, at zero incidence, of forebodies and afterbodies having straight and parabolic profiles. The afterbodies are assumed to lie behind an infinitely long cylindrical body. The curves are based on a limited number of exact and second-order solutions which have been generalized by appealing to the supersonic-hypersonic similarity law and to slender body and quasi-cylinder solutions.

N-28551*

Aeronautical Research Council (Gt. Brit.)
DESIGN OF A RIGHT-ANGLED BEND WITH CONSTANT VELOCITIES AT THE WALLS. A. S. Thom. 1953. 18p. diagrs., 5 tabs. (ARC CP 135)

In designing a corner in a two-dimensional duct, it is possible, by the insertion of an airfoil, to maintain the same constant velocity on the outer and inner walls. It is, however, necessary to shape these walls to suit the conditions. The present paper gives a method whereby the airfoil and walls can be designed. Two examples are given.

N-28552*

Aeronautical Research Council (Gt. Brit.)
AIR COOLING METHODS FOR GAS TURBINE COMBUSTION SYSTEMS. F. J. Bayley. 1953. 44p. diagrs. (ARC CP 133)

An account is given of the whole of the work which has been done at NGTE on the problem of air-cooling gas combustion systems. Each of the different methods of wall cooling is discussed separately and the theory and mechanism of the cooling process is developed from first principles. It is shown that "sweat," or effusion cooling, is by far the most effective and efficient method, while the use of "louvered" surfaces represents the nearest practical approach to this ideal which is possible while suitable porous materials remain unavailable.

N-28553*

Aeronautical Research Council (Gt. Brit.)
THE MEASUREMENT OF HEAT TRANSFER AND SKIN FRICTION AT SUPERSONIC SPEEDS. PART III. MEASUREMENTS OF OVERALL HEAT TRANSFER AND OF THE ASSOCIATED BOUNDARY LAYERS ON A FLAT PLATE AT M_1 = 2.43. R. J. Monaghan and J. R. Cooke. 1953. 63p. diagrs., 3 tabs. (ARC CP 139)

A mean value of 0.906 was obtained for temperature recovery factor and the overall heat transfer measurements from plate to stream agreed well with results from the low-speed formula of reference 2. There was some forward movement of boundary-layer transition, a variation in the exponent of the turbulent velocity distribution, and an increase in displacement thickness with heat transfer. However, no decrease in skin friction below its zero heat transfer value was found.

N-28554*

Aeronautical Research Council (Gt. Brit.)
THE THEORY OF AEROFOILS WITH HINGED FLAPS IN TWO-DIMENSIONAL COMPRESSIBLE FLOW. L. C. Woods. 1953. 32p. diagrs. (ARC CP 138)

Recently published methods of deducing practical values of the various control characteristics from a knowledge of their theoretical values increases the importance of the theory of two-dimensional controls in an inviscid compressible fluid. The classical work of Glauert neglects compressibility and airfoil thickness, and while the more recent work of Goldstein and Preston includes thickness effects, it ignores compressibility. Furthermore, this latter method achieves accuracy for thick airfoils at the cost of a complicated method of calculation. This paper presents a theory of two-dimensional controls in compressible flow which is almost as simple to apply as Glauert's theory. An example given by Goldstein and Preston is treated by the author's method to illustrate this point.

N-28555*

Aeronautical Research Council (Gt. Brit.)
THE VIBRATIONS OF A SWEPT WING. N. S. Heaps. 1953. 26p. diagrs. (ARC CP 141)

The vibrations of a swept wing with ribs parallel to the direction of flight are considered theoretically. The couplings of torsion and flexure due to the skewness of the ribs and the building-in of the root section are investigated.

N-28556*

Aeronautical Research Council (Gt. Brit.)
THE PERFORMANCE OF SOME TYPICAL TURBOJET ENGINE EXHAUST SYSTEMS, WITH PARTICULAR REFERENCE TO THE EFFECTS OF SWIRL. P. F. Ashwood and P. J. Fletcher. 1953. 28p. diagrs., 3 tabs. (ARC CP 130)

Tests made to determine the effect of swirl on the performance of a quarter-scale model of a typical turbojet engine exhaust system and propelling nozzle are described. The losses in the system were derived from direct measurement of thrust. The nondimensional thrust, expressed in terms of the nozzle area and the total pressure at inlet to the exhaust diffuser, was found to vary linearly with the ratio of ambient to inlet total pressures. An annular nozzle was found to give slightly over 2 percent more thrust at the choking condition than the standard system for the same air mass flow.

UNPUBLISHED PAPERS

N-29228*

PROPOSED METHOD FOR DEFINING THE TAPER RATIO OF MONOPLANE WINGS. (Una Proposta per la determinazione del rapporto di rastremaxione delle ali monoplane). Giuseppe Gabrielli. February 1954. 14p. diagrs. (Trans. from Onore di Modesto Panetti, 1950, p. 67-71)

A definition is given of taper ratio applicable to all plan forms included within a double infinity of analytically defined wings. A method of plotting the plan form of a wing for which area, span, and taper ratio values are given is described. The author defines an equivalent wing to which static, aerodynamic, aeroelastic, and weight calculations may be referred in first approximation for any wing.

DECLASSIFIED REPORTS

NACA RM L6L26

FREE-FALL MEASUREMENTS AT TRANSONIC VELOCITIES OF THE DRAG OF A WING-BODY CONFIGURATION CONSISTING OF A 45° SWEPTBACK WING MOUNTED FORWARD OF THE MAXIMUM DIAMETER ON A BODY OF FINENESS RATIO 12. Charles W. Mathews and Jim Rogers Thompson. April 2, 1947. 18p. diagrs., photo. (NACA RM L6L26) (Declassified from Confidential, 11/10/53)

The National Advisory Committee for Aeronautics is measuring drag of a series of complete airplane-like configurations and their various components at transonic velocities by the free-fall method. This report covers a test of one configuration of this series. The configuration was composed of a 45° sweptback wing of aspect ratio 4.1 mounted forward of the maximum diameter of a 10-inch-diameter body of fineness ratio 12 equipped with stabilizing tail fins. The wing has a 70-inch span and incorporated an NACA 65-009 airfoil section of 12-inch chord perpendicular to the leading edge. The body-tail fin combination was externally identical with a combination tested previously by this method.

NACA RM L7C25a

TESTS OF A HORIZONTAL-TAIL MODEL THROUGH THE TRANSONIC SPEED RANGE BY THE NACA WING-FLOW METHOD. Richard E. Adams and Norman S. Silsby. April 11, 1947. 24p. diagrs., photos., tab. (NACA RM L7C25a) (Declassified from Restricted, 11/10/53)

A semispan model of the horizontal tail of a fighter airplane was tested at transonic speeds. Measurements of lift, elevator hinge moment, angle of attack, and elevator angle were made in the Mach number range from 0.75 to 1.04 for elevator deflections ranging from 10° to -10° and for angles of attack of -1.2°, 0.4°, and 3.4°. The hinge moment data are considered to be only qualitative.

NACA RM L7D22

SOME PRESSURE-DISTRIBUTION MEASUREMENTS ON A SWEPT WING AT TRANSONIC SPEEDS BY THE NACA WING-FLOW METHOD. J. Ford Johnston and Edward C. B. Danforth. June 6, 1947. 21p. diagrs., photos. (NACA RM L7D22) (Declassified from Restricted, 11/10/53)

First results are given of chordwise pressure-distribution measurements on a 45° sweptback wing at transonic speeds. These tests are part of a fundamental investigation of flow phenomena near sonic velocity by the NACA wing-flow method. Distributions were obtained at two spanwise extensions of the half-span model of 2-inch chord and NACA 65-210 airfoil section measured perpendicular to the leading edge. The aspect ratios were 2.1 and 3.5.

National Advisory Committee for Aeronautics

Research Abstracts

NO.60 **MARCH 30, 1954**

CURRENT NACA REPORTS

NACA Rept. 1114

A THERMODYNAMIC STUDY OF THE TURBINE-PROPELLER ENGINE. Benjamin Pinkel and Irving M. Karp. 1953. ii, 36p. diagrs. (NACA Rept. 1114. Formerly TN 2653)

Equations and charts are presented for computing performance parameters of a turbine-propeller engine for any given set of operating conditions and component efficiencies. In order to illustrate some of the turbine-propeller system performance characteristics, the total thrust horsepower per unit mass rate of air flow and the specific fuel consumption are presented for a wide range of flight engine design operating conditions and given design component efficiencies. The performance of a turbine-propeller engine containing a matched set of components is presented for a range of engine operating conditions. The influence of the characteristics of the individual components of off-design-point performance is shown. The flexibility of operation of two turbine-propeller engines is discussed; one engine has a divided turbine system in which the first turbine drives only the compressor and the second turbine independently drives the propeller, and the other engine has a connected turbine system which drives both the compressor and the propeller.

NACA Rept. 1115

DESIGN OF TWO-DIMENSIONAL CHANNELS WITH PRESCRIBED VELOCITY DISTRIBUTIONS ALONG THE CHANNEL WALLS. John D. Stanitz. 1953. ii, 40p. diagrs., 8 tabs. (NACA Rept. 1115. Formerly TN 2593; TN 2595)

A general method of design is developed for two-dimensional unbranched channels with prescribed velocities as a function of arc length along the channel walls. The method is developed for both compressible and incompressible, irrotational, nonviscous flow and applies to the design of elbows, diffusers, nozzles, and so forth. Two types of compressible flow are considered: the general type, with the ratio of specific heats equal to 1.4, for example, and the linearized type, in which the ratio of specific heats is -1.0. Two methods of solution are used. In part I, solutions are obtained by relaxation methods and in part II, solutions are obtained by a Green's function.

NACA Rept. 1116

APPLICATION OF A CHANNEL DESIGN METHOD TO HIGH-SOLIDITY CASCADES AND TESTS OF AN IMPULSE CASCADE WITH 90° OF TURNING. John D. Stanitz and Leonard J. Sheldrake. 1953. ii, 20p. diagrs., photos., 2 tabs. (NACA Rept. 1116. Formerly TN 2652)

A technique is developed for the application of a channel design method to the design of high-solidity cascades with prescribed velocity distributions as a function of arc length along the blade-element profile. The technique applies to both incompressible and subsonic linearized compressible (ratio of specific heats equal to -1.0), nonviscous, irrotational, fluid motion. An impulse cascade with 90° turning was designed for incompressible flow and was tested at the design angle of attack over a range of downstream Mach number from 0.2 to choke flow. To achieve good efficiency, the cascade was designed for prescribed velocities with maximum allowable blade loading according to limitations imposed by considerations of boundary-layer separation.

NACA Rept. 1124

DISPLACEMENT EFFECT OF A THREE-DIMENSIONAL BOUNDARY LAYER. Franklin K. Moore. 1953. ii, 5p. diagrs. (NACA Rept. 1124. Formerly TN 2722)

A method is described for determining the "displacement surface" of a known three-dimensional compressible boundary-layer flow in terms of the mass-flow defects associated with the profiles of the two velocity components parallel to the surface. The result is a generalization of the plane flow concept of displacement thickness introduced in order to describe how a thin boundary layer distorts the outer nonviscous flow. Numerical values are found for the known three-dimensional boundary-layer flow about a cone at a small angle of attack to a supersonic stream.

NACA Rept. 1127

ONE-DIMENSIONAL ANALYSIS OF CHOKED-FLOW TURBINES. Robert E. English and Richard H. Cavicchi. 1953. ii, 18p. diagrs. (NACA Rept. 1127. Formerly TN 2810)

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E REPORT TITLE AND AUTHOR.

It is indicated that the area ratios and equivalent blade speed are the controlling factors in the design and operation of high work output turbines. For the usual class of turbine, increasing the equivalent blade speed of a given stage makes the internal flow conditions less critical. Flow conditions within choked-flow turbines are not usually sensitive to manufacturing errors in area ratio even near the stator choking limit. Six criteria are stated that will aid in establishing from test data of multistage turbines which blade rows are choked and which are not. The variation in internal flow conditions with operating conditions for a turbine equipped with an adjustable stator is determined for one application of stator adjustment.

NACA Rept. 1130

SOME EFFECTS OF FREQUENCY ON THE CONTRIBUTION OF A VERTICAL TAIL TO THE FREE AERODYNAMIC DAMPING OF A MODEL OSCILLATING IN YAW. John D. Bird, Lewis R. Fisher and Sadie M. Hubbard. 1953. ii, 17p. diagrs., photo. (NACA Rept. 1130. Formerly TN 2657)

The directional damping and stability of a fuselage - vertical-tail model oscillating freely in yaw were measured at a Mach number of 0.14 and compared with the damping and stability obtained by consideration of the effects of unsteady lift. The effects of vertical-tail aspect ratio and compressibility as predicted by the theoretical treatments are discussed in relation to the experimental stability characteristics obtained by the free-oscillation and by the curved-flow procedures.

NACA TN 3073

EXPERIMENTAL STRESS ANALYSIS OF STIFFENED CYLINDERS WITH CUTOUTS. PURE BENDING. Floyd R. Schlechte and Richard Rosecrans. March 1954. 41p. diagrs., photo., 7 tabs. (NACA TN 3073)

Bending tests were made on a cylindrical semimonocoque shell of circular cross section. The cylinder was tested without a cutout and then with a rectangular cutout which was successively enlarged through six sizes varying from 30° to 130° in circumference and from 1 to 2 bays in length. Strain measurements were made with resistance-type wire strain gages near the cutout on the stringers, the skin, and the rings for each size of cutout, and the stresses obtained are presented in tables.

NACA TN 3074

A PRELIMINARY INVESTIGATION OF THE EFFECTS OF GUSTY AIR ON HELICOPTER-BLADE BENDING MOMENTS. Joseph W. Jewel, Jr. and Paul J. Carpenter. March 1954. 28p. diagrs., photos. (NACA TN 3074)

A preliminary investigation has been made at the Langley helicopter test tower to determine the bending moments excited on typical helicopter rotor blades in quiet and gusty air. The results obtained from this investigation indicate that the effects of gusts on rotor-blade bending moments appear to be secondary compared with the vibratory moments attributed to the unsymmetrical rotor downwash for the 26-mph condition tested and analyzed. It was also found that the addition of weights at the blade tips reduced the magnitude of the blade vibratory bending moments.

NACA TN 3075

MEASUREMENTS OF PRESSURE AND TEMPERATURE FOR APPRAISAL OF THE TEMPERATURE METHOD OF AIRSPEED CALIBRATION IN THE LOWER STRATOSPHERE. Lindsay J. Lina. March 1954. 12p. diagrs., photo. (NACA TN 3075)

An investigation was made to determine whether the temperature and pressure conditions in the lower stratosphere would meet the requirements of the temperature method for accurate calibration of airspeed installations. Measurements of temperature and pressure were made in flights of a swept-wing fighter airplane on four clear days in March and April 1953 over land near Langley Field, Virginia. The results indicated that, although the temperature lapse rate was favorable to the method, large and erratic variations of temperature with time and distance precluded accurate calibration. Unfavorable atmospheric conditions had also been found previously in an investigation of the upper troposphere (NACA TN 2807).

NACA TN 3096

THEORETICAL PREDICTION OF PRESSURE DISTRIBUTIONS ON NONLIFTING AIRFOILS AT HIGH SUBSONIC SPEEDS. John R. Spreiter and Alberta Alksne. March 1954. (ii), 84p. diagrs. (NACA TN 3096)

Theoretical pressure distributions on nonlifting circular-arc airfoils in flows with high subsonic free-stream velocity are found by determining approximate solutions of an integral equation for transonic flow proposed by Oswatitsch. Solutions are obtained using an iteration process which differs from the classical methods in that the quadratic nature of the integral equation is recognized. Except for phenomena which are predominantly influenced by viscous effects, the results are in good accord with experimental data.

NACA TN 3097

TURBULENT BOUNDARY-LAYER AND SKIN-FRICTION MEASUREMENTS IN AXIAL FLOW ALONG CYLINDERS AT MACH NUMBERS BETWEEN 0.5 AND 3.6. Dean R. Chapman and Robert H. Kester. March 1954. 53p. diagrs., photos., 5 tabs. (NACA TN 3097)

Direct-force measurements have been made of the average skin-friction coefficient for completely turbulent flow along the cylindrical portion of heat-insulated cone-cylinder bodies of revolution having overall fineness ratios of 10, 15, and 25. Numerous boundary-layer surveys were made. Reynolds numbers between 4 million and 32 million were investigated. At a Mach number of 2.0, data were obtained for different pressure distributions by distorting the flexible-plate walls of the wind tunnel. The results show no significant effect of small pressure gradients and only a small effect of cylinder fineness ratio on the average skin-friction coefficient. For each fineness ratio the effect of Mach number is large and essentially the same for all Reynolds numbers investigated. Determinations of friction by the momentum method differed considerably from the more reliable direct-force measurements.

NACA TN 3099

IMPINGEMENT OF WATER DROPLETS ON AN ELLIPSOID WITH FINENESS RATIO 5 IN AXISYMMETRIC FLOW. Robert G. Dorsch, Rinaldo J. Brun and John L. Gregg. March 1954. 50p. diagrs., tab. (NACA TN 3099)

The presence of radomes and instruments that are sensitive to water films or ice formations in the nose section of all-weather aircraft and missiles necessitates a knowledge of the droplet impingement characteristics of bodies of revolution. Because it is possible to approximate many of these bodies with an ellipsoid of revolution, droplet trajectories about an ellipsoid of revolution with a fineness ratio of 5 were computed for incompressible axisymmetric air flow. From the computed droplet trajectories, the following impingement characteristics of the ellipsoid surface were obtained and are presented in terms of dimensionless parameters: (1) total rate of water impingement, (2) extent of droplet impingement zone, (3) distribution of impinging water, and (4) local rate of water impingement.

NACA TN 3100

STATISTICAL STUDY OF TRANSITION-POINT FLUCTUATIONS IN SUPERSONIC FLOW. J. C. Evvard, M. Tucker and W. C. Burgess, Jr. Appendix B. MATHEMATICAL PROCEDURES. Hugo Heermann. March 1954. 32p. diagrs., photos., tab. (NACA TN 3100)

The random movement of the transition point on a 10° cone at a free-stream Mach number of 3.12 was investigated by means of a large number of high-speed schlieren photographs. The distribution functions which statistically define the transition-point location were determined for a range of test-section Reynolds number and two levels of free-stream turbulence intensity. The intensity was varied by changing tunnel settling-chamber configurations. Temperature-recovery-factor distributions were also obtained. The axial extent of the distribution function determined from the schlieren data increased with turbulence level. The axial spread of the transition region denoted by the recovery-factor measurements roughly corresponded to that of the appropriate distribution function. These data suggest that a relatively sharp transition from laminar to turbulent flow takes place and that this flow pattern moves randomly along the aerodynamic surface. With the use of the statistical distribution functions obtained from the data and surface temperatures (as time-averaged by the surface thermocouples), the instantaneous surface-temperature distributions were calculated for two Reynolds numbers.

NACA TN 3102

AN ANALYTICAL AND EXPERIMENTAL STUDY OF THE TRANSIENT RESPONSE OF A PRESSURE-REGULATING RELIEF VALVE IN A HYDRAULIC CIRCUIT. Harold Gold and Edward W. Otto. March 1954. 54p. diagrs., photo., 3 tabs. (NACA TN 3102)

The transient response of the pressure-regulating relief valve in a hydraulic circuit is analyzed by means of an electrical analogy of the hydraulic circuit. Measurements of the transient response of a hydraulic relief valve are presented and are compared with responses calculated from the differential equation of the equivalent electric network. The comparison of experimental and analytical responses shows that the response of the relief valve can be adequately predicted by means of the equivalent network. The analysis of a typical relief valve by means of the equivalent network indicates that viscous damping is negligible and that the principle damping is derived from the flow resistance of the various elements of the hydraulic circuit. An expression is analytically developed that yields directly the area-lift relation for the relief valve for stable valve operation over the wide flow-rate ranges.

NACA TN 3103

COOLING REQUIREMENTS FOR STABILITY OF LAMINAR BOUNDARY LAYER WITH SMALL PRESSURE GRADIENT AT SUPERSONIC SPEEDS. George M. Low. March 1954. 16p. diagrs., tab. (NACA TN 3103)

The amount of cooling required to stabilize the two-dimensional supersonic laminar boundary layer for all Reynolds numbers is calculated for flows with pressure gradients of a magnitude usually encountered over slender aerodynamic shapes. Only two-dimensional disturbances are treated in the stability calculations. It is determined that small pressure gradients have an appreciable effect on stability. The cooling due to radiation alone may suffice, at moderate supersonic Mach numbers, to completely stabilize the boundary layer over wings with favorable pressure gradients. For flows with adverse pressure gradients, the cooling required for complete stability is considerably greater than that for flat-plate flows.

NACA TN 3104

EXPERIMENTAL INVESTIGATION OF SUBLIMATION OF ICE AT SUBSONIC AND SUPERSONIC SPEEDS AND ITS RELATION TO HEAT TRANSFER. Willard D. Coles and Robert S. Ruggeri. March 1954. 29p. diagrs., photo. (NACA TN 3104)

An experimental investigation was conducted in the 3.84- by 10-inch tunnel to determine the mass transfer by sublimation, heat transfer, and skin friction for an iced surface at subsonic and supersonic speeds. The results show that the Stanton numbers of sublimation and heat transfer were increased 40 to 50 percent for an iced surface of moderate roughness as compared with those obtained for a bare plate. For ice surfaces of equivalent roughness, the ratio of sublimation to heat-transfer Stanton numbers was found to be 0.90. Sublimation Stanton numbers obtained at a Mach number of 1.3 showed no appreciable deviation from those obtained at subsonic speeds. Sublimation as a means of removing ice formations of appreciable thickness is so slow as to be of little value in the de-icing of aircraft at high altitudes.

NACA TN 3105

AERODYNAMICS OF SLENDER WINGS AND WING-BODY COMBINATIONS HAVING SWEPT TRAILING EDGES. Harold Mirels. March 1954. ii, 96p. diagrs. (NACA TN 3105)

A general method, based on two-dimensional cross-flow concepts, is presented for obtaining the lift and moments on highly swept wings. Emphasis is placed on obtaining solutions for wings having swept trailing edges. The method is applicable for all problems where the velocity boundary conditions can be made homogeneous by differentiation in the streamwise or spanwise directions. Lift, roll, and pitch solutions, for highly swept wings, are presented. Both direct problems and inverse problems are considered. Applications of the method for the solution of wing-body problems and unsteady two-dimensional incompressible flow problems are also indicated.

NACA TN 3107

EFFECT OF HEAT TREATMENT UPON THE MICROSTRUCTURE AND HARDNESS OF A WROUGHT COBALT-BASE ALLOY STELLITE 21 (AMS 5385). F. J. Clauss and J. W. Weeton. March 1954. 26p. diagrs., photos. (NACA TN 3107)

An investigation has been made to study the response of wrought Stellite 21 to heat treatment. A period of 72 hours at 2250° F was sufficient for effective solution treatment of this alloy. Pearlitic structures formed at grain boundaries of solution-treated specimens during isothermal transformation at 1950°, 1750°, and 1500° F. A Widmanstaetten structure also formed during transformation at 1750° and 1500° F. Little visible precipitate formed by transformation at 1200° F for times up to 72 hours. Water quenching from 2250° F followed by aging at temperatures from 1200° to 1950° F resulted in precipitation principally along slip lines and twin boundaries. Spheroidization and agglomeration of precipitates occurred at temperatures as low as 1500° F. Isothermal or aging treatments above 1200° F increased the hardness of the solution-treated specimens. A maximum hardness of Rockwell C-42 was developed by aging 72 hours in the temperature range from 1400° to 1500° F, as compared to Rockwell C-20 to C-22 for the solution-treated condition. Overaging or softening occurred within 72 hours at temperatures of 1750° F and above for aging, and 1950° F for isothermal transformation.

NACA TN 3108

RELATION OF MICROSTRUCTURE TO HIGH-TEMPERATURE PROPERTIES OF A WROUGHT COBALT-BASE ALLOY STELLITE 21 (AMS 5385). F. J. Clauss and J. W. Weeton. March 1954. 49p. diagrs., photos., tab. (NACA TN 3108)

An investigation was conducted to determine the effects of microstructure on stress-rupture life of heat-treated wrought Stellite 21. Wrought Stellite 21, which may be considered a typical cobalt-base precipitation-hardening alloy, was found to respond readily to solution treatment and to isothermal and aging heat treatments to form pearlitic and Widmanstätten structures as well as scattered precipitates. The results obtained in this investigation, although determined specifically for the alloy wrought Stellite 21, lead to conclusions that are believed to have general significance in the heat treatment of other high-temperature alloys. The optimum high-temperature properties are associated with a dispersion of fine precipitate scattered throughout the grains of the microstructure. Such scattered precipitation was produced by solution treatment followed by a low-temperature aging treatment to develop nucleation sites and higher-temperature age to develop visible precipitation in the scattered nucleation sites.

NACA TN 3109

AN INVESTIGATION OF LAMELLAR STRUCTURES AND MINOR PHASES IN ELEVEN COBALT-BASE ALLOYS BEFORE AND AFTER HEAT TREATMENT. J. W. Weeton and R. A. Signorelli. March 1954. 50p. diagrs., photos., 12 tabs. (NACA TN 3109)

An investigation of the occurrence and nature of lamellar structures and minor phases of eleven cobalt-base high-temperature alloys (rolled, cast, and high-carbon Stellite 21, 422-19, X-63, 6059, 61, X-40, S-816, I-336, and J). The minor phases TaC, NbC, Cr_3C_2, Cr_7C_3, $Cr_{23}C_6$, M_6C, Cr_2O_3 type oxides, spinels, and sigma were identified by X-ray diffraction analysis. Sigma phase patterns appeared strongest where large numbers of carbides were also present, indicating that carbide precipitation may facilitate sigma phase formation. The most prevalent carbide indicated was $Cr_{23}C_6$. One of the two phases of the pearlitic structure consisted predominantly of the carbide $Cr_{23}C_6$.

NACA TN 3111

FRICTION AND WEAR INVESTIGATION OF MOLYBDENUM DISULFIDE. II - EFFECTS OF CONTAMINANTS AND METHOD OF APPLICATION. Marshall B. Peterson and Robert L. Johnson. March 1954. 19p. diagrs., photos., tab. (NACA TN 3111)

An experimental study was conducted using a low-speed kinetic-friction apparatus to show the effects of method of application and contaminants on the lubricating characteristics of molybdenum disulfide MoS_2. Friction coefficients for a purified grade of MoS_2 can vary from 0.025 to 0.12 merely by changing the method of application. Contaminants present in commercial grades of MoS_2 do not increase friction but can (for example, 0.5 percent silica) adversely affect wear. In room atmosphere, small amounts of oil (5 to 10 percent) reduce friction below that obtained with either purified MoS_2 or with oil alone. At least 10 percent MoS_2 should be present in the oil to obtain the lowest friction. The lowest friction values were obtained at the highest temperatures used (300° F) where the adverse effects of moisture were minimized.

NACA TN 3112

ANALOG STUDY OF INTERACTING AND NON-INTERACTING MULTIPLE-LOOP CONTROL SYSTEMS FOR TURBOJET ENGINES. George J. Pack and W. E. Phillips, Jr. March 1954. 33p. diagrs., photos. (NACA TN 3112)

An analog investigation of several turbojet control configurations was made. Both proportional and proportional-plus-integral controllers were studied, and compensating terms for engine interaction were added to the control system. Data were taken on the stability limits and the transient responses of these various configurations. Analytical expressions in terms of the component transfer functions were developed for the configurations studied and the optimum form for the compensation terms was determined. It was found that the addition of the integral term, while making the system slower and more oscillatory, was desirable in that it made the final values of the system parameters independent of source of disturbance and also eliminated droop in these parameters. Definite improvement in system characteristics results from the use of proper compensation terms. At comparable gain points the compensated system is faster and more stable. Complete compensation eliminates engine interaction permitting each loop to be developed to an optimum point independently.

NACA TN 3126

A DESIGN STUDY OF LEADING-EDGE INLETS FOR UNSWEPT WINGS. Robert E. Dannenberg. March 1954. 56p. diagrs., photos., 3 tabs. (NACA TN 3126. Formerly RM A9K02b)

A method is presented for calculating the profile coordinates for an inlet to be placed in the leading edge of an airfoil from formulas. The method includes an application of the principles of thin-airfoil theory which permits the change in velocity distribution caused by a variation in inlet profile to be calculated. Wind-tunnel tests of leading-edge inlets in an airfoil having the NACA 63_1-012 section were made to evaluate the effects of the inlets on the aerodynamic characteristics of the airfoil. The results indicated that the airfoil with an inlet devised by the design method had satisfactory aerodynamic characteristics.

NACA TN 3127

THE EFFECTIVENESS AT HIGH SUBSONIC MACH NUMBERS OF A 20-PERCENT-CHORD PLAIN TRAILING-EDGE FLAP ON THE NACA 65-210 AIRFOIL SECTION. Louis S. Stivers, Jr. March 1954. 15p. diagrs. (NACA TN 3127)

The lift-control characteristics of a 20-percent-chord plain trailing-edge flap on the NACA 65-210 airfoil section have been analyzed for Mach numbers from 0.30 to 0.875 utilizing section lift-coefficient data. In addition, the relative merits of the plain flap, a spoiler, and a dive-recovery flap employed separately as a lift-control device on the NACA 65-210 airfoil section have been determined from increments of section lift, drag, and pitching-moment coefficients which accompanied the deflection of each control device. The Reynolds number of the data varied with Mach number from about 1×10^6 to 2×10^6.

NACA TN 3129

INVESTIGATION OF A SLAT IN SEVERAL DIFFERENT POSITIONS ON AN NACA 64A010 AIRFOIL FOR A WIDE RANGE OF SUBSONIC MACH NUMBERS. John A. Axelson and George L. Stevens. March 1954. 35p. diagrs., photos., 7 tabs. (NACA TN 3129)

An investigation of a slat in several different positions on an NACA 64A010 airfoil has been conducted over a Mach number range from 0.25 to 0.85, corresponding to a Reynolds number range from 3.4 million to 8.1 million. Section force coefficients and chordwise distributions of pressure and resultant loading are presented for several different locations of the slat. The loading on the slat rather than the effects of the air flowing through the gap was found to be the primary factor determining slat performance.

NACA TN 3143

EXPERIMENTAL DETERMINATION OF THERMAL CONDUCTIVITY OF LOW-DENSITY ICE. Willard D. Coles. March 1954. 12p. diagrs., photo. (NACA TN 3143)

The thermal conductivity of low-density ice has been computed from data obtained in an experimental investigation of the heat transfer and mass transfer by sublimation for an iced surface on a flat plate in a high-velocity tangential airstream. The results are compared with data from several sources on the thermal conductivity of packed snow and solid glaze ice. The results show good agreement with the packed-snow values, and the extension of the curves for packed snow to the solid ice regime indicates that the curves are applicable to ice over the entire density range.

NACA TN 3162

EFFECTS OF SUBSONIC MACH NUMBER ON THE FORCES AND PRESSURE DISTRIBUTIONS ON FOUR NACA 64A-SERIES AIRFOIL SECTIONS AT ANGLES OF ATTACK AS HIGH AS 28°. Louis S. Stivers, Jr. March 1954. 145p. diagrs., photos., 8 tabs. (NACA TN 3162)

A high-speed wind-tunnel investigation has been made of the NACA 64A010, 64A410, 64A006, and 64A406 airfoil sections at angles of attack as high as 28°. Pressure-distribution, lift, drag, and moment characteristics were determined for each airfoil section at Mach numbers ranging from 0.30 to about 0.93, with corresponding Reynolds numbers varying from approximately 0.9×10^6 to 1.9×10^6. The $a = 0.8$ (modified) mean line was employed for the cambered airfoil sections.

NACA TN 3164

FURTHER STUDIES OF THE MECHANISM BY WHICH HYDROGEN ENTERS METALS DURING CHEMICAL AND ELECTROCHEMICAL PROCESSING. L. D. McGraw, W. E. Ditmars, C. A. Snavely and C. L. Faust, Battelle Memorial Institute. March 1954. 37p. diagrs., 4 tabs. (NACA TN 3164)

This investigation was a continuation of efforts to develop fundamental concepts which would be useful in preventing or alleviating hydrogen damage to steel. NACA Technical Note 2696 presented a new mechanism which postulates that the entry of hydrogen into metals from chemical and electrochemical action occurs when hydrogen-metal alloy formation is simultaneous with discharge (or release) of hydrogen atoms. In the present work the phenomena relating to hydrogen entry into steel were studied further. In general, the results support the newly postulated concepts.

NACA TN 3167

THERMAL CONDUCTANCE OF CONTACTS IN AIRCRAFT JOINTS. Martin E. Barzelay, Kin Nee Tong and George Hollo, Syracuse University. March 1954. 47p. diagrs., photos., 2 tabs. (NACA TN 3167)

Tests were conducted to determine the factors influencing the thermal conductance across the interface between 75S-T6 aluminum-alloy and AISI Type 416 stainless-steel structural joints. From the results it was concluded that (1) the thermal conductance of the interface joint increases with mean temperature level, while it remains approximately constant with changes in heat flow; (2) thin foils of good conducting materials inserted between the interfaces improve the heat transfer noticeably; (3) common strength-giving bonding materials produce joints with very poor thermal conductivity; and (4) none of the three modes of heat transfer (metal-to-metal conduction, air-film conduction, and radiation) has any predominance over another across the interface joints and, furthermore, there is an interdependence among these three which has not previously been recognized.

NACA TN 3177

ION TRACER TECHNIQUE FOR AIRSPEED MEASUREMENT AT LOW DENSITIES. W. B. Kunkel and L. Talbot, University of California. March 1954. 31p. diagrs. (NACA TN 3177)

A study has been made of the aerodynamic and production detection problems associated with ion tracer velocity measurement techniques, with particular emphasis on those aspects unique to low-density gas dynamics. A critical survey was made of the various techniques which have been employed and specific suggestions are offered relative to the successful use of ion tracer velocity measuring methods at low densities. A description is also included of some experimental work carried out with an ion-pulse airspeed indicator developed by the Ames Aeronautical Laboratory Low Pressures Group of the National Advisory Committee for Aeronautics for use in low-density wind tunnels.

NACA TN 3190

FATIGUE INVESTIGATION OF FULL-SCALE TRANSPORT-AIRPLANE WINGS. SUMMARY OF CONSTANT-AMPLITUDE TESTS THROUGH 1953. M. J. McGuigan, Jr., D. F. Bryan and R. E. Whaley. Appendix A. NOTES ON THE USE OF BONDED WIRES TO DETECT FATIGUE CRACKS. M. H. Levin. March 1954. 45p. diagrs., photos., 3 tabs. (NACA TN 3190)

Results are presented of constant-amplitude fatigue tests on the wings of C-46 airplanes. Eight complete wings were tested at four alternating load levels ranging from 7-1/2 to 22 percent of the design ultimate load factor. All tests were conducted with a 1 g mean load, which is about 22 percent of the design ultimate load factor. All failures which occurred are classified in five types according to the structural stress raisers in which they originated. Effective stress-concentration factors were determined for each stress raiser where failures occurred, the rate and manner of fatigue-crack propagation was investigated, and the effect of the magnitude of load on these items was determined. The scatter in fatigue life of the wings was analyzed statistically. The load-lifetime relationship of the test structure was compared with that of several other full-scale and component structures which have been subjected to fatigue tests. An appendix by M. H. Levin presents information on the use of bonded wires to detect small fatigue cracks; another appendix deals with the use of fiber glass as a method of structural repair.

NACA RM 53L22

ADDITIONAL FATIGUE TESTS ON EFFECTS OF DESIGN DETAILS IN 355-T6 SAND-CAST ALUMINUM ALLOY. I. D. Eaton and John A. Youra, Aluminum Company of America. March 1954. 24p. diagrs., photos., 5 tabs. (NACA RM 53L22)

Additional static and fatigue tests were made on aluminum-alloy 355-T6 sand-cast specimens. Direct stress fatigue tests were made on plate-type speci-

mens with a single 1-inch-diameter as-cast cored hole and on specimens in which the cored hole was reamed to 1-1/16 inch diameter. In addition, direct-stress fatigue tests were made on 0.300-inch-diameter specimens, with various degrees of porosity, machined from the butt ends of plate-type specimens. Comparisons are made with results of earlier tests, on plate-type specimens with variations in design details such as bosses and ribs, given in NACA Technical Note 2394.

NACA RM E53J30

EFFECT OF ICE FORMATIONS ON SECTION DRAG OF SWEPT NACA 63A-009 AIRFOIL WITH PARTIAL-SPAN LEADING-EDGE SLAT FOR VARIOUS MODES OF THERMAL ICE PROTECTION. Uwe H. von Glahn and Vernon H. Gray. March 1954. 59p. diagrs., photos. (NACA RM E53J30)

Studies were made to determine the effect of ice formations on the section drag of a 6.9-foot-chord 36° swept NACA 63A-009 airfoil with partial-span leading-edge slat. In general, the icing of a thin swept airfoil will result in greater aerodynamic penalties than for a thick unswept airfoil. Glaze-ice formations at the leading edge of the airfoil caused large increases in section drag even at a liquid-water content of 0.39 gram per cubic meter. The use of an ice-free parting strip in the stagnation region caused a negligible change in drag compared with a completely unheated airfoil. Cyclic de-icing when properly applied caused the drag to decrease almost to the bare-airfoil drag value.

NACA RM E53K24

KINETIC STUDY OF MASS TRANSFER BY SODIUM HYDROXIDE IN NICKEL UNDER FREE-CONVECTION CONDITIONS. Don R. Mosher and Robert A. Lad. March 1954. 14p. diagrs., photo., tab. (NACA RM E53K24)

An investigation was conducted using static capsules fabricated from "L" nickel tubing to determine the effect of temperature level, temperature gradient, and test duration on corrosion and mass transfer by molten sodium hydroxide under free-convection conditions. A base temperature range from 1000° to 1600° F with temperature differences to 500° was studied. The rate of mass transfer was found to be strongly dependent on both temperature level and gradient. The rate shows little tendency to decrease for test durations up to 200 hours, although the concentration of nickel in the melt approaches a limiting value after 100 hours.

NACA RM E53L21

PRELIMINARY INVESTIGATION OF THE "FREEZE-CASTING" METHOD FOR FORMING REFRACTORY POWDERS. W. A. Maxwell, R. S. Gurnick and A. C. Francisco. March 1954. 19p. diagrs., photos., 2 tabs. (NACA RM E53L21)

A method of preparing intricately shaped objects from refractory powders was investigated. The method consists in preparing an extremely thick slip with a small amount of binder, casting the slip into a mold, and freezing to retain the shape of the casting. The casting is then dried by sublimation and may subsequently be sintered by conventional means. It was found possible to cast high-solid-content slips by employing vibration during the casting process. Turbosupercharger blades of good appearance and free from radiographic flaws were produced. The factors affecting the density of a casting before sintering were determined.

NACA RM E53L21b

A FLOW CALORIMETER FOR DETERMINING COMBUSTION EFFICIENCY FROM RESIDUAL ENTHALPY OF EXHAUST GASES. Albert Evans and Robert R. Hibbard. March 1954. 21p. diagrs., 2 tabs. (NACA RM E53L21b)

A flow calorimeter for determining the combustion efficiency of turbojet and ram-jet combustors from measurement of the residual enthalpy of combustion of the exhaust gas is described. Briefly, the calorimeter catalytically oxidizes the combustible constituents of exhaust-gas samples, and the resultant temperature rise is measured. This temperature rise is related to the residual enthalpy of combustion of the sample by previous calibration of the calorimeter. Combustion efficiency can be calculated from a knowledge of the residual enthalpy of the exhaust gas and the combustor input enthalpy. An accuracy of ± 0.2 Btu per cubic foot was obtained with prepared fuel-air mixtures, and the combustion efficiencies of single turbojet combustors measured by both the flow-calorimeter and heat-balance methods compared within 3 percentage units. Flow calorimetry appears to be a suitable method for determining combustion efficiencies at high combustor temperatures where ordinary thermocouples cannot be used. The method is fundamentally more accurate than heat-balance methods at high combustion efficiencies and can be used to verify near-100-percent efficiency data.

BRITISH REPORTS

N-28582*

Forest Products Research Lab. (Gt. Brit.) TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. AGBA - GOSSWEILERODENDRON BALSAMIFERUM-HARMS - NIGERIA. (32 POUNDS PER CUBIC FOOT AT 15 PER CENT MOISTURE CONTENT) PROGRESS REPORT TWENTY-THREE. October 1953. 14p. 6 tabs. (Forest Products Research Lab.)

Average quality logs of Agba were selected and tested to provide comparable data with those of Khaya and Sapele. Results of processing are given. Characteristics are presented of the veneer and finally the potentialities of Agba for plywood manufacture are given.

N-28777*

Aeronautical Research Council (Gt. Brit.)
THE LOSS IN CLIMB PERFORMANCE, RELATIVE TO THE OPTIMUM, ARISING FROM THE USE OF A PRACTICAL CLIMB TECHNIQUE. K. J. Lush. 1953. 12p. diagrs., 2 tabs. (ARC R & M 2756; ARC 12,563. Formerly AAEE/Res/243)

A practical climb technique will not in general comply with the condition for optimum climb performance and will give an inferior climb. An assessment of the loss of performance involved is, therefore, desirable. A practical climb technique is considered which is defined by a fixed relation between equivalent air speed (or Mach number) and pressure altitude, and a rough estimate made of the loss in performance involved in using such a technique with a turbine jet aircraft over a range of air temperature, engine speed, thrust, or aircraft weight. An approximate method of calculating a suitable relation is given in an appendix. If the technique for optimum climb is not fixed by compressibility effects, use of such a practical climb technique will result in a loss of performance, relative to the optimum, less than the greater of 1 percent and 1/2 ft/sec in rate of climb over a wide range of aircraft weight or a moderate range of air temperature, engine speed or thrust. Approximate limits are quoted in table 2. More precise limits may be estimated for any particular aircraft. If the technique for optimum climb is determined by compressibility effects such a practical climb technique can give optimum performance over a wide range of weight, air temperature, and engine speed.

N-28778*

Aeronautical Research Council (Gt. Brit.)
THE ELASTIC STABILITY OF SANDWICH PLATES. J. H. Hunter-Tod. 1953. 39p. diagrs. (ARC R & M 2778; ARC 12,550. Formerly College of Aeronautics, Cranfield, Rept. 25)

This paper treats the elastic stability of supported rectangular plates of sandwich construction with isotropic and aeolotropic fillings under compression and shear loading. Formulas are developed for critical stresses for flat and curved panels in compression and flat panels in shear for the buckling of the whole panel, also for the wrinkling or local failure of the faces of flat panels in compression. It is established that for a wide range of conditions the critical stress for panels buckling in compression is independent of the form of the filling providing it is symmetrical about the normal; of the elastic constants of the filling only the transverse shear is of concern. As a result a simple extension of the equivalent plate theory of greatly improved accuracy is developed enabling the use of equations treating the plate as a whole.

N-28779*

Aeronautical Research Council (Gt. Brit.)
THE TURBULENT BOUNDARY LAYER IN COMPRESSIBLE FLOW. W. F. Cope. 1953. 8p. diagrs., tab. (ARC R & M 2840; ARC 7634 (rev.). Formerly Nat. Physical Lab., Engineering Dept. rept.)

The flow of a compressible gas past a flat plate is investigated for a turbulent boundary layer. The local and mean skin-friction coefficients are calculated for both power and log laws of velocity distribution. The calculations show a considerable reduction of both coefficients with increasing M. In the course of the analysis, assumptions have been made whose accuracy is not proven, though they are consistent with those made in incompressible gas dynamics. The results are applied to calculate the contribution to f_R of skin friction for a typical projectile of various calibers. The calculation shows that it should be possible by a properly selected series of wind-tunnel and full-scale experiments to ascertain if the large reduction in skin friction occurs, but that it is unlikely that it will be possible to discriminate between the two hypotheses about velocity distribution.

N-28780*

Aeronautical Research Council (Gt. Brit.)
FOUR STUDIES IN THE THEORY OF STRESS CONCENTRATION. H. L. Cox. January 1950. ii, 58p. diagrs., 9 tabs. (ARC R & M 2704. Formerly Nat. Physical Lab., Engineering Div. Repts. 359/48; 361/48; 360/48; 362/48; 444A/50)

The four papers comprised in this monograph are a study of some of the theoretical aspects of experimental work in progress in the National Physics Laboratory from 1937 to 1947. The greater part of the work is related to failure of materials by fatigue and chief attention is paid to this mode of failure. Parts II and IV deal with the development of means to compute the stress distribution in the neighborhood of holes, grooves, and fillets. Part I is mainly concerned with the effect of holes and internal flaws. Part III deals with the effect of surface irregularities on fatigue strength.

N-28781*

Aeronautical Research Council (Gt. Brit.)
A THEORETICAL APPROACH TO THE DESIGN OF HYDROFOILS. C. H. E. Warren. 1953. 20p. diagrs., 5 tabs. (ARC R & M 2836; ARC 10,181. Formerly RAE Tech. Note Aero 1739; Tech. Note Aero 1826)

An investigation has been made into the application of the theory of thin sections to the design of hydrofoils having high cavitation speeds. Consideration is given to both symmetrical sections, which themselves are suitable for struts, and camber-lines, which, when used with the symmetrical sections, lead to cambered sections which are suitable for lifting surfaces. In all the aim has been to keep the peak local velocities to a minimum and the sections developed differ from "low-drag" airfoil sections mainly in that, being hydrofoils, the sections have sharp leading edges. The theoretical optimum section consists of an elliptic symmetrical section superimposed on a logarithmic camber-line. Typical practical sections will cavitate at a speed lower by about 5 knots than the theoretical optimum section of the same thickness/chord ratio and at the same lift coefficient. For strut sections, it is shown that sections having high cavitation speeds at zero incidence tend to be inferior to other sections at incidences as small as 2°. For lifting surface

sections it is shown that although a high cavitation speed demands a low design lift coefficient, a high loading at cavitation demands a high design lift coefficient. Operation above cavitation speeds or over wide ranges of lift coefficient is not considered.

N-28782*

Aeronautical Research Council (Gt. Brit.)
WIND-TUNNEL TESTS ON THE PREVENTION OF BOUNDARY-LAYER SEPARATION BY DISTRIBUTED SUCTION AT THE REAR OF A THICK AEROFOIL (NPL 153). N. Gregory, R. C. Pankhurst and W. S. Walker. 1953. 7p. diagrs., tab. (ARC R & M 2788. Formerly ARC 13,446; Perf. 702; FM 1485)

Tests of a preliminary nature have been carried out on a 33-percent-thick symmetrical airfoil (NPL 153) with suction through a porous-surface from 0.80 chord to the trailing edge, which was rounded and fitted with a Thwaites flap. The distributed suction was found to prevent separation and to reduce the wake drag to zero. The overall effective drag (including an allowance for the power required for the suction) was reduced slightly, but still remains fairly high. No hysteresis was observed in the change of drag with suction quantity. The flap was essential to stabilize the flow: without it, the flow with suction was unsteady and the wake drag was appreciable. When the flap was deflected 20°, there was no increase in the suction quantity required to prevent separation.

N-28783*

Aeronautical Research Council (Gt. Brit.)
NOTE ON AERODYNAMIC CAMBER. H. C. Garner. 1953. 14p. (ARC R & M 2820. Formerly ARC 13,092; S & C 2391; Perf. 656)

An explanation is given of the theoretical significance of camber derivatives. The various available methods of making experimental measurements with particular reference to the use of a curved-flow tunnel are discussed. There is particular need for systematic information about the influence of curvature of flow on control hinge-moments as a step towards the understanding of three-dimensional viscous flow.

N-28784*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE USE OF THE THREE-DIMENSIONAL SHOCK-WAVE RECORDER FOR STUDYING INTERFERENCE IN A SUPERSONIC WIND TUNNEL. A. O. Ormerod. 1953. 9p. diagrs., photo. (ARC R & M 2798; ARC 13,940. Formerly RAE Tech. Note Aero 2088)

A description is given of the shock-wave recorder which has been used to investigate wind-tunnel interference on a sting-mounted wing having 50° of sweepback. Diagram of the shock-wave patterns round the wing is given for Mach numbers 1.4, 1.6, and 1.8 and angles of attack of 0° and 4°.

N-28785*

Aeronautical Research Council (Gt. Brit.)
NATURAL FREQUENCIES AND MODES OF A MODEL DELTA AIRCRAFT. D. R. Gaukroger. 1953. 32p. diagrs., tab. (ARC R & M 2762; ARC 13,377. Formerly RAE Structures 75)

Resonance tests on a model delta wing are described. Consideration is given to the effect of inertia distribution on the first three normal symmetric modes of vibration. The mean center-of-gravity position, fuselage pitching moment of inertia and wing inertia axis have been independently varied, and the effect of concentrated tip masses has been examined. Results are given which are intended as a general guide in flutter calculations.

N-28854*

Royal Aircraft Establishment (Gt. Brit.)
A SIMPLE METHOD OF PROVIDING AUTOMATIC ZERO ADJUSTMENT IN A POSITION-CONTROL SERVOMECHANISM EMPLOYING A D.C. AMPLIFIER. L. A. J. Lawrence. October 1953. 17p. diagrs. (RAE Tech. Note GW 280)

A system is described for the removal of accumulated drift from the output of a position-control servomechanism employing a d-c amplifier. The factors governing the accuracy of the zero at the instant of adjustment and its subsequent accuracy are both discussed, together with practical results and circuit details.

N-28855*

Royal Aircraft Establishment (Gt. Brit.)
ON THE LAMINAR BOUNDARY LAYER SEPARATION FROM THE LEADING EDGE OF A THIN AEROFOIL. P. R. Owen and L. Klanfer. October 1953. 19p. diagrs., 6 tabs. (RAE Aero 2508)

Low-speed wind tunnel tests have shown that when a laminar boundary layer separates from the leading edge of a thin airfoil at angle of attack, the flow often becomes attached to the surface again some distance downstream. It is suggested that the length of the "bubble" depends primarily on the Reynolds number based on the displacement thickness at the separation point. This Reynolds number in turn depends on the distance of the velocity peak on the upper surface of the airfoil from the stagnation point and it is inferred that, at a Reynolds number based on the chord, a long bubble is more likely to occur when the velocity peak is close to the stagnation point.

N-28856*

Aeronautical Research Council (Gt. Brit.)
TABULATION OF THE BLASIUS FUNCTION WITH BLOWING AND SUCTION. H. W. Emmons and D. C. Leigh. June 5, 1953. 81p. diagrs., 3 tabs. (ARC 15,966; FM 1913)

The present solutions were obtained in connection with the solution of a combustion problem. The whole possible range of blowing and suction values is

covered in this paper. Calculations were done on the Electronic Delay Storage Automatic Calculator and the results are included in table form.

N-28858*

Aeronautical Research Council (Gt. Brit.)
LARGE SCALE ATMOSPHERIC FLOW PATTERNS IN THE LABORATORY. T. V. Davies. May 5, 1953. 6p. diagr., photos. (ARC 15,876; FM 1896)

A brief description is given of laboratory apparatus which simulates the large scale features of atmospheric motion. Also given are principal results obtained together with the explanation of the correspondence between experimental flows and atmospheric flows. The research work has been conducted principally at the Department of Meteorology, Chicago University, but more recently at other meteorological departments in the U. S. A.

N-28935*

Aeronautical Research Council (Gt. Brit.)
SUMMARY OF THE THEORETICAL WORK DONE ON THE STABILITY OF THIN PLATES, 1939 TO 1946. D. M. A. Leggett. 1953. 8p. (ARC R & M 2784. Formerly ARC 13,366; Strut 1376)

Attention is drawn to the more important problems of the stability of thin plates which were requiring solutions at the beginning of the war, and progress made towards their solution during the subsequent 7 years is indicated. Three types of problems are discussed: the critical buckling load of a flat rectangular plate when the edges are not all simply supported, the post-buckling behavior of a long flat plate under shear, and the initial and post-buckling behavior of a curved plate under various combinations of shear, compression, and normal pressure.

N-28968*

Royal Aircraft Establishment (Gt. Brit.)
TESTS ON THE RELATIVE EFFICIENCY OF CHROMATE PIGMENTS IN ANTI-CORROSIVE PRIMERS. H. G. Cole. November 1953. 20p. diagr., 7 tabs. (RAE Tech. Note Met. 185)

Seawater spray corrosion tests have been made on two magnesium alloys, aluminum alloy, and mild steel, painted with primers made from 18 chromate pigments incorporated in turn in a litho-oil/coumarone medium. Best all round protection was given by zinc monoxy chromate, calcium chromate, and strontium chromate, and good protection by potassium zinc chrome (zinc yellow) and zinc tetroxy chromate. Four complex cadmium chromes and three lead chromates gave poor results. Of the zinc and alkaline earth pigments, those giving best protection were of intermediate solubility.

N-28969*

Royal Aircraft Establishment (Gt. Brit.)
CRACK SENSITIVITY, SHEAR STRENGTH, CREEP AND WATER ABSORPTION OF BIAXIALLY STRETCHED PERSPEX. A. S. Atkinson and W. W. Wright. October 1953. 8p. diagrs., 3 tabs. (RAE Tech. Note Chem. 1208)

Preliminary tests on samples of biaxially stretched polymethyl methacrylate have indicated that the process reduces sensitivity to cracks, increases the shear strength and reduces creep to an extent which may have practical advantages. On the other hand there is probably an increase in the maximum water absorption.

UNPUBLISHED PAPERS

N-12563*

National Bureau of Standards.
CORROSION OF ALUMINUM-ZINC-MAGNESIUM-COPPER ALLOYS. Fred M. Reinhart. December 15, 1951. (i), 19p. diagrs., photos., tab. (National Bureau of Standards. Rept. 1334)

Aluminum-zinc-magnesium-copper alloys, clad and unclad, anodized and unanodized, were exposed in marine environments to determine their corrosion behavior, and for comparison, specimens of anodized aluminum-copper-magnesium alloys, clad and unclad, were also exposed. Results from this experiment are presented in this report.

N-15972*

A NEW METHOD IN THE DYNAMICS OF A VISCOUS FLUID. (Novyi Metod v Dinamike Vyazkoi Zhidkosti). V. G. Nevzglyadov. 7p. (Trans. from Akademiia Nauk SSSR, Doklady, v. 77, no. 4, 1951, p.573-576)

The velocity vector of an incompressible fluid is written as the sum of two vectors; one satisfies the equation of potential flow, the other is small compared with the first. The flow equation is then obtained by replacing the velocity vector in the Navier-Stokes equation by the sum of these two vectors and neglecting products of the additional velocity vector and its derivatives. The resulting linear equation for the unknown additional velocity vector reduces to Oseen's when the vector obtained from the solution of the potential flow problem is replaced by the velocity vector very far from the body. The equation for the additional velocity vector is not solved; but it is assumed that, on a streamline near the body, the components of the additional velocity vector and their derivatives are determined by a polynomial approximation to the velocity components that is valid from this streamline to the surface of the body.

N-27945*

National Bureau of Standards.
ZINC AND CADMIUM PLATED FASTENERS ON ALCLAD 75S-T6 ALUMINUM ALLOY. Fred M. Reinhart and David B. Ballard. May 6, 1953. ii, 23p. photos., 2 tabs. (National Bureau of Standards. Rept. 2477)

This initial progress report contains the results after 9 months of exposure in tidewater, 12 months in marine and urban atmospheres. It is tentatively concluded that the galvanic corrosion with cadmium plated steel fasteners would be less damaging to Alclad 75S-T6 aluminum alloy than would that with zinc plated steel fasteners.

N-29104*

Cornell University, Graduate School of Aeronautical Engineering. ON THE RELATION AMONG STRESS, STRAIN, VELOCITY FROM TESTS ON COPPER WIRES SUBMITTED TO LONGITUDINAL IMPACT. C. Riparbelli. July 1953. (Rev.) 82p. diagrs., photos. (Cornell University, Graduate School of Aeronautical Engineering)

The relation among stress, strain and time rate of strain is found by experiments of tensile impact on copper wires. The results agree with the hypothesis that the velocity of propagation of a small disturbance is the same, whether the material is strained entirely within the elastic range or whether the disturbance is introduced and propagated in the presence of plastic flow. Results indicate that the rate of plastic flow is proportional to the excess of the strain.

N-29362*

DEGREE OF APPROXIMATION OBTAINED BY ENERGY METHODS IN CALCULATING EIGENVALUES. (Sull'Approssimazione dei procedimenti energetici per il calcolo di autovalori). Ottorino Sesini. February 1954. 15p. diagr. (Trans. from Onore di Modesto Panetti, 1950, p. 94-99)

A critical examination is made of the energy methods for the approximate calculation of the eigenvalues in engineering problems. The methods used by Bryan-Timoshenko in his calculations of critical loads and those used by Lord Rayleigh or Stodola in calculating the natural frequency of vibrating elastic systems or the speed of rotating shafts are considered.

MISCELLANEOUS

N-27708*

AERODYNAMICS - THEORY, EXPERIMENT, APPLICATION. Hugh L. Dryden. 9p. diagrs., photos. (Reprint from Aeronautical Engineering Review, v. 12, no. 12, December 1953).

Typical examples from various time periods in the growth of aerodynamics in the first half-century of flight are given. For clarity, theory, experiment, and application are treated as separate lines of effort. Today the term aerodynamics is applied to this triplet of activities, which, starting as separate and almost distinct threads, are now thoroughly interwoven into the fabric of modern aerodynamics. The great strength of aerodynamics and aeronautical engineering lies in the close integration and teamwork of the three groups within the last 20 or 25 years.

N-3074C

INDEX OF NACA TECHNICAL PUBLICATIONS, JUNE, 1951 - MAY, 1953. 1953. viii, 230p. (NACA)

There is a classified listing of subject categories; a chronological listing of NACA publications under each subject category; an alphabetical index to the subject categories; and an author index.

NACA Rept. 1127

Errata No. 1 on "ONE-DIMENSIONAL ANALYSIS OF CHOKED-FLOW TURBINES." Robert E. English and Richard H. Cavicchi. 1953.

NACA RM 54A04

Errata No. 1 on "EFFECTS OF MOLECULAR WEIGHT ON CRAZING AND TENSILE PROPERTIES OF POLYMETHYL METHACRYLATE." I. Wolock, M. A. Sherman and B. M. Axilrod. February 17, 1954.

DECLASSIFIED NACA REPORTS

NACA RM L51F04

HYDRODYNAMIC DIRECTIONAL BEHAVIOR OF A SWEPT PLANING-TAIL HULL. Donald D. Arabian. January 10, 1952. 15p. diagrs. (NACA RM L51F04) (Declassified from Confidential, 3/9/54)

A qualitative investigation of the low-speed directional behavior of a swept planing-tail hull was made in the Langley tank no. 2 in still water and still air with the use of a free self-propelled model. The configuration was directionally unstable over a range of low speed. It was, however, directionally controllable at all speeds by use of the rudder and elevator. Several modifications that were investigated did not improve the controllability.

THE FOLLOWING REPORT
HAS BEEN DECLASSIFIED
FROM CONFIDENTIAL, 3/10/54.

RM L9J20

National Advisory Committee for Aeronautics

Research Abstracts

NO. 61 APRIL 13, 1954

CURRENT NACA REPORTS

NACA TN 3023

RESULTS OF EDGE-COMPRESSION TESTS ON STIFFENED FLAT-SHEET PANELS OF ALCLAD AND NONCLAD 14S-T6, 24S-T3, AND 75S-T6 ALUMINUM ALLOYS. Marshall Holt, Aluminum Company of America. April 1954. 18p. diagrs., photos., 2 tabs. (NACA TN 3023)

This investigation was made to augment data previously obtained on the compressive strengths of stiffened flat-sheet panels to include the range where ultimate strengths approach the compressive yield strengths of the materials. The sheet materials used were alclad and nonclad 14S-T6, 24S-T3, and 75S-T6. The ultimate strengths of the panels tested varied from 93.3 to 118.0 percent of the compressive yield strengths of the materials from which they were constructed. The ultimate strengths of these panels appear to be limited by the strengths of the rivets. Higher ultimate strengths might have resulted from the use of larger or stronger rivets or a smaller rivet spacing.

NACA TN 3070

EFFECTS OF PANEL FLEXIBILITY ON NATURAL VIBRATION FREQUENCIES OF BOX BEAMS. Bernard Budiansky and Robert W. Fralich. March 1954. 55p. diagrs. (NACA TN 3070)

Effects of local panel oscillations on bending and torsional vibrations of box beams with flexible covers and webs are investigated. Theoretical analyses of simplified models are made in order to shed light on the mechanism of coupling between local and overall vibrations and to derive results that can be used to estimate the coupling effects in box beams.

NACA TN 3071

THEORETICAL SUPERSONIC FORCE AND MOMENT COEFFICIENTS ON A SIDESLIPPING VERTICAL- AND HORIZONTAL-TAIL COMBINATION WITH SUBSONIC LEADING EDGES AND SUPERSONIC TRAILING EDGES. Frank S. Malvestuto, Jr. March 1954. 69p. diagrs., 2 tabs. (NACA TN 3071)

Formulas are obtained by means of linearized flow theory for the lateral force due to sideslip, the yawing moment due to sideslip, and the rolling moment due to sideslip for a tail arrangement composed of a vertical triangular surface attached to a horizontal triangular surface. The leading edges of the surfaces are subsonic; the trailing edges, supersonic. A series of design charts are presented for rapid estimates of the stability derivatives considered.

NACA TN 3077

THE EFFECT OF DYNAMIC LOADING ON THE STRENGTH OF AN INELASTIC COLUMN. William A. Brooks, Jr. and Thomas W. Wilder, III. March 1954. 29p. diagrs., 2 tabs. (NACA TN 3077)

The maximum loads of idealized inelastic H-section columns whose pinned ends approach each other at a constant rate are presented. The solutions indicate that as the rate of end displacement becomes smaller the dynamic buckling solutions approach the static solution as a lower limit. For all rates of end displacement investigated the static maximum load may be employed as a conservative estimate of the maximum column load.

NACA TN 3079

THE HYDRODYNAMIC CHARACTERISTICS OF MODIFIED RECTANGULAR FLAT PLATES HAVING ASPECT RATIOS OF 1.00 AND 0.25 AND OPERATING NEAR A FREE WATER SURFACE. Kenneth L. Wadlin, John A. Ramsen and Victor L. Vaughan, Jr. March 1954. 64p. diagrs., photos. (NACA TN 3079)

Results are presented from an investigation of the hydrodynamic forces and moments acting on modified rectangular flat plates with aspect ratios of 1.00 and 0.25 mounted on a single strut and operating near the free water surface. A simplified method of obtaining

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the lift characteristics in unseparated flow at large depths is presented. This method shows very good agreement with the data. The experimental effects of changing the angle of attack, depth of submersion, and aspect ratio are presented. The effects of cavitation and two different types of high-angle leading-edge separation are also presented.

NACA TN 3081

THE ZERO-LIFT DRAG OF A 60° DELTA-WING—BODY COMBINATION (AGARD MODEL 2) OBTAINED FROM FREE-FLIGHT TESTS BETWEEN MACH NUMBERS OF 0.8 AND 1.7. Robert O. Piland. April 1954. 11p. diagrs., 2 tabs. (NACA TN 3081)

The zero-lift drag of a 60° delta-wing—body combination (designated AGARD model 2) has been determined by free-flight tests of two models between Mach numbers of 0.8 and 1.7. These Mach numbers correspond to Reynolds numbers, based on body length, of 4×10^6 and 12×10^6, respectively. An estimate of the drag of the configuration was made by summing the estimates of the drag of the various components. The agreement between measured and estimated drag is good.

NACA TN 3082

EXPERIMENTAL INVESTIGATION OF THE PURE-BENDING STRENGTH OF 75S-T6 ALUMINUM-ALLOY MULTIWEB BEAMS WITH FORMED-CHANNEL WEBS. Richard A. Pride and Melvin S. Anderson. March 1954. 30p. diagrs., photo., tab. (NACA TN 3082)

Experimental results are presented for the pure-bending strength of 53 multiweb beams of various proportions. The beams were fabricated from 75S-T6 aluminum-alloy sheet material and had channel-type webs which had been cold formed with bend radii of four times the web thickness. Local and wrinkling modes of buckling were observed prior to failure. All failures occurred with the formation of a trough in the compression skin extending across the web attachment flanges. The stress levels achieved at buckling and failure are discussed in terms of existing theory. Based upon the failure stresses, design charts are presented which permit rapid selection of the most efficient proportions for given values of an appropriate structural index.

NACA TN 3142

A FURTHER INVESTIGATION OF THE EFFECT OF SURFACE FINISH ON FATIGUE PROPERTIES AT ELEVATED TEMPERATURES. Robert L. Ferguson. March 1954. 27p. diagrs., photos., 3 tabs. (NACA TN 3142)

An investigation was conducted to evaluate the effects of surface roughness on fatigue properties of low carbon N-155 alloy with a grain size of A.S.T.M. 6 and of S-816 alloy with a grain size of A.S.T.M. 6 to 7. Fatigue studies were conducted at 80°, 1200°, 1350°, and 1500° F. In addition, an investigation of the effect of surface abrasion upon the character of residual stresses and of the effect of time and temperature upon the relief of these stresses was conducted. Compressive stresses were produced at right angles to the direction of abrasion. These residual compressive stresses, if of sufficient magnitude, in the surface of fatigue specimens improved fatigue strength at low temperatures. At elevated temperatures, however, these beneficial surface compressive effects were relieved and only the detrimental stress concentration effects produced by abrasion remained and reduced fatigue strength.

NACA TN 3144

COEFFICIENT OF FRICTION AND DAMAGE TO CONTACT AREA DURING THE EARLY STAGES OF FRETTING. II - STEEL, IRON, IRON OXIDE, AND GLASS COMBINATIONS. John M. Bailey and Douglas Godfrey. April 1954. 26p. diagrs., 4 tabs. (NACA TN 3144)

Experiments were conducted to study the early stages (up to 400 cycles) of fretting of steel-steel combinations at constant frequency, amplitude, load, and humidity. Pure iron, glass, and iron oxide powder compacts were used in supplementary experiments. The results of microscopic observation of the contact area, chemical analyses of fretting debris, and measurement of coefficient of friction are presented and lead to these conclusions: 1. Fretting starts with severe adhesion. The adhesion varies with the material combination, but is of primary importance because it precedes and initiates the other phenomena observed. 2. In the early stages of fretting, several other wear phenomena in addition to adhesion occur: plowing by protruding transferred material; formation of metallic and oxide debris; formation of films by compacting small particles into clearances in the contact area.

NACA TM 1362

ON THE SOUND FIELD OF A POINT-SHAPED SOUND SOURCE IN UNIFORM TRANSLATORY MOTION. (Über das Schallfeld einer gleichförmig-translatorisch bewegten punkförmigen Schallquelle). H. Hönl. April 1954. 44p. diagrs. (NACA TM 1362. Trans. from Annalen der Physik, issue 5, v. 43, 1943, p. 437-464).

A rigorous analysis presented of the excitation of sound by point sources moving in uniform translatory motion at subsonic or supersonic velocities through a two- or three-dimensional medium at rest. The construction of surfaces of constant phase is based upon Huyghens' principle in such a manner that the propagation in the medium at rest of the elementary waves emanating from the sound source is independent of the momentary state of motion of the sound source; hence, characteristic traits of the sound propagation may be understood even on the basis of simple geometric constructions.

NACA TM 1367

HEAT TRANSFER, DIFFUSION, AND EVAPORATION. (Wärmeübergang, Diffusion und Verdunstung). Wilhelm Nusselt. March 1954. 37p. diagrs. (NACA TM 1367. Trans. from Zeitschrift für angewandte Mathematik und Mechanik, v. 10, no. 2, April 1930, p. 105-121).

The general similarity of heat and mass transfer (diffusion) processes is discussed, with particular reference to the lack of complete identity of the relations governing the two phenomena. It is indicated that, for example, the boundary conditions in the two cases at the surface of a body will not be the same. The correct equation of diffusion is given for various simple cases. Generalized relations for combined heat and mass transfer are then evolved for particular situations, comparisons being made among several different approaches to the problem. Finally, the effect of a buoyancy force field on the generalized relations is considered, with special reference to the evaporation of water.

NACA RM E54B01

TOOTH-TYPE NOISE-SUPPRESSION DEVICES ON A FULL-SCALE AXIAL-FLOW TURBOJET ENGINE. Edmund E. Callaghan, Walton Howes and Warren North. March 1954. 16p. diagrs., photos. (NACA RM E54B01)

A study of two jet-noise-suppression devices consisting of teeth projecting into the air stream was conducted on a current axial-flow turbojet engine. The sound fields obtained with both noise-suppression devices were similar and, when compared with a standard nozzle, showed a reduction in maximum sound pressure level downstream of the jet and increased levels on the sides and rear. The reduction in maximum sound pressure level was only 2 decibels, and the total radiated power from the toothed and standard nozzles was almost identical (±1 db). It was concluded, therefore, that the toothed devices investigated do not represent a satisfactory solution of the jet-noise problem.

BRITISH REPORTS

N-28936*

Aeronautical Research Council (Gt. Brit.)
THE 9 x 3 IN. INDUCED-FLOW HIGH-SPEED WIND TUNNEL AT THE NATIONAL PHYSICAL LABORATORY. D. W. Holder and R. J. North. 1953. 23p. diagrs., photos., 9 tabs. (ARC R & M 2781. Formerly ARC 12,387; TP 285)

A 9 x 3 inch high-speed wind tunnel driven by a compressed-air injector has been built in the Aerodynamics Division of the National Physical Laboratory. The tunnel operates at roughly atmospheric stagnation pressure and has so far been used to give Mach numbers up to 1.8. The general arrangement of the tunnel and the preliminary calibration, which is generally satisfactory, are described.

N-28937*

Aeronautical Research Council (Gt. Brit.)
BRITISH PERFORMANCE REDUCTION METHODS FOR MODERN AIRCRAFT. D. Cameron. 1953. 32p., diagrs., 5 tabs. (ARC R & M 2447; ARC 6445. Formerly AAEE/Res/170)

The methods of reduction of performance measurements to standard conditions applicable to aircraft with highly supercharged engines and constant-speed propellers are the subject of this report. The theory of the agreed methods is summarized in brief form, tables are given from which the necessary charts can be constructed, and the practical method of applying the corrections is described. The report does not include methods appropriate to certain aircraft and engines of later development (turbosuperchargers, turbine engines, and high-speed aircraft).

N-28938*

Aeronautical Research Council (Gt. Brit.)
THE THEORETICAL EFFECT OF FLIGHT PATH ANGLE ON THE LATERAL STABILITY AND RESPONSE OF AN AIRCRAFT. E. M. Frayn and M. V. Parnell. 1954. 28p. diagrs., 8 tabs. (ARC R & M 2529; ARC 9360. Formerly RAE Aero 2097)

The response of a typical aircraft of the dive-bomber class to various disturbances has been calculated at four angles of dive covering the range 0° to 90° and for four pairs of values of ι_V, n_V. The most notable effect on stability is the marked increase in spiral damping with increasing dive angle at the same T.A.S. This has little effect on the response, since in most components, this mode is scarcely excited. For dive angles up to 30°, the variations in response are so slight as to be negligible, while for larger angles of dive, the variation is small for the first 2 airsecs. Calculations of response in level flight, which slightly underestimate the response in a dive, can thus be assumed to give a sufficiently accurate picture of the behavior at small flight path angles for most requirements.

N-28939*

Aeronautical Research Council (Gt. Brit.)
INVESTIGATION OF LATERAL AND DIRECTIONAL BEHAVIOUR OF SINGLE ROTOR HELICOPTER (HOVERFLY MK. I). J. Zbrozek. 1953. 20p. diagrs., tab. (ARC R & M 2509; ARC 11,701. Formerly RAE Aero 2268)

This note gives an elementary theory of the lateral and directional stability and control of the single rotor helicopter with particular reference to the Sikorsky R4-B. The results of the analysis give good qualitative agreement with flight tests. Preliminary flight tests show higher damping and higher frequency of oscillations than predicted by theory. A theoretical investigation of the lateral stability of the helicopter by Hohenemser, although made for a side-by-side twin-rotor helicopter, is in good agreement with the results of this note.

N-28940*

Aeronautical Research Council (Gt. Brit.)
EFFECTS OF AIR HUMIDITY IN SUPERSONIC WIND TUNNELS. Julius Lukasiewicz and J. K. Royle. 1953. 35p. diagrs., photos., 7 tabs. (ARC R & M 2563; ARC 10,977; ARC 12,374. Formerly RAE Aero 2211; SD 20; Tech. Note Aero 1982; SD 89)

The available theoretical and experimental information on condensation of water vapor in the supersonic flow of air is reviewed and the influence of condensation on operation of supersonic tunnels is considered. The mechanism of condensation in supersonic flow is of molecular nature and does not depend on the presence of solid condensation nuclei in the air. As estimated by Oswatitsch and confirmed by experimental results, the condensation in supersonic flow of air is primarily a function of the adiabatic supercooling $\Delta T_{k \text{ to ad}}$ which determines the conditions at which the condensation shock occurs. For medium-sized supersonic tunnels (say 1-foot square working section) the adiabatic supercooling is of the order of 50° C. For most test purposes, it is essential to eliminate the detrimental effects of condensation on flow distribution in the tunnel working section. The usual method is to use highly dried air, and the question of the required dryness is considered. Other methods, which do not rely on the dryness of air, are discussed. It is shown that by increasing stagnation temperature condensation can be avoided usually only at Mach numbers smaller than 1.5. Alternatively, condensation can be eliminated from the tunnel nozzle by pre-expansion in an auxiliary nozzle, as verified experimentally.

N-28941*

Aeronautical Research Council (Gt. Brit.)
SUPERSONIC THEORY FOR OSCILLATING WINGS OF ANY PLAN FORM. W. P. Jones. 1953. 11p. diagrs. (ARC R & M 2655. Formerly ARC 11,559; 0.730; FM 1254)

A theory for thin wings of any plan form describing simple harmonic oscillations of small amplitude in a supersonic airstream is developed. It is based on the use of the generalized Green's Theorem in conjunction with particular solutions which vanish over the characteristic cone with vertex at any point in the field of flow. The theory can be used to calculate the aerodynamic forces acting on fluttering wings when the modes of distortion are known.

N-28942*

Aeronautical Research Council (Gt. Brit.)
FLIGHT TESTS ON SWINGING DURING TAKE-OFF ON A SINGLE-ENGINED FIGHTER-BOMBER (TYPHOON Ib). W. Stewart. 1953. 29p. diagrs., tab. (ARC R & M 2660; ARC 11,725. Formerly RAE Aero 2261)

Values of the aerodynamic side forces and yawing moments during take-off are compared with wind-tunnel measurements. Various methods of estimating the rudder angles required to trim during take-off are compared also. Results show very good agreement with wind-tunnel tests. It was not possible to obtain smooth application of the rudder and records show considerable over-correction by the pilot. This over-correction by the pilot is quite general and as a result some considerable margin of control must be available in excess of that required for trim.

N-28943*

Aeronautical Research Council (Gt. Brit.) CORRECTIONS FOR SYMMETRICAL SWEPT AND TAPERED WINGS IN RECTANGULAR WIND TUNNELS. W. E. A. Acum. 1953. 33p. diagrs., 41 tabs. (ARC R & M 2777. Formerly ARC 13,050; Perf. 649; ARC 14,159; Perf. 815)

In the case of wings with straight leading and trailing edges, the interference upwash due to the images of the wing in the wind-tunnel walls may be determined in terms of three functions of the parameters defining the size of the wing and tunnel. These functions have been tabulated and used to estimate the effect on C_L and C_M, for wings of a variety of sizes and shapes. The variation of mean induced incidence with sweep and taper was found to be small. A formula is given for computing the residual correction to C_M for each special case.

N-28944*

Aeronautical Research Council (Gt. Brit.) THE PRESSURE DISTRIBUTION, AT SUPERSONIC SPEEDS AND ZERO LIFT, ON SOME SWEPT-BACK WINGS HAVING SYMMETRICAL SECTIONS WITH ROUNDED LEADING EDGES. G. M. Roper. 1954. 20p. diagrs. (ARC R & M 2700; ARC 12,364. Formerly RAE Aero 2312)

Formulas are found for the pressure distribution at supersonic speeds and at zero incidence for certain symmetrical surfaces of small finite thickness, with sweptback leading edges. The surfaces are set symmetrically to the wind direction. The solution is only valid if the surfaces lie wholly within the Mach cone of the apex. Solutions are applied to give the pressure distribution for wings of small finite thickness with straight leading edges and a hyperbolic or parabolic trailing edge. Some calculations for wing drag have also been made for sweptback wings.

N-28945*

Aeronautical Research Council (Gt. Brit.) AN APPROXIMATE SOLUTION OF THE COMPRESSIBLE LAMINAR BOUNDARY LAYER ON A FLAT PLATE. R. J. Monaghan. 1953. 24p. diagrs., 2 tabs. (ARC R & M 2760; ARC 12,963. Formerly RAE Tech. Note Aero 2025, sup. 96)

The flat plate problem has received the attention of many workers, but as yet all solutions have been purely numerical for special cases. In this paper, an approximate, analytical solution is presented which is more general and has the merits of simplicity. The equations are algebraic in form whereas previous results have involved complex numerical integrations for individual cases. The solution given shows clearly the effects of changes in working conditions.

N-30183*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) FLIGHT TESTS OF A YOUNGMAN-HUGHES STALL WARNING DEVICE ON A NENE VIKING AIRCRAFT. D. A. Lang. November 23, 1953. 22p. diagrs., 4 tabs. (AAEE/Inst/91)

A Youngman-Hughes stall warning device was tested on a Nene Viking. The device depends for operation on the changes in pressure distribution around the lower surface of the leading edge of the wing as the stall is approached. The installation operated satisfactorily. Though it was tested on the Nene Viking, the device should be applicable to other aircraft. It should give suitable warning of the low altitude, slow speed stall, that is for the condition where adequate warning is imperative.

N-30184*

Royal Aircraft Establishment (Gt. Brit.) THE DETERMINATION OF SIZE ON GLASS FABRICS: A STATISTICAL ANALYSIS. A. A. Fyall and E. W. Russell. December 1953. 21p. 23 tabs. (RAE Tech. Note Chem. 1212)

The apparently simple determination of organic size on glass fabrics for the preparation of polyester laminates was examined in a statistical experiment after interlaboratory disagreements. Five observers at three different laboratories examined six fabric samples including both low and high alkali glasses. The results are analyzed and recommendations are made for improving the test procedure.

UNPUBLISHED PAPERS

N-29532*

RECORDED PRESSURE DISTRIBUTION IN THE OUTER PORTION OF A TORNADO VORTEX. William Lewis and Porter J. Perkins. (Reprint from Monthly Weather Review, v. 81, no. 12, December 1953, p. 379-385)

This tornado took place on June 8, 1953 and passed through a portion of the Lewis Flight Propulsion Laboratory. Eight barographs were in operation at various locations within the laboratory at the time. Records are presented from nine barographs located in a small area close to the path of a tornado. The pressure profile in the range from 720 to 2,300 feet from the path of the tornado center as determined from the barograph records was found to be in good agreement with calculations based on a simple model consisting of a frictionless vortex with in-flow.

N-29586*

Clarkson College of Technology.
THE SIZE AND SHAPE OF COLLOIDAL PARTICLES BY LIGHT SCATTERING. Milton Kerker. December 31, 1953. 58p. diagrs., photos., 10 tabs. (Clarkson College of Technology)

Results are given of an experimental investigation of the scattering and absorption of light by a system of nonspherical particles. The sol used was the hydrosol of vanadium pentoxide. Besides, being nonspherical, these particles are further characterized by their appreciable absorption of light. The sols were also studied by electron microscopy in order to correlate the scattering and absorption with the size and shape of the particles.

N-29587*

HEAT CONDUCTION IN LAMINATED SPHERICAL AND CYLINDRICAL BODIES. (Wärmeleitung in geschichteten kugel- und zylinderkörpern). V. Vodicka. 24p. (Trans. from Schweizer Archiv, Annales Suisses, v. 16, no. 10, October 1950, p. 297-304).

The problem of unsteady heat flow within spherical and cylindrical bodies each consisting of an indefinite number of concentric spherical or cylindrical laminae is solved. The postulated conditions are: that the successive laminae are in perfect thermal contact; that the innermost surface (which may have a zero radius) is impermeable to heat; that a fixed, finite heat-transfer coefficient exists at the outer surface; and that an arbitrary known temperature distribution exists in the body initially. All of the necessary mathematical relations are worked out, including relations required to determine the coefficients appearing in the solution equations, but no numerical examples are given.

N-29598*

VORTEX FLOW IN AXIAL MACHINES. (Écoulements tourbillonnaires dans les machines axiales). R. Siestrunck and J. Fabri. 83p. diagrs. (Trans. from Office National d'Études et de Recherches Aéronautiques. Pub. 45).

Properties of rotational motion in axial machines and of an incompressible fluid in a cylindrical duct are discussed. The stream function describing the evolution of the fluid motion is used systematically. The Prandtl reduction of the blades to lifting lines is retained. Several linearized solutions for a compressible fluid are given which show that the general equations for incompressible flow, linearized, do not lead to inextricable calculations. Examples given are for cylindrical and convergent ducts.

DECLASSIFIED REPORTS

NACA RM E50D10 not in vau

AERODYNAMIC CHARACTERISTICS OF NACA RM-10 MISSILE IN 8- BY 6-FOOT SUPERSONIC WIND TUNNEL AT MACH NUMBERS FROM 1.49 TO 1.98. I - PRESENTATION AND ANALYSIS OF PRESSURE MEASUREMENTS (STABILIZING FINS REMOVED). Roger W. Luidens and Paul C. Simon. July 20, 1950. 53p. diagrs., photos. (NACA RM E50D10) (Declassified from Confidential, 3/10/54)

Experimental investigation of flow about a slender body of revolution (NACA RM-10 missile) alined and inclined to a supersonic stream was conducted at Mach numbers from 1.49 to 1.98 at a Reynolds number of approximately 30,000,000. Boundary-layer measurements at zero angle of attack are correlated with subsonic formulations for predicting boundary-layer thickness and profile. Comparison of pressure coefficients predicted by theory with experimental values showed close agreement at zero angle of attack and angle of attack except over the aft leeward side of body. At angle of attack, pitot pressure measurements in plane of model base indicated a pair of symmetrically disposed vortices on leeward side of body.

NACA RM L50L13 declassified

A FINITE-STEP METHOD FOR THE CALCULATION OF SPAN LOADINGS OF UNUSUAL PLAN FORMS. George S. Campbell. July 16, 1951. 34p. diagrs., 4 tabs. (NACA RM L50L13) (Declassified from Confidential, 3/10/54)

The applicability of a finite-step method to the calculation of subsonic spanwise load distribution, lift-curve slope, lateral center of pressure, and aerodynamic center of unusual plan forms has been investigated. Computing forms are presented to simplify calculation of span loadings for conventional swept, M plan-form, and W plan-form wings. Tables of the downwash in the plane of a yawed vortex are presented. Span loadings have been compared with those obtained by Falkner and Weissinger for several plan forms. The effect of an extra vortex located near the tip, the use of yawed vortices, and the number of steps necessary are discussed in the light of calculated results.

Declassified

NACA RM L51E29

CALCULATED AERODYNAMIC LOADINGS OF M, W, AND Λ WINGS IN INCOMPRESSIBLE FLOW. Franklin W. Diederich and W. Owen Latham. August 30, 1951. 58p. diagrs., tab. (NACA RM L51E29) (Declassified from Confidential, 3/10/54)

Presented are the results of theoretical incompressible flow calculations of the spanwise lift distributions and some associated aerodynamic parameters of 20 M, W, and Λ wings. These results are compared with similarly calculated results for ordinary swept and unswept wings.

not in vault

NACA RM L51E31

PRELIMINARY EXPERIMENTAL INVESTIGATION OF FLUTTER CHARACTERISTICS OF M AND W WINGS. Robert W. Herr. August 8, 1951. 31p. diagrs., photos., tab. (NACA RM L51E31) (Declassified from Confidential, 3/10/54)

Results of nine experimental flutter tests are presented to give a comparison of the flutter characteristics of wings having M and W type plan forms. A technique is also presented whereby the natural vibration mode shapes of the model wings are obtained photographically.

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1131

DEFLECTION AND STRESS ANALYSIS OF THIN SOLID WINGS OF ARBITRARY PLAN FORM WITH PARTICULAR REFERENCE TO DELTA WINGS. Manuel Stein, J. Edward Anderson and John M. Hedgepeth. 1953. ii, 20p. diagrs., photo. (NACA Rept. 1131. Formerly TN 2621)

The structural analysis of arbitrary solid cantilever wings by small-deflection thin-plate theory is reduced to the solution of linear ordinary differential equations by the assumption that the chordwise deflections at any spanwise station may be expressed in the form of a power series in which the coefficients are functions of the spanwise coordinate. Experimental deflection and stress data for constant-thickness delta-plate specimens of 45° and 60° sweep are presented and are found to compare favorably with the present theory.

NACA Rept. 1137

INITIAL RESULTS OF INSTRUMENT-FLYING TRIALS CONDUCTED IN A SINGLE-ROTOR HELICOPTER. Almer D. Crim, John P. Reeder and James B. Whitten. 1953. ii, 7p., diagrs., photos. (NACA Rept. 1137. Formerly TN 2721.)

Instrument-flying trials were conducted in a single-rotor helicopter, the maneuver stability of which could be changed from satisfactory to unsatisfactory. Results indicated that existing longitudinal flying-qualities requirements based on contact flight were adequate for instrument flight at speeds above that for minimum power. Lateral-directional problems were encountered at low speeds. The conclusion was reached that special helicopter instruments would be desirable under all conditions and necessary for sustained low-speed instrument flight.

NACA Rept. 1138

STUDY OF INADVERTENT SPEED INCREASES IN TRANSPORT OPERATION. Henry A. Pearson. 1953. ii, 11p. diagrs., tab. (NACA Rept. 1138. Formerly TN 2638)

Factors relating to inadvertent speed and Mach number increases in transport operation are discussed with the object of indicating the manner in which they might vary with different qualities of the airplane and the minimum margins required to guard against reaching unsafe values. Speed increments and the margins required under several assumed conditions are investigated. Results indicate that smaller margins should be required of high-speed airplanes than of low-speed airplanes to prevent overspeeding in inadvertent maneuvers. The possibility of exceeding placard speed in prolonged descents is illustrated by computations for typical transport airplanes. Equations are suggested that allow estimates to be made of the necessary speed margins.

NACA Rept. 1147

THE SIMILARITY LAW FOR HYPERSONIC FLOW AND REQUIREMENTS FOR DYNAMIC SIMILARITY OF RELATED BODIES IN FREE FLIGHT. Frank M. Hamaker, Stanford E. Neice and Thomas J. Wong. 1953. ii, 11p. diagrs. (NACA Rept. 1147. Formerly TN 2443; TN 2631)

The similarity law for nonsteady, inviscid, hypersonic flow about slender three-dimensional shapes is derived. Conclusions drawn are shown to be valid for rotational flow. Requirements for dynamic similarity of related shapes in free flight are obtained. The law is examined for steady flow about related three-dimensional shapes. Results of an experimental investigation of the pressures acting on two inclined cones are found to check the law as it applies to bodies of revolution.

NACA RM E53L31a

INVESTIGATION OF EFFECT OF NOTCHES ON ELEVATED-TEMPERATURE FATIGUE STRENGTH OF N-155 ALLOY. C. A. Hoffman. April 1954. 8p. diagrs., tab. (NACA RM E53L31a)

An investigation of the effect of notches on the fatigue strength of N-155 alloy at elevated temperatures was conducted by the NACA in cooperation with the Gas Turbine Panel of the joint A.S.T.M.-A.S.M.E. Committee on Effects of Temperature on the Properties of Metals. Studies were made at 1350° and 1500° F in completely reversed bending. The results on relatively few specimens indicated that: (a) Notches reduced fatigue strength at 1350° F by approximately 34 to 40 percent and at 1500° F by approximately 30 to 37 percent over the range of 3 to 150 hours, and (b) the notch sensitivity in fatigue under conditions of completely reversed bending at 1350° and 1500° F was considerably less than that predicted for static bending under elastic conditions.

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NACA TN 3076

LIFT AND MOMENT COEFFICIENTS EXPANDED TO THE SEVENTH POWER OF FREQUENCY FOR OSCILLATING RECTANGULAR WINGS IN SUPERSONIC FLOW AND APPLIED TO A SPECIFIC FLUTTER PROBLEM. Herbert C. Nelson, Ruby A. Rainey and Charles E. Watkins. April 1954. 53p. diagrs. (NACA TN 3076)

Linearized theory for compressible unsteady flow is used to derive the velocity potential and lift and moment coefficients in the form of power series in terms of the frequency of oscillation for a harmonically oscillating rectangular wing moving at a constant supersonic speed. Closed expressions for the velocity potential and lift and moment coefficients associated with pitching and translation are given to the seventh power of the frequency. These expressions extend the range of usefulness of NACA Report 1028 in which similar expressions were derived to the third power of the frequency of oscillation. The section and total lift and moment coefficients are discussed with the aid of several figures. In addition, flutter speeds obtained in the Mach number range from 10/9 to 10/6 for a rectangular wing of aspect ratio 4.53 by using section coefficients derived on the basis of three-dimensional flow are compared with flutter speeds for this wing obtained by using coefficients derived on the basis of two-dimensional flow.

NACA TN 3078

TRANSIENT TEMPERATURES IN HEAT EXCHANGERS FOR SUPERSONIC BLOWDOWN TUNNELS. Joseph H. Judd. April 1954. 35p. diagrs., 2 tabs. (NACA TN 3078)

A method has been presented for the computation of tube and fluid temperatures for fluid flowing through heat exchangers of the heat-accumulator type in which the temperatures are low enough so that radiation may be neglected. Three entrance air conditions were considered, constant temperature, exponentially decreasing temperature, and linearly decreasing temperature. Agreement was found between experimental and computed tube and air temperatures for inlet air at constant temperature and at atmospheric pressure.

NACA TN 3084

A METHOD FOR MEASURING THE PRODUCT OF INERTIA AND THE INCLINATION OF THE PRINCIPAL LONGITUDINAL AXIS OF INERTIA OF AN AIRPLANE. Robert W. Boucher, Drexel A. Rich, Harold L. Crane and Cloyce E. Matheny. April 1954. 39p. diagrs., photos., 6 tabs. (NACA TN 3084)

An analysis has been made of a method for experimentally determining the moments of inertia and the product of inertia about the body reference axes, the moments of inertia about the principal axes, and the inclination of the principal longitudinal axis. The results of the application of this method and the associated equipment and techniques are discussed for both a simple model and a conventional airplane.

NACA TN 3085

AN EXPERIMENTAL STUDY OF POROSITY CHARACTERISTICS OF PERFORATED MATERIALS IN NORMAL AND PARALLEL FLOW. George M. Stokes, Don D. Davis, Jr. and Thomas B. Sellers. April 1954. 24p. diagrs., photos. (NACA TN 3085. Formerly RM L53H07)

Experimental data have been obtained to show some of the flow characteristics of perforated materials when subjected to airstreams directed normal and parallel to the surface of the material. The results of these tests showed that the effective porosity of the material dropped markedly as the stream velocity increased. The most important parameter for determining the discharge coefficients of the perforated material was the ratio of the stream velocity to the free jet velocity.

NACA TN 3110

TRENDS OF ROLLING-CONTACT BEARINGS AS APPLIED TO AIRCRAFT GAS-TURBINE ENGINES. (Papers presented at the SAE Summer Meeting, Atlantic City, N.J., 1952). Panel on High-Speed Rolling-Contact Bearings. Appendix A. PROBLEMS PERTAINING TO HIGH-SPEED ROLLING-CONTACT AIRCRAFT BEARINGS OF CONCERN TO THE BEARING INDUSTRY. Daniel Gurney, Marlin-Rockwell Corp. Appendix B. PROBLEMS PERTAINING TO HIGH-SPEED ROLLING-CONTACT BEARINGS IN AIRCRAFT TURBINE ENGINES OF CONCERN TO THE MILITARY. C. M. Michaels, Wright Air Development Center. Appendix C. ROLLING-CONTACT BEARINGS AS APPLIED TO AIRCRAFT GAS TURBINES FROM THE ENGINE MANUFACTURER'S POINT OF VIEW. Stephen Drabek, General Electric Co. Appendix D. NEW DEVELOPMENTS IN HIGH-SPEED ROLLING-CONTACT BEARINGS. Frank W. Wellons, SKF Industries, Inc. Appendix E. BASIC FRICTION AND WEAR STUDIES OF ROLLING-CONTACT-BEARING CAGE MATERIALS. Robert L. Johnson, Max A. Swikert and Edmond E. Bisson. Appendix F. PRESENT STATUS OF RESEARCH KNOWLEDGE IN THE FIELD OF HIGH-SPEED ROLLING-CONTACT BEARINGS. E. F. Macks. April 1954. (ii), 62p. diagrs., photos. (NACA TN 3110)

Requirements for rolling contact bearings for future aircraft gas-turbine engines are severe. Operating temperatures to 750° F, thrust loads to 50,000 pounds, and DN values to 3.5×10^6 are desired. Cage material compatibility, bearing endurance life, high-temperature lubricants, and lubricant cooling are expected to be the major problems. These and related problems are discussed from the viewpoints of the bearing industry, engine manufacturers, and the military. Some recent research results are given, and the need for further research on an expanded scale is emphasized.

NACA TN 3128

COMPARISON BETWEEN THEORY AND EXPERIMENT FOR INTERFERENCE PRESSURE FIELD BETWEEN WING AND BODY AT SUPERSONIC SPEEDS. William C. Pitts, Jack N. Nielsen and Maurice P. Gionfriddo. April 1954. 64p. diagrs., 2 tabs. (NACA TN 3128)

Pressure-distribution data were obtained for a wing-body combination at Mach numbers 1.48 and 2.00 and at Reynolds numbers 0.6, 1.2, and 1.5 x 10^6. The model was a single-wedge, rectangular wing mounted on a cylindrical body with an ogival nose. The body angle of attack ranged between $+6^o$ and -6° and the wing-incidence angle ranged from 0° to -5.7^o. The experimental pressure-distribution and span-loading results are compared with the linear, wing-body interference theory of NACA TN 2677.

NACA TN 3146

NOTE ON THE AERODYNAMIC HEATING OF AN OSCILLATING SURFACE. Simon Ostrach. April 1954. 12p. (NACA TN 3146)

An analysis of the temperature distributions in a fluid over an oscillating surface with heat transfer is made and associated heat-transfer parameters are compared with those for the case of conduction at a stationary surface with the same initial temperature potential. It is found that the heat transfer for the oscillating surface can be considerably different from that for conduction alone. The effect of the surface oscillations on the thermal state of the fluid is studied by means of average static- or total-temperature defects, and it is demonstrated that the oscillations could alter the fluid temperature appreciably.

NACA TN 3165

PRELIMINARY INVESTIGATION OF THE EFFECTS OF HEAT TRANSFER ON BOUNDARY-LAYER TRANSITION ON A PARABOLIC BODY OF REVOLUTION (NACA RM-10) AT A MACH NUMBER OF 1.61. K. R. Czarnecki and Archibald R. Sinclair. April 1954. 23p. diagrs., photos., tab. (NACA TN 3165. Formerly RM L52E29a)

This paper presents the results of a preliminary investigation of the effects of heat transfer on boundary layer transition on a parabolic body of revolution (NACA RM-10) at Mach number of 1.61. This paper includes also a study of the effectiveness of cooling on boundary-layer transition with model surface roughened and a comparison of the results obtained in this investigation with other available theoretical and experimental data.

NACA TN 3166

AN EXTENSION OF THE INVESTIGATION OF THE EFFECTS OF HEAT TRANSFER ON BOUNDARY-LAYER TRANSITION ON A PARABOLIC BODY OF REVOLUTION (NACA RM-10) AT A MACH NUMBER OF 1.61. K. R. Czarnecki and Archibald R. Sinclair. April 1954. 21p. diagrs., photo. (NACA TN 3166. Formerly NACA RM L53B25)

This paper covers the extension of a previous investigation of the effects of heat transfer on boundary-layer transition to higher Reynolds numbers, to greater amounts of heating, and to a more extensive study of the effects of surface roughness and wind-tunnel flow disturbances. The tests were made at a Mach number of 1.6 and over a Reynolds number range from 2.5 x 10^6 to 35 x 10^6. A comparison is made between the experimental results and theory.

NACA TN 3170

AN EXPERIMENTAL INVESTIGATION AT LOW SPEEDS OF THE EFFECTS OF LIP SHAPE ON THE DRAG AND PRESSURE RECOVERY OF A NOSE INLET IN A BODY OF REVOLUTION. James R. Blackaby and Earl C. Watson. April 1954. 48p. diagrs., photos. (NACA TN 3170)

A low-speed investigation, for an angle of attack and angle of yaw of 0°, was made of the effects of inlet lip bluntness and profile on the performance of a ducted body of revolution. A sharp inlet lip profile was tested in addition to five circular-arc profiles having contraction ratios (ratio of area at inlet leading edge to minimum inlet area) of about 1.04, 1.08, 1.16, 1.24, and 1.33, and two lips with elliptical internal profiles and approximately elliptical external profiles having contraction ratios of about 1.08 and 1.18.

NACA TN 3172

EFFECTS OF LEADING-EDGE RADIUS AND MAXIMUM THICKNESS-CHORD RATIO ON THE VARIATION WITH MACH NUMBER OF THE AERODYNAMIC CHARACTERISTICS OF SEVERAL THIN NACA AIRFOIL SECTIONS. Robert E. Berggren and Donald J. Graham. April 1954. 65p. diagrs., 7 tabs. (NACA TN 3172. Formerly RM A50D04)

The results of a wind-tunnel investigation at Mach numbers to approximately 0.9 and Reynolds numbers from 1 x 10^6 to 2 x 10^6 indicate no significant effects of leading-edge-radius variation on the variation with Mach number of the aerodynamic characteristics of 4- and 6-percent-chord-thick NACA 4-digit-series airfoil sections. The results indicate beneficial effects of maximum thickness reduction on lift and drag characteristics and no important effects on moment characteristics.

BRITISH REPORTS

N-28442*

SURFACE DEFECTS IN VENEERING. R. J. Newall, Forest Products Laboratory. (Reprint from Wood, v. 18, December 1953, p. 462-465)

Examination of defective veneering shows that there are two main types of defect: (1) checking or cracking of the veneered surface and (2) shallow furrows in the surface. These defects are discussed in detail and suggestions are made for their elimination. It is indicated that the cause of the defects is that the moisture content of the base material might be too high when the veneer is applied.

N-30304*

National Gas Turbine Establishment (Gt. Brit.) A CORRELATION OF THE PERFORMANCE OF TWO AIR BLAST ATOMISERS WITH MIXING SECTIONS OF DIFFERENT SIZE. A. Radcliffe and H. Clare. October 1953. 39p. diagrs., tab. (NGTE R. 144)

The work on the N.G.T.E. air blast atomizer has been extended and the effect of increasing the orifice diameter has been examined. It is shown that the main factor controlling atomization is the air:fuel ratio and that when this is 0.1 the Sauter mean diameter is about 100 microns. This is for fuel of viscosity 20 to 40 centistokes. The droplet size increases approximately as the square root of the linear dimensions of the orifice and mixing section.

N-30305*

National Gas Turbine Establishment (Gt. Brit.)
CALCULATED PRESSURE, AREA AND IMPULSE RATIOS FOR SUPER-CRITICAL EXPANSION OF COMBUSTION GASES. A. B. P. Beeton. November 1953. 31p. diagrs., 3 tabs. (NGTE R. 145)

Expansion conditions beyond the throat of convergent-divergent exit nozzles are studied. Assuming isentropic flow, theoretical values have been calculated relating the flow area, impulse and pressure for combustion gases expanded down to supercritical pressure ratios. The results are expressed in the form of two master curves which apply to 20:1 air/fuel ratio, 450° K initial air temperature and 1 atmosphere total pressure. Additional curves are given to derive an additive correction for any air/fuel ratio between 10:1 and 50:1. The range covered is from the throat down to about 12:1 pressure ratio.

N-30307*

National Gas Turbine Establishment (Gt. Brit.)
THE FATIGUE PROPERTIES OF INVESTMENT-CAST 0.2 PER CENT CARBON, 18 PER CENT CHROMIUM, 2 PER CENT NICKEL STAINLESS STEEL AND THEIR IMPROVEMENT BY NITRIDING AND SHOT-PEENING. T. Fitzgerald and J. E. Northwood. October 1953. 46p. diagrs., photos., 6 tabs. (NGTE Memo. M. 162)

Low fatigue properties have been obtained with the 0.2-percent carbon, 18-percent chromium, 2-percent nickel stainless steel in the investment cast and heat treated condition. Attempts have been made to improve its fatigue strength by processes which increase the endurance ratio, without any serious effect on tensile properties and ductility. Fatigue tests have shown that nitriding or shot-peening can be used to increase the fatigue strength of investment cast blades to a level on a par with that of the wrought material. The increase in fatigue strength brought about by either of these processes was partly controlled by the condition of the metal surface prior to treatment, increases in fatigue strength of up to 40 percent above that of the "as cast" surface condition being obtained by nitriding or peening the surfaces of buffed or electrolytically polished blades and test pieces.

N-30309*

Aeronautical Research Council (Gt. Brit.)
LIQUID MANOMETERS WITH HIGH SENSITIVITY AND SMALL TIME-LAG. F. A. MacMillan. August 14, 1953. 14p. diagrs., photos. (ARC 16,091; TP 404; FM 1941)

For some purposes a sensitive manometer is required having a small time lag when connected to a small bore tube or orifice. The time lag which can be tolerated is limited by the rate of change of the zero reading. Some problems in the design of a manometer with small time lag and small rate of change of zero reading are discussed, and some general principles of design are derived. It is shown that with a null-reading inclined-tube manometer, changes of zero reading due to variation of temperature can be eliminated by correct choice of the manometer dimensions. A manometer designed according to the principles derived is described; this has a small time lag, a range of 2.5 cm of liquid, and a sensitivity of 0.0005 cm of liquid.

UNPUBLISHED PAPERS

N-19795*

THE CURRENT FORCE FOR PARALLEL AND CONCENTRIC CONDUCTORS. (Die Stromkraft bei parallelen und konzentrischen Leitern). Wilhelm Beetz. April 1954. 10p. diagrs. (Trans. from Elektrotechnik und Maschinenbau, v. 48, no. 33, August 1930, p. 761-763)

The repellent force for parallel and concentric conductors is calculated by substitution of an "effective distance" instead of the actual distance into the formula valid for dimensionless conductors. The influence of the current displacement in case of technical frequencies is discussed.

N-29585*

FATIGUE TESTS ON MULTIPLE-RIVETED JOINTS OF 75 S-T ALUMINUM ALLOY. (Utmattningsprov Pa Flerradigt Nitförband Av Material 75 S). Gunnar Wallgren. March 1954. 15p. diagrs., 2 tabs. (Trans. from Flygtekniska Försöksanstalten, Stockholm, February 21, 1947, Rept. HU-220)

Wöhler curves were determined for two types of riveted joints of 75-ST aluminum alloy under pulsating tension load. The static breaking limit of the joints was also determined.

N-29811*

PRESSURE ERRORS IN PNEUMATIC MEASURING INSTALLATIONS IN FLIGHT TESTS AND IN THE WIND TUNNEL. (Druckfälschung in pneumatischen Messanlagen im Flugversuch und im Windkanal). Helmut Danielzig. April 1954. 65p. diagrs., 9 tabs. (Trans. from ZWB, Berlin, FB 1907, December 8, 1943)

A theoretical method is developed which makes it possible for the engineer working in flight measurements to estimate pneumatically measured quantities like dynamic pressure, static pressure, angle of attack, or angle of sideslip with respect to the error caused by tube friction which is inherent in the measuring method. The theoretical results given in this report have been compared to examples from flight-measurement operation and from wind tunnels.

MISCELLANEOUS

NACA Rept. 1147

Errata No. 1 on "THE SIMILARITY LAW FOR HYPERSONIC FLOW AND REQUIREMENTS FOR DYNAMIC SIMILARITY OF RELATED BODIES IN FREE FLIGHT." Frank M. Hamaker, Stanford E. Neice and Thomas J. Wong. 1953.

NACA RM L53E07b

Errata No. 1 on "ANALYTICAL STUDY OF CLOCKAGE- AND LIFT-INTERFERENCE CORRECTIONS FOR SLOTTED TUNNELS OBTAINED BY THE SUBSTITUTION OF AN EQUIVALENT HOMOGENEOUS BOUNDARY FOR THE DISCRETE SLOTS." Don D. Davis, Jr. and Dewey Moore. June 29, 1953.

DECLASSIFIED NACA REPORTS

NACA RM L8J06

NACA TRANSONIC WIND-TUNNEL TEST SECTIONS. Ray H. Wright and Vernon G. Ward. October 25, 1948. 93p. diagrs., photos., 3 tabs. (NACA RM L8J06) (Declassified from Confidential, 3/10/54)

An approximate subsonic theory has been developed for the solid blockage in a circular wind tunnel with walls slotted in the direction of flow. In tests of a tunnel based on this theory, a prediction of the theory regarding the possibility of practical elimination of the interference due to solid blockage has been realized. Choking limitations did not occur in the slotted tunnel, and it could be operated with continuous Mach number variation up to low supersonic Mach numbers merely by varying the power. Pressure distributions over the surface of a nonlifting model in the slotted tunnel were compared with those obtained over the same model in a much larger tunnel where the interference was negligible.

NACA RM L9D18

PRELIMINARY INVESTIGATION OF 3-INCH SLOTTED TRANSONIC WIND-TUNNEL TEST SECTIONS. George P. Bates. September 9, 1949. 18p. diagrs. (NACA RM L9D18) (Declassified from Confidential, 3/10/54)

An investigation has been made on two slotted test sections in a 3-inch circular blowdown apparatus to determine the characteristics of slotted throats for transonic and supersonic operation. One of the sections investigated had 20 slots, with 1/5-open wall area, while the other section had 8 slots and was 1/8 open.

NACA RM L9D29a

PRELIMINARY INVESTIGATION OF A VARIABLE MACH NUMBER TWO-DIMENSIONAL SUPERSONIC TUNNEL OF FIXED GEOMETRY. William J. Nelson and Frederick Bloetscher. June 9, 1949. 54p. diagrs., photos. (NACA RM L9D29a) (Declassified from Confidential, 3/10/54)

Variable Mach number supersonic flows have been generated in a 2-1/4 by 4-1/2 inch fixed-geometry rectangular channel by removal of air through longitudinal slots of several profiles and proportions. The nature of the flow over a range of Mach numbers up to 1.45 is shown in schlieren photographs and pressure distributions along the channel. The most uniform flow was produced by removal of air through a single slot in a flat surface.

NACA RM L50B01

PRELIMINARY INVESTIGATION OF CONSTANT-GEOMETRY, VARIABLE MACH NUMBER, SUPERSONIC TUNNEL WITH POROUS WALLS. William J. Nelson and Paul L. Klevatt. May 3, 1950. 27p. diagrs., photos. (NACA RM L50B01) (Declassified from Confidential, 3/10/54)

A method of generating variable Mach number supersonic flow in a channel of fixed geometry by the removal of air through uniform porous walls is discussed. Calculated porosity distributions are presented for several minimum-length nozzles designed to operate at Mach numbers up to 2.0. The axial pressure gradient has been calculated for several constant-porosity walls over a range of Mach numbers. The applicability of these calculations to a two-dimensional tunnel is illustrated by comparison of calculated and experimentally determined pressure gradients in the 2-1/4 by 4-1/2 inch channel at Mach numbers in the range covered in the present tests, 0.99 to 1.17. Schlieren photographs of the flow in the experimental channel are also presented.

NACA RM L50D27

PRELIMINARY INVESTIGATION OF POROUS WALLS AS A MEANS OF REDUCING TUNNEL BOUNDARY EFFECTS AT LOW-SUPERSONIC MACH NUMBERS. William J. Nelson and Frederick Bloetscher. September 13, 1950. 21p. diagrs., photos. (NACA RM L50D27) (Declassified from Confidential, 3/10/54)

The use of porous-walled tunnels at supersonic Mach numbers as a means of avoiding reflection of stream disturbance extending to the walls is discussed. Calculated shock-reflection characteristics of porous materials are presented in the form of design charts for Mach numbers up to 1.5 and incident shock deviations up to 6°. Shocks reflected from sintered-bronze and bonded-screen walls at a Mach number of 1.2 are consistent with the calculated reflections.

NACA RM L50G19a

PRELIMINARY INVESTIGATION OF REFLECTIONS OF OBLIQUE WAVES FROM A POROUS WALL. Don D. Davis, Jr. and George P. Wood. November 9, 1950. 33p. diagrs., photos. (NACA RM L50G19a) (Declassified from Confidential, 3/10/54)

A porous wall was used in an attempt to eliminate reflections of oblique waves from a tunnel wall. Calculations were made of the required resistance characteristics of a wall in order that the flow through the wall, due to the pressure difference across a shock wave, would equal the component normal to the wall of the flow behind the shock wave. The resistance characteristic of a sintered-bronze wall was measured and the reflections of waves impinging on the wall were observed at a Mach number of 1.62. The intensity of the reflections was greatly reduced by permitting flow through the wall.

NACA RM L51F14

COMPARISON OF TRANSONIC CHARACTERISTICS OF LIFTING WINGS FROM EXPERIMENTS IN A SMALL SLOTTED TUNNEL AND THE LANGLEY HIGH-SPEED 7- BY 10-FOOT TUNNEL. William C. Sleeman, Jr., Paul L. Klevatt and Edward L. Linsley. November 5, 1951. 44p. diagrs., photos. (NACA RM L51F14) (Declassified from Confidential, 3/10/54)

A comparison is made of the transonic aerodynamic characteristics of two unswept and two 45° swept-back wings tested in a 4.5- by 6.25-inch slotted tunnel over a Mach number range from 0.70 to 1.30 and the Langley high-speed 7- by 10-foot tunnel side-wall reflection plane up to $M = 1.08$. Two geometrically similar wings having a semispan of 4.24 and 2.55 inches for both sweep angles were tested to investigate effects of model size in the slotted tunnel. Two slot areas, 1/8 and 1/5 of the horizontal boundaries open, were used in the tests.

NACA RM L52C18

AN EXPERIMENTAL INVESTIGATION OF THE ZERO-LIFT PRESSURE DISTRIBUTION OVER A WEDGE AIRFOIL IN CLOSED, SLOTTED, AND OPEN-THROAT TUNNELS AT TRANSONIC MACH NUMBERS. William J. Nelson and Frederick Bloetscher. June 16, 1952. 34p. diagrs., photos. (NACA RM L52C18) (Declassified from Confidential, 3/10/54)

Pressure distributions and schlieren photographs of the flow about a 10-percent-thick diamond airfoil at zero lift in two-dimensional closed, slotted, and open-throat tunnels are presented and discussed. Uncorrected airfoil pressures obtained in 1/5- and 1/8-open slotted throat tunnels are compared at subsonic Mach numbers with corrected results from open and closed test sections of the same dimensions. The effect of varying the slot width has been investigated at Mach numbers up to 0.92. At Mach numbers up to 1.18, data obtained in test sections whose upper and lower boundaries were slotted to provide openings the combined width of which was equal to 1/8 of the tunnel width are shown to be consistent with theory and available experiments.

NACA RM L52E27

REFLECTION OF SHOCK WAVES FROM SLOTTED WALLS AT MACH NUMBER 1.62. George P. Wood. July 21, 1952. 16p. diagrs., photos. (NACA RM L52E27) (Declassified from Confidential, 3/10/54)

A brief study was made of the effect of slots in a test-section wall on the reflection from the wall of an incident oblique shock wave at a free-stream Mach number of 1.62. The reflection was observed with an interferometer for various combinations of slot width, spacing, and contour. The reflections from the open and closed portions of the wall, being at different angles to the wall, were not superposed and, therefore, did not cancel each other.

NACA RM L53A26

THEORETICAL STUDY OF THE TUNNEL-BOUNDARY LIFT INTERFERENCE DUE TO SLOTTED WALLS IN THE PRESENCE OF THE TRAILING-VORTEX SYSTEM OF A LIFTING MODEL. Clarence W. Matthews. April 7, 1953. 56p. diagrs. (NACA RM L53A26) (Declassified from Confidential, 3/10/54)

The equations which represent the interference on the lift of uniformly loaded wings of finite span in circular tunnels with mixed open and closed boundaries are derived, with special attention to those tunnels containing symmetrical arrangements of the open and closed portions. The equations are applicable to tunnels with other cross-sectional shapes, provided a transformation function can be found which will transform the tunnel cross section into a circle.

NACA RM L53E07b

ANALYTICAL STUDY OF BLOCKAGE- AND LIFT-INTERFERENCE CORRECTIONS FOR SLOTTED TUNNELS OBTAINED BY THE SUBSTITUTION OF AN EQUIVALENT HOMOGENEOUS BOUNDARY FOR THE DISCRETE SLOTS. Don D. Davis, Jr. and Dewey Moore. June 29, 1953. 57p. diagrs. (NACA RM L53E07b) (Declassified from Confidential, 3/10/54)

Numerical results are presented for the boundary interference on lifting wings and for the solid-blockage interference for a doublet on the tunnel axis in circular, rectangular, and two-dimensional slotted tunnels. In the analysis, an equivalent homogeneous wall has been substituted for the physical boundary of discrete slots. The results are found to be consistent with those calculated for the discrete slots and with available experimental results.

NACA RM A53E29

WALL INTERFERENCE IN WIND TUNNELS WITH SLOTTED AND POROUS BOUNDARIES AT SUBSONIC SPEEDS. Barrett S. Baldwin, Jr., John B. Turner and Earl D. Knechtel. October 9, 1953. 42p. diagrs. (NACA RM A53E29) (Declassified from Confidential, 3/10/54)

Linearized compressible-flow analysis is applied to the study of wind-tunnel-wall interference for subsonic flow in either two-dimensional or circular test sections having slotted or porous walls. Expressions are developed for evaluating blockage and lift interference.

National Advisory Committee for Aeronautics

Research Abstracts

NO.63 MAY 18, 1954

CURRENT NACA REPORTS

NACA Rept. 1125

DYNAMICS OF MECHANICAL FEEDBACK-TYPE HYDRAULIC SERVOMOTORS UNDER INERTIA LOADS. Harold Gold, Edward W. Otto and Victor L. Ransom. 1953. ii, 21p. diagrs., photos. (NACA Rept. 1125. Formerly TN 2767)

An analysis of the dynamics of mechanical feedback-type hydraulic servomotors under inertia loads is developed and experimental verification is presented. This analysis, which is developed in terms of two physical parameters, yields direct expressions for the following dynamic responses: (1) the transient response to a step input and the maximum cylinder pressure during the transient and (2) the variation of amplitude attenuation and phase shift with the frequency of sinusoidally varying input. Close agreement was obtained between analytically determined responses and measured responses.

NACA Rept. 1128

CALCULATIONS ON THE FORCES AND MOMENTS FOR AN OSCILLATING WING-AILERON COMBINATION IN TWO-DIMENSIONAL POTENTIAL FLOW AT SONIC SPEED. Herbert C. Nelson and Julian H. Berman. 1953. ii, 16p. diagrs., 2 tabs. (NACA Rept. 1128. Formerly TN 2590)

The linearized theory for compressible unsteady flow is used, as suggested in recent contributions to the subject, to obtain the velocity potential and the lift and moment for a thin, harmonically oscillating, two-dimensional wing-aileron combination moving at sonic speed. The velocity potential is derived by considering the sonic case as the limit of the linearized supersonic theory. The paper provides extensive tables of numerical values for the coefficients contained in the expressions for lift and moment, for various values of the reduced frequency $k(0 < k \leq 3.5)$ and aileron hinge position (from 10 to 90 percent of the wing chord).

NACA Rept. 1129

TRANSVERSE VIBRATIONS OF HOLLOW THIN-WALLED CYLINDRICAL BEAMS. Bernard Budiansky and Edwin T. Kruszewski. 1953. ii, 10p. diagrs. (NACA Rept. 1129. Formerly TN 2682)

The variational principle, differential equations, and boundary conditions considered appropriate to the analysis of transverse vibrations of hollow cylindrical beams are shown. General solutions for the modes and frequencies of cantilever and free cylindrical beams of arbitrary cross section but of uniform thickness are given. The combined influence of the secondary effects of transverse shear deformation, shear lag, and longitudinal inertia is shown in the form of curves for cylinders of rectangular cross section and uniform thickness. The contribution of each of the secondary effects to the total reduction in the actual frequency is also indicated.

NACA RM E54B08

APPLICATION OF PULSE TECHNIQUES TO STRAIN GAGES. Newell D. Sanders and George H. Brodie. May 1954. 17p. diagrs. (NACA RM E54B08)

Pulse techniques have been applied to strain gages for increasing the output level and extending the usable range. Bonded and unbonded strain gages which normally operate with exciting potentials between 3.5 and 14 volts were operated satisfactorily with 200-volt pulses of 1-microsecond duration and a repetition rate of 350 per second. Outputs 15 times greater than normal outputs were measured. A pulse-generating circuit and a pulse-detecting circuit are described. An analysis of pulsed operation of strain gages is given.

NACA RM E54B15

EFFECTS OF SOME METAL ADDITIONS ON PROPERTIES OF MOLYBDENUM DISILICIDE. H. A. DeVincentis and W. E. Russell. May 1954. 22p. diagrs., photos., 6 tabs. (NACA RM E54B15)

The effect of the addition of approximately 6 percent nickel, cobalt, or platinum on some properties of molybdenum disilicide was investigated. These additions resulted in appreciably lowering the modulus-of-rupture strength from that of unalloyed molybdenum disilicide. The thermal shock resistance was unimproved. The resistance to oxidation was decreased at higher temperatures. It is believed that above 2000° and 2400° F the nickel and cobalt alloys, respectively, formed low-melting intermetallics and possibly eutectics between these intermetallics. This resulted in considerable porosity. No uncombined metal could be detected in either hot-pressed or heat-treated material. In the platinum-containing bodies, uncombined metal was detected after hot pressing. The concentration of uncombined metal decreased as a result of heat treatment, and after treatment at the higher temperatures, could not be detected.

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NACA RM E54B19

VARIATION OF SPONTANEOUS IGNITION DELAYS WITH TEMPERATURE AND COMPOSITION FOR PROPANE-OXYGEN-NITROGEN MIXTURES AT ATMOSPHERIC PRESSURE. Joseph L. Jackson and Richard S. Brokaw. May 1954. 29p. diagrs., 4 tabs. (NACA RM E54B19)

The ignition delays of propane-oxygen-nitrogen mixtures as a function of temperature and composition have been determined in a flow system. The variation of the ignition lag τ at constant temperature can be represented by the equation

$$1/\tau = k\left[C_3H_8\right]\left[O_2\right]^{1/4}$$

where k is a constant. The temperature dependence of this equation over the range investigated (525° to 740° C) is given within 30 percent by the empirical equation:

$$\tau\left[C_3H_8\right]\left[O_2\right]^{1/4} = 0.030 + 5.4 \times 10^{-9}\, e^{14,500/T}$$

with concentrations expressed as mole fractions and temperature as degrees Kelvin.

NACA RM E54C05

EFFECT OF CHANNEL GEOMETRY ON THE QUENCHING OF LAMINAR FLAMES. A. L. Berlad and A. E. Potter, Jr. May 1954. 32p. diagrs., tab. (NACA RM E54C05)

The effect of channel geometry on flame quenching, as calculated on the basis of average active particle chain lengths, is related among six different geometries: plane parallel plates of infinite extent, cylindrical tubes, rectangular slots, cylindrical annuli, and tubes of elliptical and equilaterally triangular shape. Experimental determination of the quenching behavior of propane-air flames over an equivalence-ratio range of 0.82 to 1.30 was made for a series of rectangular slots, cylindrical annuli, and cylindrical tubes in the pressure range 0.08 to 1.0 atmosphere. Ten rectangular-slot geometries covering a length-to-width ratio range of 1:1 to 33.3:1, nine cylindrical annulus geometries covering a diameter-ratio range of 1.33:1 to 25:1, and four cylinder diameters were investigated. Generally good agreement between theory and experiment was found for both rich and lean flames. The average deviation of the predicted quenching distances from the observed ones is 4.3 percent for equivalence ratios less than or equal to unity and 8.6 percent for equivalence ratios greater than unity. These deviations are generally systematic, rather than random. It was also found that relatively small cold surfaces may, when flame immersed, exhibit very large quenching effects.

NACA TN 3067

ROLLING EFFECTIVENESS AND AILERON REVERSAL OF RECTANGULAR WINGS AT SUPERSONIC SPEEDS. John M. Hedgepeth and Robert J. Kell. April 1954. 79p. diagrs., 4 tabs. (NACA TN 3067)

Linearized supersonic lifting-surface theory is used in conjunction with structural influence coefficients to formulate a method for analyzing the aeroelastic behavior in roll at supersonic speeds of a rectangular wing mounted on a cylindrical body. Rolling effectiveness and aileron reversal speed are computed by using a numerical solution which incorporates matrices. Results obtained for an example configuration by using this method are compared with the results obtained by using simplified methods of analysis. For the particular configuration considered, the variation of rolling effectiveness with Mach number is found for two constant-altitude flights.

NACA TN 3086

MANEUVER ACCELERATIONS EXPERIENCED BY FIVE TYPES OF COMMERCIAL TRANSPORT AIRPLANES DURING ROUTINE OPERATIONS. Thomas L. Coleman and Martin R. Copp. April 1954. 26p. diagrs., 3 tabs. (NACA TN 3086)

The magnitude and frequency of occurrence of maneuver accelerations experienced by five types of commercial transport airplanes during routine operations obtained from time-history (VGH) records are presented. The results are compared with available gust-acceleration data for the operations considered.

NACA TN 3141

COMBINED NATURAL- AND FORCED-CONVECTION LAMINAR FLOW AND HEAT TRANSFER OF FLUIDS WITH AND WITHOUT HEAT SOURCES IN CHANNELS WITH LINEARLY VARYING WALL TEMPERATURES. Simon Ostrach. April 1954. 74p. diagrs., 2 tabs. (NACA TN 3141)

The flow of fluids with and without heat sources and subject to body forces between two plane parallel surfaces which are oriented in the direction of the generating body force is analyzed under the condition that the temperature vary linearly along these surfaces. Solutions of this problem are obtained in terms of "universal" functions which are tabulated for simple application to specific cases. Representative velocity and temperature distributions from which detailed study of the heat transfer is made are then computed. It is found that under certain conditions the effects of aerodynamic or frictional heating can be appreciable. Asymptotic solutions (for large values of the Rayleigh number) which render the computations simple are also presented. Comparison of the results from the method given herein with those obtained elsewhere in an approximate manner for a special case simulating the natural-convection flow of fluids with heat sources in a completely enclosed region shows that the approximate method is sufficiently accurate for problems in which the modified Rayleigh number is less than 10^4.

NACA TN 3145

ANALYSIS OF TURBULENT HEAT TRANSFER, MASS TRANSFER, AND FRICTION IN SMOOTH TUBES AT HIGH PRANDTL AND SCHMIDT NUMBERS. Robert G. Deissler. May 1954. 53p. diagrs. (NACA TN 3145)

The expression for eddy diffusivity from a previous analysis was modified in order to account for the effect of kinematic viscosity in reducing the turbulence in the region close to a wall. By using the modified expression, good agreement was obtained between predicted and experimental results for heat and mass transfer at Prandtl and Schmidt numbers between 0.5 and 3000. The effects of length-to-diameter ratio and of variable viscosity were also investigated for a wide range of Prandtl numbers.

NACA TN 3147

IMPINGEMENT OF WATER DROPLETS ON AN ELLIPSOID WITH FINENESS RATIO 10 IN AXISYMMETRIC FLOW. Rinaldo J. Brun and Robert G. Dorsch. May 1954. 37p. diagrs., tab. (NACA TN 3147)

The presence of radomes and instruments that are sensitive to water films or ice formations in the nose section of all-weather aircraft and missiles necessitates a knowledge of the droplet impingement characteristics of bodies of revolution. Because it is possible to approximate many of these bodies with an ellipsoid of revolution, droplet trajectories about an ellipsoid of revolution with a fineness ratio of 10 were computed for incompressible axisymmetric air flow. From the computed droplet trajectories, the following impingement characteristics of the ellipsoid surface were obtained and are presented in terms of dimensionless parameters: (1) total rate of water impingement, (2) extent of droplet impingement zone, and (3) local rate of water impingement. These impingement characteristics are compared briefly with those for an ellipsoid of revolution with a fineness ratio of 5 reported in NACA TN 3099.

NACA TN 3160

A CALCULATION STUDY OF WING-AILERON FLUTTER IN TWO DEGREES OF FREEDOM FOR TWO-DIMENSIONAL SUPERSONIC FLOW. Donald S. Woolston and Vera Huckel. April 1954. 26p. diagrs., tab. (NACA TN 3160)

Results are presented of some sample calculations made for the bending-aileron and torsion-aileron flutter of a wing-aileron system of infinite aspect ratio for several values of Mach number in supersonic flow and also for some subsonic Mach numbers. It is pointed out that the results are subject to various limitations and are not intended to be applicable to a particular configuration. They may serve, however, to provide a preliminary knowledge of the influence of variations in certain parameters and to indicate some of the differences in trends exhibited by the calculations for high speeds and those known to exist for low speeds.

NACA TN 3179

A THEORETICAL INVESTIGATION OF THE HEATING-UP PERIOD OF INJECTED FUEL DROPLETS VAPORIZING IN AIR. M. M. El Wakil, O. A. Uyehara and P. S. Myers, University of Wisconsin. May 1954. 83p. diagrs., tab. (NACA TN 3179)

Theoretical calculations were performed to determine whether the unsteady state, or the time during which the droplet is heating up or cooling down to the wet-bulb temperature, is of importance when single fuel droplets are vaporizing under conditions of interest in jet engines. The calculations were performed for droplets of different size and fuel composition under different ambient air conditions and the results are presented in the form of temperature-, mass-, and penetration-time histories as well as heat and mass transfer histories of single droplets. Experimental apparatus set up in an attempt to verify the importance of the unsteady state is described and a few experimental curves are presented.

NACA TN 3183

MINIMUM-WAVE-DRAG AIRFOIL SECTIONS FOR ARROW WINGS. Morton Cooper and Frederick C. Grant. May 1954. 26p. diagrs., 5 tabs. (NACA TN 3183)

A linearized theoretical analysis has been made to determine minimum-wave-drag airfoil sections for arrow wings at supersonic speeds. The drag was minimized subject to the conditions of either a given thickness ratio at a specified chordwise location or a given volume. Numerical computations were performed for a delta wing and an arrow wing having a ratio of the tangent of the trailing-edge sweep angle to the tangent of the leading-edge sweep angle of 0.4.

NACA TN 3184

BUCKLING OF LONG SQUARE TUBES IN COMBINED COMPRESSION AND TORSION AND COMPARISON WITH FLAT-PLATE BUCKLING THEORIES. Roger W. Peters. May 1954. 15p. diagrs., photo. (NACA TN 3184)

The results of buckling tests of long square tubes loaded in compression, torsion, and combined compression and torsion are compared with theoretical compression and shear buckling curves and with theoretical interaction curves for the buckling of simply supported flat plates. A compression buckling curve previously compared with experiment is again shown to be in good agreement with experimental results; the shear buckling curves derived from compressive stress-strain data by the secant modulus method is in good agreement with experimental results; and theoretical interaction curves previously presented are in good agreement with the results of the combined-load buckling tests. The direction of the loading path is shown to have little or no effect on the shape of the interaction curve.

NACA TN 3189

MINIMUM-DRAG DUCTED AND POINTED BODIES OF REVOLUTION BASED ON LINEARIZED SUPERSONIC THEORY. Hermon M. Parker. May 1954. 30p. diagrs. (NACA TN 3189)

The linearized-drag integral for bodies of revolution at supersonic speeds is presented in a double-integral form which is not based on slender-body approxima-

tions but which reduces to the usual slender-body expression in the proper limit. With the aid of a suitably chosen auxiliary condition, the minimum-external-wave-drag problem is solved for a transition section connecting two semi-infinite cylinders. The projectile tip is a special case and is compared with the Von Kármán projectile tip. Calculations are presented which indicate that the method of analysis gives good first-order results in the moderate supersonic range.

NACA TN 3211

STATISTICAL STUDY OF OVERSTRESSING IN STEEL. G. E. Dieter, G. T. Horne and R. F. Mehl, Carnegie Institute of Technology. April 1954. 34p. diagrs., photos., 7 tabs. (NACA TN 3211)

The effect of overstressing on the fatigue properties of SAE 4340 steel has been studied statistically. In the first part of the study the effect of microstructure on the fatigue damage produced by overstressing was investigated. Fatigue damage was measured by the percentage decrease in fatigue life at the test stress for specimens subjected to varying cycle ratios of fatigue damage at the prestress. The second part of the study was an investigation of the effect of a certain amount of overstressing on the endurance limit and its statistics.

BRITISH REPORTS

1111. 4-122*

Ministry of Aircraft Production (Gt. Brit.)
ON THE INFLUENCE OF SINKS ON THE LIFT AND PRESSURE DISTRIBUTION OF AIRFOILS WITH SUCTION SLOTS. F. Ehlers. September 1, 1946. 45p. diagrs., photos. (MAP VG 67; MAP Reports & Translations 189)

The lift and the pressure distribution of an airfoil with suction slots are calculated by the potential theory under special consideration of the trailing-edge suction. The alteration of the lift is shown to be only a function of the sucked-off quantity, if the suction slot is sufficiently distant from the trailing edge; if the suction is applied at the trailing edge, it is moreover dependent on the profile shape, the width of the suction slot, and, to a higher degree, on the angle of incidence. The maximum lift attainable by suction depends on the profile shape according to an estimate. In order to attain higher lift values by trailing-edge suction, it is advantageous to employ thick profiles.

N-30450*

Aeronautical Research Council (Gt. Brit.)
TWO-DIMENSIONAL WIND-TUNNEL INTERFERENCE. L. G. Whitehead. 1954. 15p. diagrs. (ARC R & M 2802. Formerly ARC 13,198; FM 1451)

Exact solutions are given for the inviscid flow past two cylindrical profiles in the center of a stream of limited depth. The first of these relates to a nearly circular cylinder and the second to a thin section giving a constant pressure drop over the greater part of its surface. The stream has either parallel walls, constant pressure walls, or the boundaries may be partly parallel and partly of the constant pressure type. For the thin profiles, the changes of thickness ratio required to give the same pressure distribution as in an unlimited flow are found.

N-30451*

Aeronautical Research Council (Gt. Brit.)
CHEMICAL SOLIDS AS DIFFUSIBLE COATING FILMS FOR VISUAL INDICATIONS OF BOUNDARY-LAYER TRANSITION IN AIR AND WATER. J. D. Main-Smith. 1954. 16p. diagrs., photos., 2 tabs. (ARC R & M 2755; ARC 13,115. Formerly RAE Chem. 466)

Experimental investigations have been made on various chemical solids as diffusible coating films for visual indication of boundary-layer transition in air and water. Originally, the method was applicable only at low speeds in wind tunnels and water tanks, and the indications were somewhat transient. More durable coating materials have now been made available, admitting of use at subsonic and supersonic wind-tunnel speeds from 30 to 1350 mph, and at ship-hull speeds from 2-1/2 to 20 kt. The method has also proved capable of extension to aircraft in flight at speeds from 100 to 445 mph at temperatures down to -22° C and at altitudes up to 20,000 ft. The diffusible-solid-coating method, with its advantages of autographic indication and simplicity and rapidity of operation, has thus become a versatile technique in investigations on fluid flow in aerodynamics and hydrodynamics.

N-30452*

Aeronautical Research Council (Gt. Brit.)
RESONANT VIBRATION OF HELICOPTER ROTOR BLADES. J. Morris. 1954. 4p. diagr. (ARC R & M 2801; ARC 13,485. Formerly RAE SME 4042)

The blades of the operative rotors of helicopters are usually hinged both in the lift and rotational planes and it is because of this articulation that the blades in the course of rotation are akin dynamically to "pendulum vibration dampers." If the fundamental frequency of this species of pendulum vibration is numerically equal to nN where n is the number of blades and N is the frequency of rotation of the rotor then serious resonant forced vibration may ensue and it would appear that this is quite likely to occur in practical cases with the blades in vibration in the plane of rotation of the rotor.

N-30453*

Aeronautical Research Council (Gt. Brit.)
A NEW RELAXATIONAL TREATMENT OF THE COMPRESSIBLE TWO-DIMENSIONAL FLOW ABOUT AN AEROFOIL WITH CIRCULATION. L. C. Woods and A. Thom. 1954. 17p. diagrs., 2 tabs. (ARC R & M 2727. Formerly ARC 13,034; FM 1429; Oxford Univ., Engineering Lab. No. 35)

The method appears to be satisfactory treatment of the compressible flow of an inviscid fluid about an airfoil. Discrepancies with experiment appear at high Mach numbers due to the movement of the velocity peak towards the trailing edge where the boundary layer cannot be ignored. The airfoil used presented a difficult case for calculation as the nose was very sharp.

N-30471*

Department of Supply (Australia)
SOME CONTRIBUTIONS TO THE STUDY OF THE TURBULENT BOUNDARY-LAYER NEAR SEPARATION. B. G. Newman. March 1951. 40p. diagrs., photos. (Department of Supply. ACA-53)

An experimental and theoretical study is made of the turbulent boundary layer near separation in subsonic incompressible flow. A hot wire anemometer was developed and tested by measuring the shearing stress in turbulent flow down a circular pipe. The instrument was used in two series of measurements of turbulent boundary-layer flow near separation and some qualitative conclusions on turbulent separation are drawn. The use of the von Karman momentum equation as a means of determining the skin friction near separation is examined. Simple analysis of the flow in the laminar sublayer leads to estimation of skin friction in a turbulent boundary layer.

N-30494*

Royal Aircraft Establishment (Gt. Brit.)
THE UNSTEADY BURNING OF CORDITE. J. D. Huffington. February 1954. 23p. diagrs., photos. (RAE Tech. Note RPD 95)

By burning cordite charges in small vented vessels an investigation has been made of chuffing (sporadic burning with the pressure falling to atmospheric between peaks) and of the continuous but oscillatory burning into which chuffing is transformed when the nozzle size is reduced. The observations lead to the postulate that burning during chuffing is thermal-explosive in nature. During a chuff, the surface layer of the propellant is first liquified and then immediately burns explosively down to a certain critical depth, the process being repeated during subsequent chuffs. Some information is given on steady oscillatory burning.

N-30498*

Royal Aircraft Establishment (Gt. Brit.)
CALIBRATION OF THE R.A.E. NO.18 (9 IN. x 9 IN.) SUPERSONIC WIND TUNNEL. PART II - TESTS AT ATMOSPHERIC STAGNATION PRESSURE. W. T. Lord, G. K. Hunt, R. J. Pallant and J. Turner. September 1953. 25p. diagrs., 3 tabs. (RAE Tech. Note Aero 2236)

This report presents distribution of Mach number in the empty working section of the R.A.E. No. 18 (9- by 9-inch) supersonic wind tunnel at nominal Mach numbers of 1.4, 1.5, 1.6, 1.8, and 1.9, for condensation-free flow at atmospheric stagnation pressure and at a stagnation temperature of 35° C. The mean measured Mach numbers are 1.41, 1.61, 1.81, and 1.91 when calculated from values of pitot and stagnation pressures. The major contributions to the nonuniformity of the flow are from the disturbances which arise from the junctions of the windows with the side walls of the tunnels.

N-30502*

Royal Aircraft Establishment (Gt. Brit.)
THE MECHANICAL PROPERTIES OF GLASS. M. Dyke. January 1954. 18p. (RAE Library Bibliog. 111)

This bibliography is arranged under two main headings "Glass" and "Glass Fibres." Within these headings references are arranged first by form, that is under Books, Articles in journals, Reports and Patents, and then by date with the most recent last. The sources consulted were the Library subject index, Chemical Abstracts 1937-53, Engineering Index 1942-43, 45-52, Journal of the Society of Glass Technology 1951-3, and British Ceramic Abstracts.

N-30505*

Royal Aircraft Establishment (Gt. Brit.)
NOTE ON SAMPLING AND PHOTOGRAPHING CLOUD DROPLETS IN FLIGHT. F. J. Bigg and G. C. Abel. September 1953. 27p. diagrs., photos., tab. (RAE Tech. Note Mech. Eng. 156)

This note describes the progress made at R.A.E. and A. & A.E.E. in the development of a satisfactory means for determining the size and distribution of supercooled water droplets in icing clouds. The system is at present adequate for measuring in flight the median droplet diameter of liquid cloud droplets up to a speed of 220 knots. The system should be capable of development to a stage where with a possible flight speed limitation the liquid water content, total water content, and liquid median droplet diameter can be obtained under any type of icing condition.

N-30506*

Royal Aircraft Establishment (Gt. Brit.)
CALIBRATION OF THE R.A.E. NO.18 (9 IN. x 9 IN.) SUPERSONIC WIND TUNNEL. PART I - PRELIMINARY INVESTIGATIONS. W. T. Lord and D. Beastall. September 1953. 45p. diagrs., 6 tabs. (RAE Tech. Note Aero 2235)

A detailed account is given of the investigation performed in the R.A.E. No. 18 (9- by 9-inch, continuous flow, variable density) supersonic wind tunnel prior to an extensive calibration of the tunnel. Variables affecting the behavior of the flow are discussed, and preliminary experiments to determine their significance are described. The calibration program is outlined: Part II will deal with tests at atmospheric stagnation pressure, and further tests at various stagnation pressures are proposed.

N-30508*

Royal Aircraft Establishment (Gt. Brit.)
A ROOT MEAN SQUARE MEASURING INSTRUMENT FOR NONPERIODIC VOLTAGES. D. E. Verrian. February 1954. 14p. diagrs. (RAE Tech. Note GW 297)

A description is given of an instrument which may be used to measure the rms value of alternating voltages. It is primarily designed for measuring the rms values of random noise voltages. It may be used to measure voltages of from 0.2 volts to 50 volts, over time intervals up to 100 seconds, with an error not exceeding 2 percent of the maximum scale reading.

N-30507*

Royal Aircraft Establishment (Gt. Brit.)
INTERIM NOTE ON THE DEVELOPMENT OF A MAGNETIC POWDER CLUTCH. F. L. West. January 1954. 18p. diagrs. (RAE Tech. Note IAP 1028)

The most important test results obtained during the course of work on experimental magnetic powder clutches and iron powder materials in IAP Dept., RAE have been collected to illustrate difficulties being encountered with magnetic media for the guidance of future workers. The note covers an investigation of shear forces transmitted to a flat steel plate by magnetized iron powder media, and outlines phenomena observed during tests on experimental clutches of disk and cylinder rotor construction. The development and performance of a small cylinder clutch designed for use with an aircraft autopilot servoactuator is dealt with in some detail up to the stage of small quantity reproduction.

UNPUBLISHED PAPERS

N-15881*

ON A FEW METHODS OF RELAXATION CALCULATION. (Über einige Methoden der Relaxationsrechnung). Eduard Stiefel. April 1954. 50p. diagrs. (Trans. from Zeitschrift für angewandte Mathematik und Physik, v. 3, no. 1, 1952, p. 1-33)

The general outlines of the so-called relaxation technique are developed. After a short discussion of the trial methods developed by Southwell and his school, allowing full leeway to the intuition of the computing person, the general mathematical background is treated. After a study of the gradient method, it is shown that relaxation methods are not necessarily successive approximations taking an infinite number of steps but that it is possible to speed up convergence such that the desired result is reached in a finite number of steps. These methods may be suitable for use on a sequence-controlled computing machine.

N-29996*

Iowa State College, Iowa Engineering Experiment Station. HEAT CAPACITY LAG OF GAS MIXTURES. Thomas D. Rossing and Sam Legvold. August 31, 1953. (i), 49p. diagrs., 4 tabs. (Iowa State College, Iowa Engineering Experiment Station)

The vibrational relaxation time has been measured in monochlorodifluoromethane (Freon 22) and its mixtures with argon and helium. The addition of argon or helium is found to reduce slightly the time necessary to excite molecular vibrations. Freon 22 is found to have a single relaxation time, and binary collisions are responsible for its vibrational excitation. The interferometer has been calibrated for absorption measurements. Absorption measurements are reported for Freon 22, argon, and a 9:1 mixture of the latter two.

N-29997*

Calif. Institute of Technology, Pasadena. Guggenheim Aeronautical Lab. THE LIFT OF THIN AIRFOILS AT HIGH-SUBSONIC SPEEDS. William W. Willmarth. September 1953. v, 87p. diagrs., photos. (Calif. Institute of Technology, Pasadena. Guggenheim Aeronautical Lab.)

Experimental results are presented for the lift characteristics of thin, two-dimensional airfoils at high-subsonic speeds and small angles of attack. Symmetrical airfoils with different locations of maximum thickness were investigated. Flow fields over each airfoil are discussed and the quantitative results for the lift and location of the center of lift are compared with theory. The effects of flow separation caused by boundary-layer shock-wave interaction are noted and discussed. The possibility of the forced oscillation of control surfaces due to boundary-layer separation is mentioned.

N-29998*

Univ. of Fla., Engineering and Industrial Experiment Station. HEAT TRANSFER TO CLOUDS OF PARTICLES AT ELEVATED TEMPERATURES. Robert B. Bennett, C. M. Oktay and B. G. Kyle. February 10, 1954. (iii), 81p. diagrs., photos., 34 tabs. (Univ. of Fla., Engineering and Industrial Experiment Station)

Sand and glass beads were dropped at various rates through still air at various temperatures. Overall heat-transfer coefficients and the radiation component of heat transfer were calculated. Experimental results show that heat transmission takes place principally by convection at low temperatures, and by radiation to an increasing extent at high temperatures. Of all the variables tried, the feed rate had the greatest effect on the overall coefficient of heat transfer. Presumably this was due to the shielding effect of the increase in cloud concentration.

N-29999*

Univ. of Fla., Engineering and Industrial Experiment Station. A SPECIAL ANALYTICAL STUDY OF HEAT TRANSFER PHENOMENA WITH CLOUDS OF SMALL PARTICLES IN AIR AT ELEVATED TEMPERATURES. H. M. Hawkins, Y. S. Tang, J. H. Gary and A. O. Wikman. December 1, 1950. (ii), 85p. diagrs. (Univ. of Fla., Engineering and Industrial Experiment Station)

An analytical study is made of heat-transfer phenomena which occur when clouds of small solid particles in air are surrounded by hot surfaces. Radiation from two infinite parallel walls to stationary and moving clouds between the walls is considered. Some study was done on the convective heat transfer at the surfaces of particles. The combined effect of radiation and convection on particles in enclosed spaces has been investigated. A bibliography of literature of interest in the study of this problem has been compiled.

N-31117*

STATIC MEASUREMENT OF AERODYNAMIC ROLLING DERIVATIVES. (Mesure statique des dérivées aérodynamiques de roulis). M. Bismut. April 1954. 17p. diagrs., photo. (Trans. from Recherche Aeronautique, no. 30, 1952, p. 9-13)

Conventional wind-tunnel balances permit measurement of the forces as a function of the components of the velocity of the center of gravity. Complementary methods must be employed for the measurement of forces as a function of the rotation of the axes fixed in the airplane. The procedure described has permitted measurement of the forces due to the rolling component (the reduced rolling velocity) in subsonic and supersonic wind tunnels.

N-31005*

WIND-TUNNEL MEASUREMENT OF THE AERODYNAMIC DERIVATIVES OF A MODEL BY A METHOD OF SUSTAINED OSCILLATIONS. (Mesure en soufflerie des dérivées aérodynamiques d'une maquette par une méthode d'oscillations entretenues). M. Scherer. April 1954. 10p. diagr., photos., tab. (Trans. from Recherche Aéronautique, no. 30, 1952, p. 15-18)

A method of measurement is described which permits a relatively simple and rapid determination of the derivatives of the two linearized stability problems in a wind tunnel of conventional form.

National Advisory Committee for Aeronautics

Research Abstracts

NO. 64 **JUNE 8, 1954**

CURRENT NACA REPORTS

NACA Rept. 1126

THE EFFECT OF BLADE-SECTION THICKNESS RATIOS ON THE AERODYNAMIC CHARACTERISTICS OF RELATED FULL-SCALE PROPELLERS AT MACH NUMBERS UP TO 0.65. Julian D. Maynard and Seymour Steinberg. 1953. ii, 55p. diagrs., photos., tab. (NACA Rept. 1126. Formerly RM L9D29)

Results of an investigation of two full-scale NACA propellers are presented for a range of blade angles from 20° to 55° at airspeeds up to 500 miles per hour. These results are compared with the results from previous tests of five related NACA propellers to evaluate the effects of blade-section thickness ratios on propeller aerodynamic characteristics.

NACA Rept. 1136

ESTIMATION OF THE MAXIMUM ANGLE OF SIDESLIP FOR DETERMINATION OF VERTICAL-TAIL LOADS IN ROLLING MANEUVERS. Ralph W. Stone, Jr. 1953. ii, 12p. diagrs., 5 tabs. (NACA Rept. 1136. Formerly TN 2633)

This paper presents the results of a study, by a step-by-step integration of the equations of motion, of the variations of angle of sideslip and angle of attack in rolling maneuvers, particularly for airplanes with mass distributed mainly along the fuselage. The results are compared with those of existing methods for estimating angles of sideslip for determining vertical-tail loads in rolling maneuvers.

NACA RM 54D01

DEVELOPMENT OF METAL-BONDING ADHESIVES WITH IMPROVED HEAT-RESISTANT PROPERTIES. John M. Black and R. F. Blomquist, Forest Products Laboratory. May 1954. 12p., 3 tabs. (NACA RM 54D01)

Results are reported of current studies at the Forest Products Laboratory to develop a metal-bonding adhesive with greater resistance to temperatures up to 600° F that is easier to use than present ones.

NACA TN 3080

MEASUREMENT AND ANALYSIS OF WING AND TAIL BUFFETING LOADS ON A FIGHTER-TYPE AIRPLANE. Wilber B. Huston and T. H. Skopinski. May 1954. i, 86p. diagrs., photo., 8 tabs. (NACA TN 3080)

Wing and tail buffeting loads measured in 194 runs with a fighter-type airplane are tabulated with the associated flight conditions. Measurements were made at altitudes of 30,000 to 10,000 feet and at Mach numbers up to 0.8. Preliminary analysis indicates that the loads vary with the square root of the dynamic pressure and shows the effects of aerodynamic damping, duration of buffeting, maneuver abruptness, penetration beyond the buffet boundary, and reduction of the wing natural frequency in bending through addition of wing-tip weights.

NACA TN 3083

DETERMINATION OF LATERAL-STABILITY DERIVATIVES AND TRANSFER-FUNCTION COEFFICIENTS FROM FREQUENCY-RESPONSE DATA FOR LATERAL MOTIONS. James J. Donegan, Samuel W. Robinson, Jr. and Ordway B. Gates, Jr. May 1954. 61p. diagrs., 12 tabs. (NACA TN 3083)

A method is presented for calculating the lateral-stability derivatives and lateral transfer-function coefficients from frequency-response data for a rigid airplane. Two examples are used to illustrate the method. Accurate lateral-stability derivatives can be obtained only when accurate frequency-response data are available.

NACA TN 3148

EVALUATION OF ALLOYS FOR VACUUM BRAZING OF SINTERED WROUGHT MOLYBDENUM FOR ELEVATED-TEMPERATURE APPLICATIONS. Kenneth C. Dike. May 1954. 13p. diagrs., photos., 2 tabs. (NACA TN 3148)

The brazing characteristics of 28 alloys, with liquidus temperatures in the range 2000° to 2500° F, were established in vacuum. The tensile strength of butt-brazed molybdenum joints of 10 of the alloys ranged from 21,000 to 49,000 pounds per square inch at room temperature and 0 to 18,900 pounds per square inch at 1800° F. The three alloys having 1800° F bonding strengths greater than 17,000 pounds per square inch were heated in vacuum for 24 hours at 1800° F to determine the effect on tensile strength.

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This treatment lowered the strength of one considerably but did not seem to affect the 84 percent nickel - 16 percent titanium and 52 percent niobium - 48 percent nickel alloy bonds. Therefore, these two alloys may be potentially useful for brazing molybdenum.

NACA TN 3156

CHARTS FOR ESTIMATING TAIL-ROTOR CONTRIBUTION TO HELICOPTER DIRECTIONAL STABILITY AND CONTROL IN LOW-SPEED FLIGHT. Kenneth B. Amer and Alfred Gessow. May 1954. 54p. diagrs., photo., 2 tabs. (NACA TN 3156)

Theoretically derived charts and equations are presented by which tail-rotor design studies of directional trim and control response at low forward speed can be conveniently made. Comparisons between theoretical and experimental results are presented. The charts indicate and flight tests confirm that, under certain flight conditions, a region of vortex roughness is encountered by the tail rotor, making prolonged operation difficult in this region.

NACA TN 3173

A STUDY OF HYPERSONIC SMALL-DISTURBANCE THEORY. Milton D. Van Dyke. May 1954. 51p. diagrs. (NACA TN 3173)

The small-disturbance equations are derived for inviscid flow past thin bodies at high supersonic speeds. Reinterpreted, they apply throughout the supersonic range. The theory is used to find pressures on cones and wedges, initial gradients on ogives, and initial pressure curvatures on ogives of revolution. Additional approximations from existing theories are discussed.

NACA TN 3175

DOWNWASH CHARACTERISTICS AND VORTEX-SHEET SHAPE BEHIND A 63° SWEPT-BACK WING-FUSELAGE COMBINATION AT A REYNOLDS NUMBER OF 6.1×10^{6}. William H. Tolhurst, Jr. May 1954. 45p. diagrs., photo. (NACA TN 3175. Formerly RM A52J08)

Downwash-angle contour maps are presented for nine vertical transverse planes located between 0.57 and 2.71 semispans aft of the 0.25 mean aerodynamic chord point for three angles of attack. The shape of the vortex sheet is presented for the various survey planes and angles of attack. Theoretical and experimental downwash angles are compared.

NACA TN 3176

WALL INTERFERENCE IN WIND TUNNELS WITH SLOTTED AND POROUS BOUNDARIES AT SUBSONIC SPEEDS. Barrett S. Baldwin, Jr., John B. Turner and Earl D. Knechtel. May 1954. 42p. diagrs. (NACA TN 3176. Formerly RM A53E29)

Linearized compressible-flow analysis is applied to the study of wind-tunnel-wall interference for subsonic flow in either two-dimensional or circular test sections having slotted or porous walls. Expressions are developed for evaluating blockage and lift interference.

NACA TN 3181

EXPERIMENTAL INVESTIGATION OF HEAT-TRANSFER AND FLUID-FRICTION CHARACTERISTICS OF WHITE FUMING NITRIC ACID. Bruce A. Reese and Robert W. Graham, Purdue University. May 1954. 46p. diagrs., tab. (NACA TN 3181)

Experiments have been conducted to determine the heat-transfer and fluid-friction characteristics of white fuming nitric acid over a wide range of conditions. A satisfactory equation for relating the Fanning friction coefficient with heat transfer and the isothermal friction coefficient measured at the same Reynolds number is presented. An equation is also presented for correlating the heat-transfer results. Some preliminary results are presented for the regime of forced convection with nucleate boiling.

NACA TN 3182

MANUAL OF THE ICAO STANDARD ATMOSPHERE. CALCULATIONS BY THE NACA. International Civil Aviation Organization, Montreal, Canada and Langley Aeronautical Laboratory, Langley Field, Va., U.S.A. May 1954. iii, 132p. incl. 102p. tabs., diagrs. (NACA TN 3182. Supersedes and extends NACA Rept. 218)

The physical constants and basic equations defining the International Civil Aviation Organization (ICAO) Standard Atmosphere are presented together with tables and diagrams of the properties of the ICAO Standard Atmosphere computed by the National Advisory Committee for Aeronautics in both metric and English units for altitudes from -5,000 meters to 20,000 meters and from -16,500 feet to 65,800 feet.

NACA TN 3186

EVALUATION OF THE ACCURACY OF AN AIRCRAFT RADIO ALTIMETER FOR USE IN A METHOD OF AIRSPEED CALIBRATION. Jim Rogers Thompson and Max C. Kurbjun. May 1954. 15p. diagrs., photos., tab. (NACA TN 3186)

A method which may provide a rapid and convenient means for calibrating the airspeed systems of high-performance aircraft is proposed and discussed. The accuracy of the method is comparable with that of the NACA radar phototheodolite method (NACA Rep. 985), but the tests must be performed over a large body of water.

NACA TN 3201

DIRECTIONAL STABILITY CHARACTERISTICS OF TWO TYPES OF TANDEM HELICOPTER FUSELAGE MODELS. James L. Williams. May 1954. 44p. diagrs., photos. (NACA TN 3201)

The results of a low-speed wind-tunnel investigation of the directional stability characteristics of an overlap-type fuselage as affected by fuselage and pylon (vertical tail) modifications and of a nonoverlap type fuselage as influenced by spoilers and vertical-tail changes are presented in this report. Tuft-grid pictures of the air flow behind the nonoverlap type fuselage are also presented.

NACA TN 3210

THE ROLE OF TRIPLE COLLISIONS IN EXCITATION OF MOLECULAR VIBRATIONS IN NITROUS OXIDE. Richard A. Walker, Thomas D. Rossing and Sam Legvold, Iowa State College. May 1954. 24p. diagrs., photo., 3 tabs. (NACA TN 3210)

Results are presented of an investigation to determine the importance of triple collisions in the thermal relaxation process (heat capacity lag) of gaseous mixtures. The experimental work involved the measurement at ultrasonic frequencies of the velocity of sound in mixtures of the basic dispersive gas nitrous oxide and impurity gases nitrogen, helium, and argon. Wide ranges of pressures and concentrations for the gas mixtures were required in the experiments to ascertain the possible effects of triple collisions. The rudiments of the theory of sound dispersion and relaxation phenomena are presented along with an analysis of the manner in which the effects of triple collisions might be determined.

BRITISH REPORTS

N-30425*

Forest Products Research Lab. (Gt. Brit.)
INVESTIGATIONS INTO GLUES AND GLUING. PROGRESS REPORT SEVENTY-NINE - DECEMBER, 1953. THE COMPARATIVE DURABILITY OF ASSEMBLY GLUES IN ENGLAND AND IN NIGERIA. ANALYSIS AFTER EIGHTEEN MONTHS EXPOSURE. J. F. S. Carruthers and M. S. Burridge. 11p. photos., 4 tabs. (Forest Products Research Lab.)

This report gives the comparative durability of various adhesives used in the wood-working industries after exposure experiments in England and Nigeria. Results are given on the following glue types: animal, casein, urea formaldehyde, phenol formaldehyde, and resorcenol formaldehyde.

N-30446*

Aeronautical Research Council (Gt. Brit.)
EXPERIMENTS ON THE FLOW PAST A POROUS CIRCULAR CYLINDER FITTED WITH A THWAITES FLAP. R. C. Pankhurst and B. Thwaites. APPENDIX II - SMOKE VISUALIZATION OF FLOW PAST CIRCULAR CYLINDER WITH THWAITES FLAP. W. S. Walker. 1953. 28p. diagrs., photos. (ARC R & M 2787. Formerly ARC 13,447; FM 1486; 13,507; FM 1496)

This paper describes wind-tunnel experiments on a porous circular cylinder of 3-inch diameter fitted with a Thwaites flap. Measurements were made of the pressure distribution at midspan, together with a number of wake traverses, over a range of suction quantity, flap size, wind speed, and flap setting. The distributed suction effectively prevented boundary layer separation and enabled a close approximation to potential flow to be achieved. The flap was essential to the attainment of steady flow conditions with suction.

N-30447*

Aeronautical Research Council (Gt. Brit.)
RECORDS OF MAJOR STRENGTH TESTS. P. B. Walker. 1954. 5p. diagrs., tab. (ARC R & M 2790; ARC 12,601. Formerly RAE Structures 44)

The strength attained in major strength tests, made over a period of 10 years, is given for 24 wing systems and 10 fuselages. A preliminary analysis is also presented from the standpoints of safety and design efficiency. One third of all the wing systems tested are found to be seriously understrength as originally designed, and it is concluded that wing and fuselage testing for all new types is essential for safety. The majority of understrength aircraft, however, were brought up to the required standard by local strengthening, and it is concluded that this has an important bearing on design efficiency.

N-30448*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF SWEEPBACK ON THE FUNDAMENTAL DERIVATIVE COEFFICIENT FOR FLEXURAL MOTION. J. B. Bratt and K. C. Wight. 1953. 22p. diagrs., photos., 5 tabs. (ARC R & M 2774. Formerly ARC 13,452; 0.898; S & C 2438)

Measurements have been made with new equipment for derivative tests in a 9- by 7-foot tunnel, to determine the effect of sweepback on the derivatives $\lambda_{\dot{\phi}}$ and λ_{ϕ} for a rectangular airfoil of aspect ratio 6. A numerical reduction was observed in each case. Values of $\lambda_{\dot{\theta}}$ and λ_{θ} for the swept model were obtained from measurements relating to oscillation about an axis perpendicular to the leading edge. A comparison of $\lambda_{\dot{\phi}}$ and λ_{ϕ} with available theoretical results for finite aspect ratio is made and good agreement observed in the case of the former. The less satisfactory agreement with λ_{ϕ} is thought to be due to lower accuracy of the theoretical values.

N-30449*

Aeronautical Research Council (Gt. Brit.)
AN INVESTIGATION OF HIGH-ALTITUDE CLEAR-AIR TURBULENCE OVER EUROPE USING MOSQUITO AIRCRAFT. G. S. Hislop and D. M. Davies. 1953. 39p. diagrs., 3 tabs. (ARC R & M 2737; ARC 13,316. Formerly Brit. European Airways Corp. RSD Rept. 15)

Some 20 areas of turbulence were actually investigated, the greatest vertical gust velocity encountered was 26 ft/sec E.A.S. The results were examined

from the passenger comfort and structural aspect, and from the meteorological aspect. More data are needed before a forecasting technique can be established. It has been found that severe turbulence may be found in a jet stream and that turbulence is frequently found near the tropopause.

N-30454*

Aeronautical Research Council (Gt. Brit.)
THE PERFORMANCE AFTER POWER FAILURE OF A HELICOPTER WITH BLADE PITCH CONTROL. PARTS I AND II. F. O'Hara and H. A. Mather. 1953. 16p. diagrs. (ARC R & M 2797; ARC 12,892; ARC 13,867. Formerly Airborne Forces Exp. Establishment AFEE Rept. Rota 1; AFEE Rept. Rota 6)

In part I, a review is made of helicopter performance after engine failure. Transition from powered operation to autorotation is discussed and a theoretical analysis of the motion is given for a single-rotor helicopter with blade-pitch control. In part II, tests are made to investigate the performance of a Hoverfly I in the transition to autorotation following power cut in level flight.

N-30455*

Aeronautical Research Council (Gt. Brit.)
A SURVEY OF PERFORMANCE REDUCTION, WITH PARTICULAR REFERENCE TO TURBO-PROPELLER AIRCRAFT. K. J. Lush. 1954. 7p. (ARC R & M 2757; ARC 12,951. Formerly AAEE/Res/247)

A survey of the methods available for performance reduction, with particular reference to turbo-propelled aircraft, has been made. The purpose of performance reduction is briefly examined. Methods in use are classified into experimental methods, which require no advance numerical data, and analytical methods, which require such data. The latter class if subdivided into methods based on small corrections and methods based on performance analyses. The suitability of each class of method is discussed.

N-30456*

Aeronautical Research Council (Gt. Brit.)
SOME ADDITIONAL NOTES ON THE DERIVATION OF AIRWORTHINESS PERFORMANCE CLIMB STANDARDS. A. K. Weaver. 1953. 12p. diagr. (ARC R & M 2769; ARC 13,500. Formerly AAEE/Tech/61)

After the publication of a report (R & M 2631) on the derivation of airworthiness performance climb standards, various subsidiary points raised in the course of discussions were examined. Some of these have been collected together in the present note. They are in the nature of elaborations of the original method and include a refined method of deriving the take-off climb standard, a method of treating interdependence of engine failure and a method for including the effect of sideslip in the margin allowed for pilotage errors. The main principles set forth in the earlier report remain unaffected.

N-30457*

Aeronautical Research Council (Gt. Brit.)
THE CALCULATED PERFORMANCE OF ETHYL ALCOHOL-WATER MIXTURES AS ROCKET FUELS WITH LIQUID OXYGEN. A. B. P. Beeton. 1953. 8p. diagrs. (ARC R & M 2816; ARC 11,534. Formerly RAE Tech. Note Aero 1943; SD 75)

Specific impulses and combustion temperatures have been calculated for rocket propellants consisting of liquid oxygen and ethyl alcohol-water mixtures. This system appears to have a number of advantages compared with the corresponding liquid oxygen and petrol system.

N-30458*

Aeronautical Research Council (Gt. Brit.)
WATER PERFORMANCE OF A FOUR-ENGINED FLYING BOAT WITH STEP FAIRINGS OF LENGTH 3, 6 AND 9 TIMES THE STEP DEPTH. G. J. Evans, A. G. Smith, R. A. Shaw, and W. Morris. Edited by A. G. Smith. 1953. 28p. diagrs., photos., 2 tabs. (ARC R & M 2868. Formerly MAEE H/Res/140; H/Res/142)

Two reports thought to be of interest in that the results first demonstrated the importance of the possible interference between the water wake from the forebody and the afterbody bottom on porpoising instability are combined in this report. The report also gives an outline of the mechanism of the water flow over the forebody and clearance from the afterbody in the course of take-offs and landings, both with and without the various forms of porpoising instability.

N-30520*

Aeronautical Research Council (Gt. Brit.)
PRESSURE DISTRIBUTION AND BOUNDARY LAYER INVESTIGATIONS ON 44 DEGREE SWEPT-BACK TAPERED WING. PART I - THREE-DIMENSIONAL TESTS ON THE WING. PART II - TWO-DIMENSIONAL PRESSURE DISTRIBUTION TESTS ON 10 PER CENT THICK SYMMETRICAL AEROFOIL SECTION. Joseph Black. 1953. 52p. diagrs., photos., 2 tabs. (ARC CP 137)

Chordwise pressure distributions at a number of spanwise locations were measured over a range of incidence. Attention was given to investigating the boundary layer, quantitative measurements being made with a novel form of yawmeter head. A technique for revealing the direction of flow and formation of vortices in the layer was developed. One of the most important results established was the relation of the unstable break in the pitching-moment curve to the initiation of stalling at the tip.

N-30521*

Aeronautical Research Council (Gt. Brit.)
A REVIEW AND ASSESSMENT OF VARIOUS FORMULAE FOR TURBULENT SKIN FRICTION IN COMPRESSIBLE FLOW. R. J. Monaghan. 1953. 52p. diagrs. (ARC CP 142)

An extended comparison is made of available formulas which have been developed for the variation of turbulent skin friction on a flat plate in compressible flow, with and without heat transfer. Assumptions made in their development are examined and are checked against experimental evidence where possible. A formula is given which should be sufficiently accurate in application probably up to M = 4 until further experimental evidence may make refinement possible.

N-30522*

Aeronautical Research Council (Gt. Brit.)
AN INVESTIGATION INTO THE PITOT RAKE METHOD OF MEASURING TURBO JET ENGINE THRUST IN FLIGHT. J. Stephenson, R. T. Shields and D. W. Bottle. 1954. 60p. diagrs., 9 tabs. (ARC CP 143)

Tests were made to find whether a pitot rake could be used as an absolute measure of the thrust of a jet engine on the ground and in flight. The tests were made on Derwent 5 engines installed in Meteor 4 aircraft. The test covered a wide range of flight conditions and included test bed measurements on bare engines and later, measurements of exit static pressure. The same final nozzle was used in all the main tests. The tests were also planned to check the generally nondimensional thrust relationship for jet engines.

N-30536*

TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. R. A. G. Knight, Forest Products Research Laboratory. (Reprint from Wood, v. 19, February 1954, p. 76-80)

This report summarizes in tabular form the results of the pilot tests on 44 species of timber for plywood manufacture. Of the species dealt with, some are already well known to the British plywood industry and have been used to provide basic comparative data. Other timbers are new for plywood and have been tested on request.

N-30589*

Royal Aircraft Establishment (Gt. Brit.)
EXPERIMENTAL WORK ON THE ELECTROSTATIC CHARGES FORMED ON AIRCRAFT CAMERA FILM. J. A. Wells. October 1953. 50p. diagrs., photos., 4 tabs. (RAE Tech. Note Ph. 479)

The note gives a survey of the existing information on frictional electricity with particular reference to its application to "static" on aircraft camera film. Suitable equipment for the measurement of frictional charges is described. Some limited experimental work on the distribution of charge which occurs when a dielectric rubs continuously over a fixed surface and a method of assessing films for liability to static discharge are described. Recommendations are made for methods of reducing the occurrence of discharges.

N-30590*

National Gas Turbine Establishment (Gt. Brit.)
SOME EXPERIMENTS ON THE MEASUREMENT OF AIR FLOW BY TRAVERSING A DUCT. H. A. Knight. November 1953. 51p. diagrs. (NGTE Memo. M. 178)

Experiments to obtain a reliable aerodynamic calibrating technique in a measuring duct are summarized. The final result was only partly successful and the method has been postponed while an alternative is tried. The tests resulted from attempts to reduce errors as they were discovered. The principle source of inaccuracy with the original method was the static pressure variation across the measuring plane. Features of the experiments which are applicable to general flow measurements are listed. Three untried improvements are listed.

N-30606*

Aeronautical Research Council (Gt. Brit.)
FURTHER EXTRACTS FROM CURRENT LITERATURE ON THE DILASTRAIN METHOD OF DETERMINING THE ENDURANCE LIMIT OF MATERIALS. ENDURANCE LIMIT TEST, Reprint from Mechanical Engineering, Jan., 1952, p. 25-26. THE DILASTRAIN METHOD OF FATIGUE TESTING, Reprint from Engineer, v. 195, no. 5079, May 29, 1953, p. 767. October 12, 1953. 4p. diagrs. (ARC 16,203; Strut. 1649)

A rapid and accurate method for determining the endurance limit of steels and other metals has been developed. Called the R/S Dialstrain Method, the test requires only 2 hours in itself. The endurance limit of any particular material is found under present methods of testing by subjecting test bars to varying loads of stresses and vibrating them until they fracture or prove enduring.

N-30611*

Aeronautical Research Council (Gt. Brit.)
THE INFLUENCE OF THE EXIT VELOCITY PROFILE ON THE NOISE OF A JET. Alan Powell. September 22, 1953. 20p. diagrs., 4 tabs. (ARC 16,156; FM 1952. Formerly ARC 15,473; FM 1837)

The noise levels of a jet issuing from a long pipe are compared with those of a jet having a square velocity profile at the exit. On comparison with a jet of smaller diameter which has an equal thrust for the same maximum jet velocity, it is found that the changes in noise level are smaller. For jets of equal diameters the effects on the subsonic aerodynamic noise generated by a reduction of velocity gradient near the boundary are more than offset by the increased velocities necessary near the center of the jet to obtain equal thrust.

N-30692*

Royal Aircraft Establishment (Gt. Brit.)
THE SLIP BAND EXTRUSION EFFECT OBSERVED IN SOME ALUMINIUM ALLOYS SUBJECTED TO CYCLIC STRESSES. P. J. E. Forsyth and C. A. Stubbington. January 1954. 19p. diagrs., photos. (RAE Met. 78)

Extrusion of crystal material from slip bands has been observed during the final stages of fatiguing of a number of solution heat treated materials. The extruded material is in the form of ribbon, the thickness of which is estimated as less than 0.1 μ. It appears suddenly after a period of cyclic stressing, and leaves behind a crevasse which represents the initial crack. The effect may be associated with a segregation or ordering of the solute atoms in the lattice. This ordering may to a certain extent already exist in the solution heat treated material, but is mainly caused by the action of the cyclic stresses on the metastable matrix.

MISCELLANEOUS

N-25045*

Advisory Group for Aeronautical Research and Development. SOME FACTORS CONTRIBUTING TO SCALE EFFECT AT SUPERSONIC SPEEDS. Ira H. Abbott. (Presented at London AGARD conference, September 3-11, 1953) 26p. diagrs., photos. (Advisory Group for Aeronautical Research and Development. AG8/M4)

Information is included on the Reynolds number effects at supersonic speeds on skin friction, transition and separation. Some of the effects of airstream turbulence, weak shock waves from the walls, and heat transfer are considered briefly.

N-30426*

Advisory Group for Aeronautical Research and Development. TECHNICAL PRESENTATIONS BEFORE THE AGARD COMBUSTION PANEL: INTRODUCTION TO CHEMICAL KINETICS FOR AERONAUTICAL ENGINEERS. S. S. Penner, California Institute of Technology. EXPERIMENTAL INVESTIGATION OF INTERNAL STRUCTURE OF FLAMES. J. W. Linnett, Oxford University. IGNITION DELAY MEASUREMENTS ON GAS TURBINE FUELS BY THE N.G.T.E. METHOD. B. P. Mullins, National Gas Turbine Establishment. COMBUSTION INSTABILITY IN ROCKET MOTORS. Luigi Crocco, Princeton University. COMBUSTION PROBLEMS IN TURBOJETS. Jean Surugue, Office National d'Etudes et de Recherches Aéronautiques. REPORT ON COMBUSTION SYMPOSIUM. COMBUSTION CHAMBER PROBLEMS. Jean Fabri, Office National d'Etudes et de Recherches Aéronautiques. COMBUSTION PROBLEMS IN RAMJETS. Raymond Siestrunck, Office National d'Etudes et de Recherches Aéronautiques. (Presented at Rome AGARD conference, December 12-19, 1952) 90p. diagrs., photos. (Advisory Group for Aeronautical Research and Development. AG5/P2)

N-31356

Advisory Group for Aeronautical Research and Development. SELECTED COMBUSTION PROBLEMS: FUNDAMENTAL AND AERONAUTICAL APPLICATIONS. Edited by W. R. Hawthorne and J. Fabri. (Combustion colloquim, Cambridge University, England, December 7 to 11, 1953) viii, 534p. diagrs., photos., tabs. (Advisory Group for Aeronautical Research and Development)

Contents include 18 articles: Fundamental approach to laminar flame propagation, by Theodore von Karman and S. S. Penner. Aerothermodynamic study of combustion, by Jean Fabri. Diffusion processes as rate-controlling steps in laminar flame propagation, by Dorothy M. Simon. Some experimental results relating to laminar flame propagation, by J. W. Linnett. Ignition and combustion in a laminar mixing zone, by Frank E. Marble and Thomas C. Adamson, Jr. Use of spectroscopy in elucidating reaction mechanism, by A. G. Gaydon. Spectroscopic studies of premixed laminar flames, by S. S. Penner. A few results and classical methods of study for turbulent flows, by Jean-J. Bernard. Experimental studies on turbulent flames, by Arch C. Scurlock and John H. Grover. A turbulent flame theory derived from experiments, by Bela Karlovitz. The combustion of double-base propellants, by Gordon K. Adams and Leonard A. Wiseman. The mechanism of combustion of solid propellants, by Richard D. Geckler. Combustion of a single droplet and of a fuel spray, by D. B. Spalding. Combustion instability in liquid-propellant rocket motors - a survey, by Chandler C. Ross and Paul P. Datner. The problem of combustion at high altitude, by Peter Lloyd and Brian P. Mullins. Flame stabilization by bluff bodies, by M. Barrere and A. Mestre. Combustion in vitiated air, by Brian P. Mullins. Some properties of pulsating combustion: the pulse jet, action of doped fuels, by J. Bertin.

UNPUBLISHED PAPERS

N-19025*

THE DIVIDED-FLOW "ASPIN I" TURBOJET. (Le réacteur a double flux). M. Faury. May 1954. 25p. diagrs., photo., 3 tabs. (See also Docaero, no. 6, Nov., 1950, p. 19-38)

The propulsive efficiency of propellers, even of the most modern type, drops rapidly at speeds above 700/km/h, while that of jet engines is not important at speeds below 900 km/h. The range between these two limits, that of the heavy airplanes of tomorrow, demands a new propeller. The divided-flow turbojet, midway between turbojet and simple jet, seems best suited for this purpose.

National Advisory Committee for Aeronautics

Research Abstracts

NO. 65 **JUNE 22, 1954**

CURRENT NACA REPORTS

NACA Rept. 1132

LAMINAR BOUNDARY LAYER ON CONE IN SUPERSONIC FLOW AT LARGE ANGLE OF ATTACK. Franklin K. Moore. Appendix B: NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS. Lynn Albers. 1953. ii, 13p. diagrs. (NACA Rept. 1132. Formerly TN 2844)

The laminar boundary-layer flow about a cone at large angles of attack to a supersonic stream has been analyzed in the plane of symmetry. At the bottom of the cone, velocity profiles were obtained showing the expected tendency of the boundary layer to become thinner on the under side of the cone as the angle of attack is increased. At the top of the cone, the analysis failed to yield unique solutions, except for small angle of attack. Beyond a certain critical angle of attack, boundary-layer flow does not exist in the plane of symmetry, thus indicating separation.

NACA Rept. 1139

CHARTS AND APPROXIMATE FORMULAS FOR THE ESTIMATION OF AEROELASTIC EFFECTS ON THE LATERAL CONTROL OF SWEPT AND UNSWEPT WINGS. Kenneth A. Foss and Franklin W. Diederich. 1953. iii, 25p. diagrs., 2 tabs. (NACA Rept. 1139. Formerly TN 2747)

Charts and approximate formulas are presented for the estimation of static aeroelastic effects on the spanwise lift distribution, rolling-moment coefficient, and rate of roll due to aileron deflections on swept and unswept wings at subsonic and supersonic speeds. Some design considerations brought out by the results of this paper are discussed.

NACA Rept. 1148

A SPECIAL INVESTIGATION TO DEVELOP A GENERAL METHOD FOR THREE-DIMENSIONAL PHOTOELASTIC STRESS ANALYSIS. M. M. Frocht and R. Guernsey, Jr., Illinois Institute of Technology. 1953. ii, 17p. diagrs., photos., 3 tabs. (NACA Rept. 1148. Formerly TN 2822)

The method of strain measurement after annealing is reviewed and found to be unsatisfactory for the materials available in this country. A new, general method is described for the photoelastic determination of the principal stresses at any point of a general body subjected to arbitrary loads. The method has been applied to a sphere subjected to diametral compressive loads. The results show possibilities of high accuracy.

NACA RM 54D19

PRELIMINARY MEASUREMENTS OF TURBULENCE AND TEMPERATURE FLUCTUATIONS BEHIND A HEATED GRID. A. L. Kistler, V. O'Brien and S. Corrsin, Johns Hopkins University. June 1954. 24p. diagrs., photo. (NACA RM 54D19)

Preliminary measurements have been made of velocity and temperature fluctuations in the flow behind a heated grid in a uniform air stream. Temperature correlation shows a reasonable degree of isotropy, and the temperature fluctuations die out at large distances more slowly than the turbulence, as has been predicted theoretically under some strongly simplifying postulates.

NACA TN 3072

A THEORETICAL INVESTIGATION OF THE AERODYNAMICS OF WING-TAIL COMBINATIONS PERFORMING TIME-DEPENDENT MOTIONS AT SUPERSONIC SPEEDS. John C. Martin, Margaret S. Diederich and Percy J. Bobbitt. May 1954. 226p. diagrs., tab. (NACA TN 3072)

A theoretical investigation is presented on the contribution of the horizontal tail to the lift and pitching moment due to angle of attack, a constant rate of pitch, and a constant vertical acceleration. Numerical values of the aerodynamic coefficients associated with these motions are presented for a number of two-dimensional wing-tail combinations, a triangular-wing—triangular-tail combination, and a number of rectangular-wing—triangular-tail combinations. A method of treating unsteady aerodynamics based on an infinite series of stability derivatives of successively higher order is presented. Methods for calculating the flow fields behind wings with a constant vertical acceleration are developed. Calculated results are presented for the upwash behind two-dimensional wings and for certain regions behind triangular and rectangular wings for a constant rate of pitch and for a constant rate of vertical acceleration.

NACA TN 3150

METHOD FOR RAPID DETERMINATION OF PRESSURE CHANGE FOR ONE-DIMENSIONAL FLOW WITH HEAT TRANSFER, FRICTION, ROTATION, AND AREA CHANGE. James E. Hubbartt, Henry O. Slone and Vernon L. Arne. June 1954. 22p. diagrs., 2 tabs. (NACA TN 3150)

An approximate method for rapid determination of the pressure change for subsonic flow of a compressible fluid under the simultaneous action of heat transfer, friction, rotation, and area change is developed. In the development of this method, the momentum equation was approximated and re-

arranged for a convenient solution employing charts. This report presents the analysis involved in simplifying the momentum equation, the charts necessary for obtaining particular solutions, and comparisons with more rigorous numerical solutions with conditions typical for air-cooled turbine blades.

NACA TN 3174

INFLUENCE OF AIRFOIL TRAILING-EDGE ANGLE AND TRAILING-EDGE-THICKNESS VARIATION ON THE EFFECTIVENESS OF A PLAIN FLAP AT HIGH SUBSONIC MACH NUMBERS. Albert D. Hemenover and Donald J. Graham. June 1954. 101p. diagrs., photos., 5 tabs. (NACA TN 3174. Formerly RM A51C12a)

The effects of variation of trailing-edge angle and trailing-edge thickness on the characteristics of a 10-percent-chord thick NACA airfoil section with a 25-percent-chord plain flap are appraised from wind-tunnel tests at Mach numbers from 0.3 to 0.9 and Reynolds numbers varying correspondingly from 1 to 2 million. The airfoil trailing-edge angle was varied from 18° to 6°, and the trailing-edge thickness from zero to the thickness at the flap hinge line.

NACA TN 3207

ROLE OF NICKEL DIP IN ENAMELING OF SHEET STEEL. D. G. Moore, J. W. Pitts and W. N. Harrison, National Bureau of Standards. June 1954. 27p. diagrs., photos., 8 tabs. (NACA TN 3207)

An investigation was made of the effects of the firing time and the weight of the nickel deposited from the nickel-dip solution on the adherence developed by a cobalt-free and a cobalt-bearing ground-coat enamel on both enameling iron and a titanium-bearing low-carbon steel.

NACA TN 3215

TESTS OF BONDED AND RIVETED SHEET-STRINGER PANELS. Leonard Mordfin and I. E. Wilks, National Bureau of Standards. June 1954. 45p. diagrs., photos., 5 tabs. (NACA TN 3215)

Bending and compression tests were performed on 21 sheet-stringer panels of 75S-T6 aluminum alloy having alclad sheets nominally 0.051 inch thick and stringers nominally 3-1/2 inches apart. Nine panels had I-stringers bonded to the sheets with Araldite Type I adhesive, three panels had I-stringers bonded to the sheets with Metlbond adhesive, and nine panels had Z-stringers riveted to the sheets. All tests were carried to failure and strain and deformation measurements were made. The test results did not indicate any great superiority of one type of construction over the other but rather that the choice in any given case would depend upon the particular designs being compared. They also showed that the scatter of results obtained with bonded construction was not significantly greater than that obtained with riveted construction and that cleavage was not always the governing factor in the strength of bonded panels.

BRITISH REPORTS

N-30793*

Royal Aircraft Establishment (Gt. Brit.)
A HIGH SPEED ELECTRO-MECHANICAL MULTIPLIER. C. A. A. Wass and D. W. Allen. February 1954. 13p. diagrs., photos. (RAE Tech.Note GW 300)

Requirements exist in simulator work for a simple high-speed squaring and multiplying unit of moderate accuracy. This note describes a simple electro-mechanical multiplier using a type E.4 relay as a position servo driving a potentiometer. The unit will operate on frequencies up to 15 cps without introducing any appreciable phase shift. Accuracy depends primarily on the quality of the potentiometers used but maximum errors of 1 percent of the maximum output appear possible.

N-30835*

Royal Aircraft Establishment (Gt. Brit.)
A NOTE ON THE USE OF STRAIN GAUGES IN WIND TUNNEL BALANCES. J. R. Anderson. January 1954. 28p. diagrs., photos. (RAE Tech. Note Aero 2290)

This note is substantially that presented at the NATO/AGARD wind tunnel and model testing panel on September 3, 1953. It reviews briefly some of the experience obtained in the employment of wind-tunnel balances using bonded, resistance type electrical strain gages, in the smaller high-speed wind tunnels of Aerodynamics Department. The effects of temperature on the strain gages are discussed and shown to be a major limitation in their use. A self-balancing potentiometer instrument, specially designed and developed for use with wind-tunnel strain-gage balances, is also described briefly.

N-30837*

Marine Aircraft Experimental Establishment (Gt. Brit.) THE DEVELOPMENT OF A MINIATURE PRESSURE PICK-UP. J. K. Friswell. March 1954. 10p. diagrs., photos. (MAEE F/TN/3)

Details are given of the construction of a miniature pressure pickup of the diaphragm and strain-gaged cantilever type. The unit is cylindrical, with overall diameter 1 inch and overall length 2 inches, its weight being 1.9 ounces. It is designed to operate in the range 0-20 psi and will record either positive or negative pressures. It can be readily adapted for use over a much greater pressure range. It is easy to service.

N-30839*

Marine Aircraft Experimental Establishment (Gt. Brit.) ASSESSMENT OF REVERSIBLE PITCH PROPELLER TRAIL INSTALLATION - SOLENT N. J. 201. J. Taylor. March 1954. 23p. diagrs., photos., 2 tabs. (MAEE F/TN/2)

An assessment was required on the operation of the reversible pitch propeller trial installation, on the Solent N. J. 201, as part of a general research program for seaplanes. Results are given with the reversing pitch propellers fitted to the inboard engines in tests on low speed maneuvering, particularly in buoy approaches, and when used as braking units during landing. Some brief turning circle measurements have also been done.

N-30843*

Aeronautical Research Council (Gt. Brit.) THE PERFORMANCE OF THE 108 COMPRESSOR FITTED WITH LOW STAGGER FREE VORTEX BLADING. D. V. Foster. 1954. 36p. diagrs., photos. (ARC CP 144)

A large three-stage compressor is described which is designed for detail three-dimensional flow investigations. Particular attention has been paid to the accuracy of measurement on the rig and it is shown that the main errors are due to the unsteady nature of the flow and to speed fluctuations. Test characteristics of the first set of low stagger free vortex blading are presented and compared with various theoretical performance calculations. A description of the surging behavior of the compressor and the effect of blade position upon the measured static pressure are given.

N-30844*

Aeronautical Research Council (Gt. Brit.) ZERO LIFT DRAG MEASUREMENTS ON SWEPT WINGS AT TRANSONIC AND SUPERSONIC SPEEDS USING THE GROUND-LAUNCHED ROCKET-BOOSTED MODEL TECHNIQUE. T. Lawrence and C. Kell. 1954. 35p. diagrs., photo., tab. (ARC CP 145)

This is mainly a documentary record of drag measurements on 14 swept wings varying in plan form from deltas to swept untapered wings from 4 percent to 10 percent thick. Results are compared with theory for wings of double-wedge section; an attempt is made to check the validity of supersonic similarity laws. Three primary conclusions are drawn; at supersonic speeds, wave drag of a given wing varies as the square of thickness ratio; supersonic similarity law allows drag of "similar" wings to be compared; drag of round-nose wings perhaps may be estimated from calculations of drag of double-wedge wings.

N-30845*

Aeronautical Research Council (Gt. Brit.) VIBRATION AND FLUTTER OF AIRCRAFT AERIALS. W. H. Johnson. 1954. 15p. diagrs., photos. (ARC CP 146)

Fatigue failures of blade and whip aircraft aerials have been investigated and it is shown that stalling flutter and mechanically excited vibration have both contributed in large measure to the failures. All the aerial types involved possess considerable flexibility and very low internal damping. It is shown that the introduction of damping into the mounting of the aerials has a very beneficial effect on their behavior as regards both flutter and mechanically excited vibration. Methods are described for preventing failure from either cause.

N-30846*

Aeronautical Research Council (Gt. Brit.) FACTORS INFLUENCING THE OPTIMUM AERODYNAMIC DESIGN OF COOLED TURBINES. G. F. C. Rogers. 1954. 27p. diagrs. (ARC CP 155)

Owing to the losses in performance which increase with the rate of heat extraction required for turbine cooling, it is desirable to know what range of aerodynamic designs is associated with low values of this quantity. Different aerodynamic designs of turbine, all passing the same mass flow and having approximately the same disc and blade stresses, have been compared on the basis of the ratio of heat extraction rate to work output. It is found that high values of flow coefficient are beneficial in this respect, and that impulse turbines have a slight advantage over reaction turbines.

N-30847*

Aeronautical Research Council (Gt. Brit.) THE EFFECT OF ROLLING ON FIN-AND-RUDDER LOADS IN YAWING MANOEUVRES. D. R. Puttock. 1954. 31p. diagrs., 3 tabs. (ARC CP 153)

Exact solutions are derived for angle of sideslip and fin-and-rudder loads for an aircraft performing two yawing maneuvers induced by the rudder. Angles of sideslip and fin-and-rudder loads are then calculated for three selected aircraft and compared with results obtained by a simplified method in which rolling motion is neglected. Further calculations are made using a modified method in which the coefficients of the response formulas of the simplified method have been adjusted to take some account of rolling. The analysis shows that errors of 20 percent may be incurred if rolling is neglected in the estimation of fin-and-rudder loads for aircraft with swept and delta wings.

N-30895*

Royal Aircraft Establishment (Gt. Brit.)
SECONDARY FLOW IN A BOUNDARY LAYER. L. Sowerby. March 1954. 21p. diagrs., tab. (RAE Aero 2512)

The laminar boundary layer on a flat plate is considered. It is shown that a secondary flow in the boundary layer is a consequence of curvature in the streamlines of the mainstream flow (in planes parallel to the plate). The special case in which the streamlines form a family of translates is discussed and the equations of possible families of streamlines are determined. The boundary-layer equations are solved in the case where the streamlines are a family of equal parabolas; this leads to an extension of Blasius' result for uniform flow over a flat plate. Finally, in the appendix, the skin friction coefficient is calculated, from which is obtained a quantity analogous to the profile-drag coefficient of a swept wing, for comparison with the results of Weber and Brebner for the latter case. The comparison confirms the assumptions made by them in the development of their theory.

N-30898*

Royal Aircraft Establishment (Gt. Brit.)
NOTES ON THE RESPONSE OF A LINEAR VIBRATION SYSTEM TO IMPACT LOADING. H. K. P. Neubert. March 1954. 21p. diagrs. (RAE Tech. Note Instn. 138)

In the course of investigations into the effect of impact loadings, the general equations for deflection, velocity, and acceleration of a linear system of one degree of freedom with velocity damping have been derived for a case of a mass being dropped onto a spring (with negligible mass). Response curves are plotted and discussed for two idealized cases of aircraft landing, and for a drop table test. The possible errors for a proposed integrating touch-down velocity meter are discussed. Frequency spectra for three typical impact curves have been computed and the error introduced when measuring the impact with an accelerometer of inadequate frequency response is discussed.

MISCELLANEOUS

NACA Rept. 1028

Errata No. 1 on "EFFECT OF ASPECT RATIO ON THE AIR FORCES AND MOMENTS OF HARMONICALLY OSCILLATING THIN RECTANGULAR WINGS IN SUPERSONIC POTENTIAL FLOW." Charles E. Watkins. 1951.

UNPUBLISHED PAPERS

N-1726*

ON SEVERAL MEASURES, TAKEN IN PRACTICE, FOR ELIMINATING OSCILLATORY YAW WITH FREE RUDDER. (Über einige praktisch durchgeführte Massnahmen zur Beseitigung von Gierschwingungen mit losem Ruder). R. Schmidt. April 1954. 10p. diagrs., photo. (Trans. from Lilienthal-Gesellschaft für Luftfahrtforschung, Berlin, Bericht 143, Nov. 6-7, 1941, p. 22-24)

Measures, tested and carried out on several airplanes at Dornier works when unsatisfactorily damped oscillatory yaw had occured, and its elimination by modifications of the tail had not been possible, are discussed. The two groups of measures discussed are measures which augment the increase of rudder moment in the region of zero position of the controls; and measures which impede the free motion relative to the air of the rudder.

N-31386*

MEASURES FOR ELIMINATION OF OSCILLATORY YAW WITH FREE RUDDER. (Massnahmen zur Beseitigung von Gierschwingungen mit losem Seitenruder). H. G. Schumann. April 1954. 6p. diagrs. (Trans. from Lilienthal-Gesellschaft für Luftfahrtforschung, Berlin, Bericht 143, Nov. 6-7, 1941, p. 27-29)

Experiences are given which were made with the Ju 88 in controlling oscillatory yaw with free rudder. This method of attaining the degree of rudder load reduction required in the individual case by the control force itself, involved the return to harmless variations of rudder-self-adjustment and eliminated thus for a long time the difficulties occurring now and again at other firms.

N-31449*

THEORETICAL AND EXPERIMENTAL STUDY OF THE MEANS OF PROTECTING AN AIRPLANE FROM GUST ACCELERATIONS. CHAPTER VIII - EXPERIMENTAL STUDY. (Recherches théoriques et expérimentales sur les moyens de soustraire un avion aux accélérations que peuvent engendrer les perturbations atmosphériques. Chapitre VIII - Étude expérimentale). René Hirsch. February 1954. 45p. diagrs., photos. (Trans. from Ministère de l'Air. Publications Scientifiques et Techniques, no. 138, 1938)

Changes in direction and intensity of the relative wind which strikes the airplane in flight induce changes in the total hinge moment of the controlled aileron so that the consecutive rotations of the latter produce exactly defined variations of the total lift coefficient. Two basic airfoils were studied, the Potez 403 and NACA 23012.

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1140

CHARTS AND APPROXIMATE FORMULAS FOR THE ESTIMATION OF AEROELASTIC EFFECTS ON THE LOADING OF SWEPT AND UNSWEPT WINGS. Franklin W. Diederich and Kenneth A. Foss. 1953. iii, 48p. diagrs., 3 tabs. (NACA Rept. 1140. Formerly TN 2608)

Charts are presented for the estimation of aeroelastic effects on spanwise lift distribution, lift-curve slope, aerodynamic center, and damping in roll of swept and unswept wings at subsonic and supersonic speeds. Some design considerations brought out by the results of this paper are discussed.

NACA TM 1375

ON THE THREE-DIMENSIONAL INSTABILITY OF LAMINAR BOUNDARY LAYERS ON CONCAVE WALLS. (Über eine dreidimensionale Instabilität laminarer Grenzschichten an konkaven Wänden). H. Görtler. June 1954. 32p. diagrs. (NACA TM 1375. Trans. from Gesellschaft der Wissenschaften zu Göttingen, Nachrichten, Mathematik, v. 2, no. 1, 1940)

A study is made of the stability of laminar boundary-layer profiles on slightly curved walls relative to small disturbances that result from vortices whose axes are parallel to the principal direction of flow. The result is an eigenvalue problem by which, for a given undisturbed flow at a prescribed wall, the amplification or decay is computed for each Reynolds number and each vortex thickness. For neutral disturbances (zero amplification) a critical Reynolds number is determined for each vortex distribution. The numerical calculation produces amplified disturbances on concave walls only.

NACA RM E54E03

EFFECT OF HIGH PRESSURE ON SMOKING TENDENCY OF DIFFUSION FLAMES. Glen E. McDonald and Rose L. Schalla. June 1954. 7p. diagrs., tab. (NACA RM E54E03)

The variation in smoking tendency of a diffusion flame was measured over a pressure range of 4 to 20 atmospheres (abs) for the two fuel types ethane and ethylene. The fuels were burned as diffusion flames inside a pressure vessel equipped with windows for observation of the flame. It was found that the changes in flame height, which measures the relative amount of fuel that can be burned without producing smoke, vary inversely with the pressure.

NACA TN 3130

A PROCEDURE FOR THE DESIGN OF AIR-HEATED ICE-PREVENTION SYSTEMS. Carr B. Neel, Jr. June 1954. 63p. diagrs., photo. (NACA TN 3130)

The procedure to be followed in the design of aircraft ice-prevention equipment in which the components are protected by means of internally circulated heated air is outlined. In addition to presentation of the required heat-transfer and air-pressure-loss equations, a simple electrical analogue is described which was devised to facilitate the design of an air-heated system. An illustration is given of the application of the analogue to a design problem.

NACA TN 3153

VARIATION OF LOCAL LIQUID-WATER CONCENTRATION ABOUT AN ELLIPSOID OF FINENESS RATIO 5 MOVING IN A DROPLET FIELD. Robert G. Dorsch and Rinaldo J. Brun. July 1954. 68p. diagrs., photos., 2 tabs. (NACA TN 3153)

Analyses of calculated water-droplet trajectories show that the concentration of liquid water at various points about an ellipsoid of revolution moving through a droplet field varies considerably. Curves of local concentration factor as a function of spatial position are presented in terms of dimensionless parameters.

NACA TN 3154

INFRARED SPECTRA OF 47 DICYCLIC HYDROCARBONS. John H. Lamneck, Jr., Harold F. Hipsher and Virginia O. Fenn. June 1954. 34p. diagrs., 5 tabs. (NACA TN 3154)

The infrared spectra are presented for 47 dicyclic hydrocarbons consisting of some alkyldiphenylmethanes, alkyldicyclohexylmethanes, alkylnaphthalenes, alkyltetralins, 1,3-diphenyl-2-alkylpropanes and 1,3-dicyclohexyl-2-alkylpropanes. The physical properties of these highly purified compounds are included for reference purposes.

NACA TN 3161

AN INVESTIGATION OF THE USE OF ROCKET-POWERED MODELS FOR GUST-LOAD STUDIES WITH AN APPLICATION TO A TAILLESS SWEPT-WING MODEL AT TRANSONIC SPEEDS. A. James Vitale, H. Press and C. C. Shufflebarger. June 1954. 36p. diagrs., photos., tab. (NACA TN 3161)

*AVAILABLE ON LOAN ONLY.

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Flight tests in continuous rough air at transonic speeds have been made of a tailless 45° sweptback-wing rocket model as part of a program to investigate the feasibility of using existing rocket-model techniques for obtaining gust-loads information. The results of airplane flight surveys for determining a working basis for forecasting and selecting suitable test days are presented. Use is made of power-spectral methods of generalized harmonic analysis in presenting both the experimental and calculated characteristics of load response in rough air of a configuration having low damping in pitch.

NACA TN 3168

A NEW HODOGRAPH FOR FREE-STREAMLINE THEORY. Anatol Roshko, California Institute of Technology. July 1954. 39p. diagrs., 3 tabs. (NACA TN 3168)

The Helmholtz-Kirchhoff method for separated flow past a flat plate normal to the stream is modified to allow arbitrary separation velocity and base pressure so that values more in conformity with experiment may be chosen. The solution depends on a single base-pressure parameter k. The computations depend on a particular choice of free-streamline hodograph which gives a definite wake width for every value of k. In this way the wake width is correlated with the drag. Examples are worked out for a wedge and a circular cylinder.

NACA TN 3169

ON THE DRAG AND SHEDDING FREQUENCY OF TWO-DIMENSIONAL BLUFF BODIES. Anatol Roshko, California Institute of Technology. July 1954. 29p. diagrs., tab. (NACA TN 3169)

A semiempirical study was made of the bluff-body problem. The relation between the wake and the potential flow outside the wake and cylinder was studied and some experiments were made with interference elements in the wake close behind a cylinder. Free-streamline theory was combined with experimental results to obtain a correlation between bluff cylinders of different shapes.

NACA TN 3171

SOME NEW DRAG DATA ON THE NACA RM-10 MISSILE AND A CORRELATION OF THE EXISTING DRAG MEASUREMENTS AT M = 1.6 AND 3.0. Robert J. Carros and Carlton S. James. June 1954. 24p. diagrs., photos., tab. (NACA TN 3171)

Measurements of the zero-lift total drag of the NACA RM-10 missile were made on gun-launched, free-flight models at Mach numbers of 1.6 and 3.0 and corresponding Reynolds numbers of 3.0 million and 5.0 million. Results showed transition location to have an important effect on the drag. Results of this and several other investigations were correlated on the basis of considerations of Mach number, Reynolds number, transition location, and heat-transfer effects.

NACA TN 3180

DETERMINATION OF VISCOSITY OF EXHAUST-GAS MIXTURES AT ELEVATED TEMPERATURES. J. C. Westmoreland, National Bureau of Standards. June 1954. 41p. diagrs., photo., 10 tabs. (NACA TN 3180)

The viscosities of five samples of dry-exhaust-gas mixtures at approximately atmospheric pressure and at temperatures of from 0° to 1,100° C are presented. A method of analysis and correlation proposed by Sutherland has been applied to the data and equations were derived therefrom for representing the results. It is believed that these equations may be used for computing viscosities of all mixtures having compositions within the range of the five studied at any temperature up to about 1,300° C. The effect of moisture upon the viscosity of exhaust gas was computed by a relation developed from experimental values for moist air.

NACA TN 3185

TABLES FOR THE COMPUTATION OF WAVE DRAG OF ARROW WINGS OF ARBITRARY AIRFOIL SECTION. Frederick C. Grant and Morton Cooper. June 1954. 9p. diagr., 28p. tabs. (in pocket) (NACA TN 3185)

Tables and computing instructions are presented for the rapid evaluation of the wave drag of delta wings and of arrow wings having a ratio of the tangent of the trailing-edge sweep angle to the tangent of the leading-edge sweep angle from -1.0 to 0.8. The tables cover a range of both subsonic and supersonic leading edges.

NACA TN 3187

THE NEAR NOISE FIELD OF STATIC JETS AND SOME MODEL STUDIES OF DEVICES FOR NOISE REDUCTION. Leslie W. Lassiter and Harvey H. Hubbard. July 1954. 38p. diagrs., photos. (NACA TN 3187)

Experimental studies of the pressure fluctuations near jets were made during unchoked operation of both a full-scale turbojet engine and a 1-inch-diameter high-temperature model jet and during choked operation of model jets of 0.275-inch to 2.00-inch diameter with unheated air. Frequency spectra and spatial distributions of pressure magnitude are given for the full-scale configuration and model data are used to illustrate probable trends at different operating conditions for the unchoked jets. Model tests for choked operation indicate the presence of a discrete-frequency component, and shadowgraph records illustrate that an unusual type of flow formation is associated with this condition. The frequency of this component is shown to be somewhat related to the shock-separation distances and to nozzle diameter. Laboratory methods of reducing the magnitude of pressure fluctuations from choked and unchoked jets are discussed and sample illustrations are given.

NACA TN 3188

AN ANALYTICAL INVESTIGATION OF AIRPLANE SPIN-RECOVERY MOTION BY USE OF ROTARY-BALANCE AERODYNAMIC DATA. Stanley H. Scher. June 1954. 38p. diagrs., tab. (NACA TN 3188)

A method for analytically investigating the motions of an airplane while in a spin or a recovery from the spin by use of applicable equations of motion, modified wind-tunnel rotary-balance measurements, and spin-geometry relationships is presented and applied to the step-by-step calculation of the spin recovery for one airplane configuration. Difficulties encountered in applying the rotary-balance data in the calculations are discussed, and it is pointed out that certain inconsistencies must be cleared up before the method can be accepted as adequate to give detailed spin-recovery motions for a specific airplane.

NACA TN 3193

AN EXPLORATORY INVESTIGATION OF SKIN FRICTION AND TRANSITION ON THREE BODIES OF REVOLUTION AT A MACH NUMBER OF 1.61. John H. Hilton, Jr. and K. R. Czarnecki. June 1954. 15p. diagrs. (NACA TN 3193)

The present report contains results of an exploratory investigation of the effects of pressure gradient on skin friction and boundary-layer transition of three bodies of revolution at a Mach number of 1.61. The pressure gradients investigated were those obtained on an ogive-cylinder, a cone-cylinder, and a blunt-base (NACA RM-10) parabolic body, all having a fineness ratio of 12.2. Tests were made at zero angle of attack and over a Reynolds number range, based on body length, from about 2.5×10^6 to 37×10^6.

NACA TN 3194

STATISTICAL MEASUREMENTS OF CONTACT CONDITIONS OF 478 TRANSPORT-AIRPLANE LANDINGS DURING ROUTINE DAYTIME OPERATIONS. Norman S. Silsby. June 1954. 32p. diagrs., photos., 3 tabs. (NACA TN 3194)

Statistical measurements have been obtained from photographs taken with a specially built motion-picture camera of 478 landings of present-day transport airplanes during routine daylight operations in clear air at the Washington National Airport. From these measurements, sinking speeds, bank angles, rolling velocities, and horizontal speeds have been evaluated and a limited statistical analysis of the results has been made. An attempt was made to determine the effect of various parameters such as gusty-wind conditions, wing loading, and size of airplane (number of engines) which influence the landing contact conditions.

NACA TN 3195

TIME-TEMPERATURE PARAMETERS AND AN APPLICATION TO RUPTURE AND CREEP OF ALUMINUM ALLOYS. George J. Heimerl. June 1954. 35p. diagrs., tab. (NACA TN 3195)

The application of time-temperature parameters to stress-strain, rupture, and creep data for metals and alloys is reviewed. Some comparisons are made of theoretical and experimental parameters. A parameter based upon rate-process theory was successfully applied to rupture and creep data for aluminum and various aluminum alloys. The value of the constant in the parameter, which provided the best correlation of the data, was determined for each material and application. Master curves of stress against the parameter which summarize extensive data on the aluminum alloys are presented for rupture, minimum creep rate, and time to 1 or 2 percent strain. Predictions of long-time life from short-time data are shown to be possible.

NACA TN 3198

DYNAMIC STABILITY AND CONTROL CHARACTERISTICS OF A CASCADE-WING VERTICALLY RISING AIRPLANE MODEL IN TAKE-OFFS, LANDINGS, AND HOVERING FLIGHT. Marion O. McKinney, Louis P. Tosti and Edwin E. Davenport. June 1954. 45p. diagrs., photos., tab. (NACA TN 3198)

An investigation has been made to determine the stability and control characteristics of a cascade vertically rising airplane model in the take-off, landing, and hovering phases of flight. The model had four propellers with the shaft axes essentially parallel to the fuselage axis and distributed along the span so that the four wings, which were arranged in cascade relation to turn the slipstream downward approximately 90°, were completely immersed in the slipstream of the propellers.

NACA TN 3202

OSCILLATING PRESSURES NEAR A STATIC PUSHER PROPELLER AT TIP MACH NUMBERS UP TO 1.20 WITH SPECIAL REFERENCE TO THE EFFECTS OF THE PRESENCE OF THE WING. Harvey H. Hubbard and Leslie W. Lassiter. July 1954. 35p. diagrs., photos., tab. (NACA TN 3202)

Static tests were conducted for the measurement of free-space oscillating pressures near the propeller in the region where a wing might be located for the tip Mach number range of 0.50 to 1.20. Some measurements were also made near the tips in the region of the fuselage in order to extend the range of existing work from a tip Mach number of 1.00 to 1.20. Some comparisons of these results with theory are given. In addition to a description of the free-space pressure field, measurements are given for some of the same field points with a wing in place. Charts based on experimental data are presented to enable a designer to estimate the maximum free-space oscillating pressures near the propeller for tip Mach numbers up to 1.20.

NACA TN 3204

AN INVESTIGATION OF THE CREEP LIFETIME OF 75S-T6 ALUMINUM-ALLOY COLUMNS. Eldon E. Mathauser and William A. Brooks, Jr. July 1954. 28p. diagrs., photos., tab. (NACA TN 3204)

The results of short-time elevated-temperature creep tests of 75S-T6 aluminum-alloy columns are presented and examined with the objective of obtaining procedures for predicting column lifetime. Semiempirical lifetime curves are obtained with the aid of a previously published column creep theory and are used for deriving column curves. A study is made of the effects of variations of stress and out-of-straightness on column lifetime. Small variations in out-of-straightness have been found to be of little practical significance; whereas, small stress variations change the column lifetime considerably. Plots that do not explicitly include out-of-straightness are presented and may be satisfactory for predicting column lifetime for design purposes.

NACA TN 3214

FUNDAMENTAL STUDY OF EROSION CAUSED BY STEEP PRESSURE WAVES. B. G. Rightmire and J. M. Bonneville, Massachusetts Institute of Technology. June 1954. 30p. diagrs., photos., 2 tabs. (NACA TN 3214)

A fundamental study of erosion caused by steep pressure waves has been carried out. It is believed that the study gives an insight to the possible causes of damage in high-speed sleeve bearings. In particular, the effect on annealed copper surfaces of steep-fronted pressure waves in oil has been studied, the general conclusion being that cavitation of the oil is the probable cause of damage.

NACA TN 3220

AERODYNAMIC LOADS ON A LEADING-EDGE FLAP AND A LEADING-EDGE SLAT ON THE NACA 64A010 AIRFOIL SECTION. John A. Kelly and George B. McCullough. June 1954. 33p. diagrs., 8 tabs. (NACA TN 3220)

Loads data in the form of chordwise distributions of pressure, normal-force, chord-force, and moment-coefficients are presented for a leading-edge flap and leading-edge slat installed on a two-dimensional NACA 64A010 airfoil. Pressure data for various model arrangements are presented in tabular form. The data were obtained for a Reynolds number of 6 million.

NACA TN 3221

STUDY OF THE SUBSONIC FORCES AND MOMENTS ON AN INCLINED PLATE OF INFINITE SPAN. Bradford H. Wick. June 1954. 25p. diagrs. (NACA TN 3221)

A study has been made of the flow about an inclined plate, the forces on the plate, the adequacy of theory in predicting the forces, and the extent to which the force characteristics of the plate are indicative of those of thin airfoil sections.

NACA TN 3222

MEASUREMENT OF HEAT TRANSFER IN THE TURBULENT BOUNDARY LAYER ON A FLAT PLATE IN SUPERSONIC FLOW AND COMPARISON WITH SKIN-FRICTION RESULTS. C. C. Pappas. June 1954. 32p. diagrs., tab. (NACA TN 3222)

Local heat-transfer rates and average skin-friction coefficients on the surface of a heated flat plate at zero incidence to the air stream at Mach numbers of 1.69 and 2.27 are presented for a Reynolds number range of 10^6 to 10^7. The variation of heat transfer with Mach number was found to be the same as that of directly measured skin friction on unheated bodies.

NACA TN 3228

AERODYNAMIC INVESTIGATION OF A FOUR-BLADE PROPELLER OPERATING THROUGH AN ANGLE-OF-ATTACK RANGE FROM 0° TO 180°. H. Clyde McLemore and Michael D. Cannon. June 1954. 62p. diagrs., photo. (NACA TN 3228)

The results of an investigation in the Langley full-scale tunnel of the aerodynamic characteristics of a four-blade, 5.33-foot diameter propeller are presented for angles of attack from 0° to 180°, blade angles from 0° to 67.5°, and a range of advance ratio from 0 to 6.2. The results include a preliminary exploration of vertical descent and a comparison with theory of the rate of change of the normal-force coefficient with angle of attack and the aerodynamic characteristics of the propeller at zero angle of attack.

NACA TN 3230

INVESTIGATION OF DISTRIBUTED SURFACE ROUGHNESS ON A BODY OF REVOLUTION AT A MACH NUMBER OF 1.61. K. R. Czarnecki, Ross B. Robinson and John H. Hilton, Jr. June 1954. 35p. diagrs., photo., 2 tabs. (NACA TN 3230)

An investigation has been conducted in the Langley 4- by 4-foot supersonic pressure tunnel to study the effect of surface roughness on the skin friction and temperature-recovery factor of an ogive-cylinder body of revolution at a Mach number of 1.61. Tests of models having four different surface roughnesses were made at zero angle of attack through a Reynolds number range (based on body length) of 2.5×10^6 to 37×10^6. The drag, base pressure, and surface temperatures were measured for conditions of natural and fixed transition.

BRITISH REPORTS

N-30870*

Aeronautical Research Council (Gt. Brit.)
A BRIEF REVIEW OF THE PROBLEM OF EXHAUST SILENCING. F. L. West. 1954. 13p. diagrs. (ARC R & M 2803; ARC 9714. Formerly RAE Tech. Note Gas 20)

This note reviews past and present work on noise reduction of the reciprocating engine exhaust. Collected measurements of the noise level surrounding various engine installations and the effect of silencing experiments on engine and aircraft performance are presented. Some observations of gas turbine noises are also included.

N-30871*

Aeronautical Research Council (Gt. Brit.)
REPORT ON THE FLOW PHENOMENA AT SUPERSONIC SPEED IN THE NEIGHBOURHOOD OF THE ENTRY OF A PROPULSIVE DUCT. G. H. Lean. 1954. 15p. diagrs., photos. (ARC R & M 2827. Formerly ARC 11,868; EAP 94)

With a parallel entry duct followed by a straight divergent diffuser of 10° total angle, the flow inside the parallel tube was supersonic provided the outlet pressure of the diffuser was less than a certain critical value. For pressure higher than the critical value, the flow became subsonic at the duct entry, a shock wave was formed at the entrance lip and the rate of air flow through the tube decreased. For outlet pressure less than critical, the flow was supersonic for a distance inside the duct entry depending on the outlet pressure, the flow becoming subsonic further along the duct. Annular type intakes gave lower pressure recoveries than the unobstructed type.

N-30872*

Aeronautical Research Council (Gt. Brit.)
THE USE OF TENSOR NOTATION TO DEVELOP CHARACTERISTIC EQUATIONS OF SUPERSONIC FLOW. C. N. H. Lock and R. C. Tomlinson. 1954. 18p. diagrs. (ARC R & M 2632; ARC 11,584. Formerly ARC 12,206; FM 1341)

General equations of steady motion of a nonviscous fluid are given in tensor notation. It is assumed that one family of coordinate surfaces, x^{a} = constant, are characteristic surfaces, that is, surfaces in which the transverse derivatives of the flow variables are not determined by their values on the surface itself. The condition for this gives the result that the velocity normal to the surface is sonic. The relation which must then hold between the variables on the surface itself is also determined (characteristic equation). Simplicity gives a deeper insight into behavior of axisymmetric and two-dimensional flows.

N-30873*

Aeronautical Research Council (Gt. Brit.)
THE FLUTTER OF SWEPT AND UNSWEPT WINGS WITH FIXED-ROOT CONDITIONS. PART I - WIND-TUNNEL EXPERIMENTS. PART II - COMPARISON OF EXPERIMENT AND THEORY. PART III - WING TORSIONAL STIFFNESS CRITERION. W. G. Molyneux. 1954. 23p. diagrs., 4 tabs. (ARC R & M 2796; ARC 13,306. Formerly RAE Structures 58)

The "fixed-root" flexure-torsion flutter characteristics of four model wings of different taper ratios have been investigated in the wind tunnel. The wing interia axis and the angle of sweepback have been varied on each wing over the ranges 0.4c and 0.5c and 0° to 50°, respectively.

N-30874*

Aeronautical Research Council (Gt. Brit.)
CRITICAL MACH NUMBERS FOR THIN UNTAPERED SWEPT WINGS AT ZERO INCIDENCE. S. Neumark. 1954. 74p. diagrs., 12 tabs. (ARC R & M 2821; ARC 13,541. Formerly RAE Aero 2355)

This report is a continuation of two previous papers. Subsonic flow is further investigated using linear theory. Methods for calculating "lower" and "upper" critical Mach numbers are given, the solution for the main problem being preceded by a short analysis of critical Mach numbers for the simpler cases of infinite wings. Critical Mach numbers for wings with four different profiles, showing the effect of thickness ratio and of sweepback angle, are determined. The method applies strictly to wings of large aspect ratio. Several conclusions concerning the practical use of swept-wing design are presented.

N-30875*

Aeronautical Research Council (Gt. Brit.)
DETERMINATION OF REVERSAL SPEED OF A WING WITH A PARTIAL-SPAN FLAP AND INSET AILERON. W. G. Molyneux and E. G. Broadbent. 1954. 10p. diagrs., tab. (ARC R & M 2793; ARC 13,308. Formerly RAE Tech. Note Structures 23)

Control reversal due to deformation of a wing with a partial-span flap and inset aileron is considered theoretically for the particular case of a flap held at the root end. The semirigid method is used. An investigation is made for a particular aircraft. The calculated reversal speed is found to be considerably lower than for the straight-forward wing-aileron case. The effect of variation of the degrees of wing and flap constraint is also considered. It is concluded that an increase in reversal speed is best obtained by an increase in flap root stiffness.

N-30876*

Aeronautical Research Council (Gt. Brit.)
WIND-TUNNEL TESTS ON TWO-DIMENSIONAL SUPERSONIC AEROFOILS AT M = 1.86 AND M = 2.48. D. Beastall and R. J. Pallant. 1954. 20p. diagrs., photos., 4 tabs. (ARC R & M 2800; ARC 13,768. Formerly RAE Aero 2384)

Unswept double-wedge and circular-arc airfoils were used to study the viscous effects which are not accounted for in the linearized and shock-expansion airfoil theories. Characteristics derived from measured surface pressures are compared with theoretical values. Schlieren observation was employed to observe the flow and, in particular, the separation near the trailing edges. Wires caused a delay in separation; pitot-tube traverses indicated the velocity profiles. The position of separation was also examined by means of oil.

N-30877*

Aeronautical Research Council (Gt. Brit.)
GENERAL PERFORMANCE CALCULATIONS FOR GAS TURBINE ENGINES. D. H. Mallinson. 1954. 58p. diagrs. (ARC R & M 2684; ARC 10,552. Formerly Power Jets Rept. R. 1214)

An attempt is made to summarize theoretical work carried out during the past few years aimed at discovering the potentialities of the gas turbine as power plant in many fields of application, especially as an aircraft power unit. The performance of various modification of the ideal gas turbine cycle is considered in some detail. Works of various authors are combined and edited in order to depict performance attainable by practical engines. Association between the gas turbine and jet reaction is considered. A method of estimating performance of a simple jet engine is detailed.

N-30878*

Aeronautical Research Council (Gt. Brit.)
VELOCITY DISTRIBUTION ON THIN BODIES OF REVOLUTION AT ZERO INCIDENCE IN INCOMPRESSIBLE FLOW. S. Neumark. 1954. 42p. diagrs. (ARC R & M 2814; ARC 13,756. Formerly RAE Aero 2389)

A new method of determining velocity distribution on slender bodies of revolution in axial flow is expounded, analogous to the linear perturbation method widely used for slender symmetrical profiles in two dimensions. The proposed method leads to simple approximate formulas for velocity distribution on a body, once the equation of the meridian line is given, either in the form of a polynomial, of a square root of one. The method has been used for computing velocity distributions on 12 different bodies, of seven different thickness ratios each, so as to exhibit the most characteristic features in typical cases, and to show some effects of thickness changes.

N-30990*

Royal Aircraft Establishment (Gt. Brit.)
PRESSURE DISTRIBUTIONS ILLUSTRATING FLOW REATTACHMENT BEHIND A FORWARD MOUNTED FLAP. E. C. Maskell. March 1954. 23p. diagrs., tab. (RAE Tech. Note Aero 2295)

A series of pressure distributions over an NACA.0015 wing with a forward mounted 5-percent chord split flap are presented. The results, obtained by Clarke in 1946, have not previously been published. Two basic types of pressure distribution are identified; and these are associated with fully detached flow behind the flap, and with reattachment of the flow to the wing surface. An intermediate type - corresponding, it is suggested, to reattachment in the neighborhood of the wing trailing edge - is also identified. The physical nature of the flow behind a flap is considered and some ideas on the mechanism of reattachment are suggested.

N-32012*

Aeronautical Research Council (Gt. Brit.)
DOWNWASH MEASUREMENTS BEHIND A 12-FT DIAMETER HELICOPTER ROTOR IN THE 24-FT WIND TUNNEL. R. A. Fail and R. C. W. Eyre. 1954. 12p. diagrs., 9 tabs. (ARC R & M 2810; ARC 12,895. Formerly RAE Tech. Note Aero 2018)

Some measurements of downwash have been made in a plane behind a 12-ft diameter helicopter rotor over a range of shaft inclination and tip speed ratio. In the various operation conditions, the tunnel tests are in reasonable agreement with the theoretical results for the appropriate type of loading.

N-32013*

Aeronautical Research Council (Gt. Brit.)
24-FT. WIND TUNNEL TESTS ON A PROPELLER WITH NACA 16 SERIES SECTIONS. TEST RESULTS AND ANALYSIS INTO MEAN LIFT-DRAG DATA. A. R. C. MacDougall and A. B. Haines. 1954. 18p. diagrs., 6 tabs. (ARC R & M 2602; ARC 11,817. Formerly RAE Aero 2276)

The de Havilland propeller was designed to give good performance at high speeds and the aim of the tests was to check whether, as a result, serious losses in take-off performance had been incurred. Results are reassuring and have been analyzed into lift and drag data for use with the standard single-radius method. Data are compared with results from Clark Y propellers. Improvement becomes greater with increase in Mach number, and so NACA series 16 sections appear to have a beneficial effect on the stalling performance at all tip speeds.

N-32014*

Aeronautical Research Council (Gt. Brit.)
HEAT TRANSFERENCE AND PRESSURE LOSS FOR AIR FLOWING IN PASSAGES OF SMALL DIMENSIONS. J. Remfry. 1954. iv, 56p. diagrs., photos., 4 tabs. (ARC R & M 2638)

This investigation had as its primary object the experimental determination of the heat-transfer and pressure-loss characteristics for air flowing in small triangular, square, hexagonal, and round passages. The heat interchanger models, with a frontage 6 inches square, each comprised from just under 150 to over 2,250 passages, according to their size and spacing. The hydraulic diameter of the smallest tubes was about 0.08 inch. The heat transfer in small smooth passages was found to be less than that usually measured for turbulent flow in tubes of larger size, and there was a tendency for a prolonged transition.

N-32015*

Aeronautical Research Council (Gt. Brit.)
THE DERIVATION OF AIRWORTHINESS PERFORMANCE CLIMB STANDARDS. F. G. R. Cook and A. K. Weaver. 1954. 64p. diagrs., 3 tabs. (ARC R & M 2631; ARC 12,079. Formerly AAEE/Res/239)

A more rational basis for deriving climb standards is proposed. The conception is introduced of a "datum" performance, below which conditions predisposing to an accident exist, and the level of safety judged by an "incident rate" which is the frequency with which the operational performance of aircraft falls below this datum. A standard is chosen so that when the aircraft type complies, the incident rate will not exceed some tolerable value. The effect of engine failure is included by taking account of the probability of engine failure and the associated loss in performance.

N-32016*

Aeronautical Research Council (Gt. Brit.)
MEASUREMENTS OF MID-CHORD PITCHING MOMENT DERIVATIVES AT HIGH SPEEDS. J. B. Bratt and A. Chinneck. 1954. 36p. diagrs., photos., 9 tabs. (ARC R & M 2680. Formerly ARC 10,709; 0.672; FM 1125)

Measurements were made on a 7-1/2 percent biconvex airfoil oscillating about a midchord axis in a high-speed wind tunnel by the method of decaying oscillations. The effect of variation of frequency parameter was also investigated, and conditions giving rise to sustained or growing oscillations at subsonic speeds were examined. Comparison with existing flat plate theories for supersonic flow shows complete disagreement in the trend of the damping with Mach number change, the linearized theory for a flat plate giving an increasing positive value. A recent theory which takes into account the shape of the profile agrees in trend with experiment.

N-32017*

Aeronautical Research Council (Gt. Brit.)
AN INVESTIGATION OF THE DISTURBANCES CAUSED BY A REFLECTION PLATE IN THE WORKING-SECTION OF A SUPERSONIC WIND TUNNEL. A. O. Ormerod. 1954. 16p. diagrs. (ARC R & M 2799; ARC 13,915. Formerly RAE Tech. Note Aero 2084)

In the region above the plate, two main disturbances were found; there was a small disturbance from the leading edge and a disturbance further downstream which had originated beneath the plate. Between the two there was a region of approximately constant pressure in which a model could be located. The forward disturbance seemed unavoidable. Increasing the area of the passage beneath the plate by a recess in the tunnel wall was the most effective way of moving back and reducing the magnitude of the disturbance at the rear.

N-32018*

Aeronautical Research Council (Gt. Brit.)
DESIGN AND USE OF COUNTING ACCELEROMETERS. J. Taylor. 1954. 11p. diagrs., photos., 3 tabs. (ARC R & M 2812; ARC 13,587. Formerly RAE Structures 78)

The fundamental principles underlying acceleration recording by means of a counting accelerometer are analyzed. The essential design requirements for a counting accelerometer are presented. A design that has been specially made to meet these requirements is described. Both mechanical and electrical counting are considered, but mechanical counting is found to be superior.

N-32020*

Aeronautical Research Council (Gt. Brit.)
LIST OF CURRENT PAPERS PUBLISHED BY THE AERONAUTICAL RESEARCH COUNCIL, NOS. 101-150. 1954. 5p. (ARC CP 150)

N-32021*

Aeronautical Research Council (Gt. Brit.)
EXPERIMENTS AT M = 1.8 ON BODIES OF REVOLUTION HAVING OGIVAL HEADS. H. K. Zienkiewicz, A. Chinneck, C. J. Berry and P. J. Peggs. 1954. 11p. diagrs., photos., 2 tabs. (ARC CP 148)

Measurements have been made in the N.P.L. 9- by 3-inch high-speed wind tunnel of the pressure distributions at a Mach number of 1.8 on three bodies of revolution with ogival heads of different shapes at zero incidence. Comparison between the experimental pressures and those obtained theoretically showed good agreement.

N-32022*

Aeronautical Research Council (Gt. Brit.)
ANALYSIS OF FLIGHT MEASUREMENTS ON THE AIRBORNE PATH DURING TAKE-OFF. W. R. Buckingham and D. Lean. 1954. 26p. diagrs., 2 tabs. (ARC CP 156)

Analysis of a series of systematic take-off tests with a Meteor IV aircraft has shown that to a good approximation the minimum airborne path to 50 feet may be treated as an arc of a circle. With this assumption, it is a simple process to derive the mean equivalent lift coefficient used during this part of the take-off. It has been found that the total equivalent lift coefficient used during the airborne phase decreases with increase in the ratio of the airspeed to the stalling speed in a simple manner, which is independent of the thrust/weight ratio when the shortest possible distance is required.

N-32023*

Aeronautical Research Council (Gt. Brit.)
THEORETICAL LOAD DISTRIBUTIONS ON WINGS WITH CYLINDRICAL BODIES AT THE TIPS. D. E. Hartley. 1954. 39p. diagrs., tab. (ARC CP 147)

The effect of tip-tanks on spanwise lift distributions is investigated theoretically for the case of minimum induced drag in incompressible potential flow. Charts enabling rapid estimation of the changes in span loadings, total lifts, and induced drags are presented for a practical range of the ratio to tank diameter to wing span. It is shown how the results may be applied approximately to wings of any plan form, including those with sweep or of low aspect ratio.

N-32024*

Aeronautical Research Council (Gt. Brit.)
CRITERIA FOR CONDENSATION FREE FLOW IN THE R.A.E.NO. 18 (9 IN. x 9 IN.) SUPERSONIC TUNNEL. D. J. Raney and B. Beastall. 1954. 18p. diagrs. (ARC CP 164)

Tests were made to determine the dryness of the air circulating through the tunnel necessary to ensure condensation free flow through the working section. Indications are that a strong shock wave has little effect in causing premature condensation but that local expansions around a model may substantially reduce the critical humidity.

N-32025*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE EFFECT OF THICKNESS AND ASPECT RATIO ON THE DAMPING OF PITCHING OSCILLATIONS OF RECTANGULAR WINGS MOVING AT SUPERSONIC SPEEDS. W. E. A. Acum. 1954. 16p. diagrs. (ARC CP 151)

An estimate is made of the effect of variation of aspect ratio and thickness parameter on the damping derivative of a rectangular wing performing pitching oscillations in a supersonic stream. After a discussion of various theories of unsteady two-dimensional supersonic flow round airfoils, that due to Van Dyke is combined with the linearized supersonic theory for a rectangular flat plate to obtain the effect on the damping in pitch. The values given apply to wings of symmetrical biconvex section oscillating at low frequency, in a stream of Mach number such that the shock at the leading edge is attached.

MISCELLANEOUS

Errata No. 1 on "THIRTY-SEVENTH ANNUAL REPORT OF THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS - REPORT 1028." 1951.

UNPUBLISHED PAPERS

N-31692*

ON THE CRITERION OF WING TORSIONAL STIFFNESS. (Sul Criterio Di Rigidezza Torsionale Delle Strutture Alari). Placido Cicala. February 1954. 15p. diagrs. (Trans. from Onore di Modesto Panetti, 1950, p. 45-49)

The official regulations for the stress analysis of airplanes provide criteria which specify in simple form the required torsional stiffness. At the time the Italian standards were established a criterion of stiffness had been introduced which consisted in fixing the maximum angle of torsion produced by a stipulated torsional moment, distributed spanwise by a law proportional to the square of the chord. The present report is an attempt to improve this criterion with due consideration to the characteristics of every type of aircraft in relation to the threats of the cited aeroelastic phenomena, while maintaining the necessary simplicity.

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Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1144

AERODYNAMIC CHARACTERISTICS OF A REFINED DEEP-STEP PLANING-TAIL FLYING-BOAT HULL WITH VARIOUS FOREBODY AND AFTERBODY SHAPES. John M. Riebe and Rodger L. Naeseth. 1953. ii, 19p. diagrs., photos., 8 tabs. (NACA Rept. 1144. Formerly TN 2489; RM L8F01)

An investigation was made in the Langley 300-mph 7- by 10-foot tunnel to determine the aerodynamic characteristics of a refined deep-step planing-tail hull with various forebody and afterbody shapes and, for comparison, a streamline body simulating the fuselage of a modern transport airplane. The results of the tests indicated that the configurations incorporating a forebody with a length-beam ratio of 7 had lower minimum drag coefficients than the configurations incorporating a forebody with length-beam ratio of 5. The lowest minimum drag coefficients, which were considerably less than that of a conventional hull and slightly less than that of a streamline body, were obtained on the length-beam-ratio-7 forebody, alone and with round center boom. Drag coefficients and longitudinal- and lateral-stability parameters presented include the interference of a 21-percent-thick support wing.

NACA TM 1372

DROP HAMMER TESTS WITH THREE OLEO STRUT MODELS AND THREE DIFFERENT SHOCK STRUT OILS AT LOW TEMPERATURES. (Fallhammerversuche mit drei Ölfederstrebenmustern und drei verschiedenen Federstrebenölen bei tiefen Temperaturen). Kranz. July 1954. 55p. diagrs., photos., 10 tabs. (NACA TM 1372. Trans. from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin, UM 564, Jan. 17, 1939)

Drop hammer tests with different shock strut models and shock strut oils were performed at temperatures ranging to -40 C. The various shock strut models do not differ essentially regarding their springing and damping properties at low temperatures; however, the influence of the different shock strut oils on the springing properties at low temperatures varies greatly.

NACA TN 3191

THEORETICAL INVESTIGATION OF LONGITUDINAL RESPONSE CHARACTERISTICS OF A SWEPT-WING FIGHTER AIRPLANE HAVING A NORMAL-ACCELERATION CONTROL SYSTEM AND A COMPARISON WITH OTHER TYPES OF SYSTEMS. Fred H. Stokes and Charles W. Mathews. July 1954. 50p. diagrs., tab. (NACA TN 3191)

An analysis is made of a normal-acceleration control system as applied to a swept-wing fighter airplane. The results show the response characteristics of the airplane-autopilot combination. The effects that changes in altitude and Mach number have on these response characteristics and the effects of changes in the parameter settings of the system are investigated. A comparison is also made of the normal-acceleration system with pitch-attitude, pitching-velocity, and angle-of-attack systems.

NACA TN 3192

EXPERIMENTAL STRESS ANALYSIS OF STIFFENED CYLINDERS WITH CUTOUTS. SHEAR LOAD. Floyd R. Schlechte and Richard Rosecrans. July 1954. 87p. diagrs., photo., 13 tabs. (NACA TN 3192)

A cylindrical semimonocoque shell of circular cross section was mounted as a cantilever and loaded by a direct shear at the tip. The cylinder was tested with no cutout, with a rectangular cutout on the tension side, and with the cutout centered on the neutral axis on one side of the cylinder. The cutout was successively enlarged through six sizes varying from 30° to 130° in circumference and from 1 and 2 bays in length. Strain measurements were made with resistance-type wire strain gages near the cutout on the stringers, the skin, and the rings for each case, and the stresses obtained are presented in tables.

NACA TN 3196

LIFT AND PITCHING MOMENT AT SUPERSONIC SPEEDS DUE TO CONSTANT VERTICAL ACCELERATION FOR THIN SWEPTBACK TAPERED WINGS WITH STREAMWISE TIPS. SUPERSONIC LEADING AND TRAILING EDGES. Isabella J. Cole and Kenneth Margolis. July 1954. 67p. diagrs., 4 tabs. (NACA TN 3196)

On the basis of linearized time-dependent supersonic flow theory, the lift and pitching-moment derivatives due to constant vertical acceleration are evaluated for a series of thin sweptback tapered wings with streamwise tips. The analysis is valid, in general, at those speeds for which the wing leading and trailing edges are both supersonic. The major portion of the computational results is presented in the form of detailed charts covering the practical range of wing-geometry parameters and Mach number from which fairly rapid estimates of the derivatives may be obtained.

*AVAILABLE ON LOAN ONLY.

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NACA TN 3203

CONSIDERATIONS ON A LARGE HYDRAULIC JET CATAPULT. Upshur T. Joyner and Walter B. Horne. July 1954. 49p. diagrs., photos., tab. (NACA TN 3203. Formerly RM L51B27)

A survey of various types of catapults, which has been made in connection with the problem of accelerating a large (100,000 lb) car along a track to a speed of 150 miles per hour, is given. A hydraulic jet catapult is indicated as the best suited among these catapult types for the purpose intended, and various design problems of this type are treated. Equations are given for calculating the performance of the jet and of the test car, and consideration is given to the physical conditions affecting the jet flow. Design procedures are presented for the jet nozzle and for the bucket on the car which receives the jet and imparts thrust to the car. The expected propulsive efficiency of the jet catapult is given and the effect of a side wind on the jet trajectory is calculated.

NACA TN 3205

THEORETICAL INVESTIGATION AT SUBSONIC SPEEDS OF THE FLOW AHEAD OF A SLENDER INCLINED PARABOLIC-ARC BODY OF REVOLUTION AND CORRELATION WITH EXPERIMENTAL DATA OBTAINED AT LOW SPEEDS. William Letko and Edward C. B. Danforth, III. July 1954. 56p. diagrs. (NACA TN 3205)

Approximate formulas, based on subsonic linearized theory, are derived for the static-pressure increment and flow inclination ahead of slender inclined parabolic-arc bodies of revolution at subsonic speeds. Charts are presented from which these quantities can be estimated. Some comparisons with experimental data obtained for a Mach number of 0.21 are also presented. Consideration is given to the induced effects of the wing and mounting boom on flow-inclination measurements.

NACA TN 3208

HEAT, MASS, AND MOMENTUM TRANSFER FOR FLOW OVER A FLAT PLATE WITH BLOWING OR SUCTION. H. S. Mickley, R. C. Ross, A. L. Squyers and W. E. Stewart, Massachusetts Institute of Technology. July 1954. ii, 149p. diagrs., photos., 9 tabs. (NACA TN 3208)

The effect on the boundary layer of sucking or blowing air through a porous flat plate into or out of a main air stream flowing parallel to the plate was studied theoretically and experimentally. Laminar-boundary-layer theory was used to calculate transfer coefficients and velocity, temperature, and concentration profiles in laminar, zero Euler number flow under certain restricted mass transfer conditions and for a range of Prandtl or Schmidt numbers. For turbulent flow film theory was used to predice the effect of mass transfer on friction, heat, and mass transfer coefficients. Experimental measurements of velocity and temperature profiles and of friction and heat transfer coefficients were carried out over a range of flow conditions.

NACA TN 3225

AN EXPERIMENTAL STUDY OF THE LIFT AND PRESSURE DISTRIBUTION ON A DOUBLE-WEDGE PROFILE AT MACH NUMBERS NEAR SHOCK ATTACHMENT. Walter G. Vincenti, Duane W. Dugan and E. Ray Phelps. July 1954. 43p. diagrs. (NACA TN 3225)

An account is given of measurements at low supersonic speeds of the pressure distribution on a double-wedge profile. The results cover the Mach number range from 1.166 to 1.377, which brackets the value (1.221) for bow-wave attachment at zero angle of attack. The results are discussed and compared with the findings of the transonic small-disturbance theory.

NACA TN 3255

SHOCK-TURBULENCE INTERACTION AND THE GENERATION OF NOISE. H. S. Ribner. July 1954. 60p. diagrs., tab. (NACA TN 3255)

Interaction of convected field of turbulence with shock wave is analyzed to yield modified turbulence, entropy spottiness, and noise generated downstream of the shock. Analysis is generalization of single-spectrum-wave treatment of TN 2864. Formulas for spectra and correlations are obtained. Numerical calculations yield curves of rms velocity components, temperature, pressure, and noise in db against Mach number for $M = 1$ to ∞; both isotropic and strongly axisymmetric (lateral/longitudinal = 36/1) initial turbulence are treated. In either case, turbulence of 0.1 percent longitudinal component generates about 120 dbs of noise.

NACA TN 3256

EXPERIMENTAL INVESTIGATION OF TEMPERATURE RECOVERY FACTORS ON A 10° CONE AT ANGLE OF ATTACK AT A MACH NUMBER OF 3.12. John R. Jack and Barry Moskowitz. July 1954. 15p. diagrs. (NACA TN 3256)

At angles of attack from 0° to 10° over the Reynolds number range (1.5 to 8×10^6), an increase in angle of attack increased the equilibrium surface temperatures in the laminar and turbulent flow regions. The equilibrium surface temperatures in regions of probable cross-flow separation were in the same range as those obtained for fully turbulent flow. For the windward surface, local recovery factors in the fully laminar and turbulent regions were not significantly affected by changes in angle of attack.

BRITISH REPORTS

N-32117*

Royal Aircraft Establishment (Gt. Brit.)
THE CHANGE IN INFLUENCE COEFFICIENTS CAUSED BY A CHANGE OF DATUM. D. Williams. April 1954. 8p. diagrs. (RAE Tech. Note Structures 133)

A method is described for transforming a set of influence coefficients for a structure relative to a given datum into an equivalent set relative to a different datum.

N-32120*

Royal Aircraft Establishment (Gt. Brit.)
A METHOD FOR CALIBRATING A WIND TUNNEL REAR STING BALANCE. J. R. Anderson. March 1954. 14p. diagrs., tab. (RAE Tech. Note Aero 2299)

A method is described for calibrating a wind-tunnel balance consisting of a sting support bearing strain gages. The form of calibration obtained is essentially suitable for the automatic computing of wind-tunnel results. The technique of static loading of the balance is discussed, and an appendix contains practical notes on matrix inversion.

N-32123*

Nat. Gas Turbine Establishment (Gt. Brit.)
AN APPLICATION OF THE CAPACITY PROBE METHOD TO THE MEASUREMENT OF ROTOR BLADE TIP DEFLECTIONS IN AN AXIAL COMPRESSOR. R. Chaplin. December 1953. 35p. diagrs., photos. (NGTE Memo. M. 199)

An application to the first rotor stage of an axial compressor, or the capacity probe method of measuring blade tip deflections is described. Results obtained from strain gages on the same stage are included. Results from the capacity probe method were not satisfactory and it is suggested that the standards of stability required by this method were not practicable in this instance.

N-32124*

Royal Aircraft Establishment (Gt. Brit.)
CORROSION OF STAINLESS STEEL AND ALUMINIUM ALLOYS IN CONTACT WITH TITANIUM. C. Braithwaite. February 1954. 18p. photos., 2 tabs. (RAE Tech. Note Met. 192)

Titanium samples consisting of 1-inch diameter discs, sheet and 1/2-inch diameter threaded bar were placed in contact with stainless steel and aluminum alloys and exposed to the intermittent seawater spray test for 1 year. Test results and recommendations for corrosion prevention of these joints are given.

N-32185*

Forest Products Research Lab. (Gt. Brit.)
INVESTIGATIONS INTO GLUES AND GLUING. PROGRESS REPORT SEVENTY-SIX - MARCH 1954. DURABILITY TESTS ON PLYWOOD ADHESIVES - SERIES II. ANALYSIS AFTER SEVEN AND A HALF YEARS. R. A. G. Knight, R. J. Newall and J. E. Grosert. 9p. 4 tabs. (Forest Products Research Lab. Supersedes Progress reports 44, 46, 46 (add.) and 60)

This report analyzes the behavior of a range of adhesives used in beech plywood exposed to four natural conditions: storage in a normally heated workshop; exposure to the weather on racks facing south in an open field; storage in an open-sided shed and momentarily dipped in water once a month; and submersion in fresh water tanks standing in the open. The adhesives include a number of phenolic and resorcinol resins, one experimental melamine, fortified and normal ureas, casein and animal glues and sodium silicate.

UNPUBLISHED PAPERS

N-25921*

ON THE MAGNUS EFFECT ACCORDING TO THE ASYMPTOTIC HYDRODYNAMIC THEORY. (Über den Magnuseffekt nach der Asymptotischen Hydrodynamischen Theorie). Torsten Gustafson. June 1954. ii, 93p. diagrs., photos. (Trans. from Hakan Ohlssons Buchdruckerei, Lund, 1933)

A comparison of the theoretically and experimentally determined values of pressure, drag, and lift on a rotating cylinder in fluid flow gives information on how far the asymptotic flow theory is capable of reproducing the characteristic properties of the actual flow in the case of small friction. The pressure values as well as the lift coefficients agree with experiments. For a prescribed flow in the case of small friction the flow process can be represented by determination of the wake form and formation of the corresponding potential expressions.

N-31850*

Iowa State College. ROLE OF TRIPLE COLLISIONS IN EXCITATION OF MOLECULAR VIBRATIONS. Richard Alden Walker. 1952. vii, 132p. diagrs., photos., 8 tabs. (Iowa State College)

An experimental program has been initiated to study thermal relaxation in gas mixtures. The major goal of this work is to reach a better understanding of the perplexing trace catalysts problem. The initial phase of the program reported in this paper has been a study of collision types responsible for vibrational excitation in mixtures.

N-31994*

TESTS ON A FLAT PLATE IN A UNIFORM AIRSTREAM, REGARDING THE INFLUENCE OF ROUGHNESS ON THE TRANSITION FROM LAMINAR TO TURBULENT FLOW. (Versuche an einer parallel angeströmten ebenen Platte über den Rauhigkeitseinfluss auf den Umschlag laminar/turbulent). Horst Holstein. April 1954. 16p. diagrs. (Trans. from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin, UM 3110, June 8, 1944)

A study is made of the maximum roughness that a surface may have without causing a significant forward-shifting of the transition point. Results show that in the case of small roughness the critical Reynolds number does not depend to a very high degree on the roughness.

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CURRENT NACA REPORTS

NACA Rept. 1121

DIRECT MEASUREMENTS OF SKIN FRICTION. Satish Dhawan, California Institute of Technology. 1953. ii, 20p. diagrs., photos. (NACA Rept. 1121. Formerly TN 2567)

A device was developed to measure local skin friction on a flat plate by measuring the force exerted on a very small movable part of the flat plate. The apparatus was applied to measurements in the low-speed range, for both laminar and turbulent boundary layers, and the measured skin-friction coefficients show excellent agreement with Blasius' and Von Kármán's results. Measurements were made in high-speed subsonic flow and turbulent-skin-friction coefficients were determined up to a Mach number of about 0.8. A few measurements were also made in supersonic flow.

NACA Rept. 1122

SURVEY OF PORTIONS OF THE CHROMIUM-COBALT-NICKEL-MOLYBDENUM QUATERNARY SYSTEM AT 1200° C. Sheldon Paul Rideout and Paul A. Beck, University of Notre Dame. 1953. ii, 38p. diagrs., photos., 20 tabs. (NACA Rept. 1122. Formerly TN 2683)

A survey was made of portions of the chromium-cobalt-nickel-molybdenum quaternary system at 1200° C by means of microscopic and X-ray diffraction studies. Since the face-centered cubic (alpha) solid solutions form the matrix of almost all practically useful high-temperature alloys, the solid solubility limits of the quaternary alpha phase were determined up to 20 percent molybdenum. The component cobalt-nickel-molybdenum, chromium-cobalt-molybdenum, and chromium-nickel-molybdenum ternary systems were also studied. The survey of these systems was confined to the determination of the boundaries of the face-centered cubic (alpha) solid solutions and of the phases coexisting with alpha at 1200° C.

NACA RM E54E19

EFFECTS OF ADDITIVES ON CORROSION AND MASS TRANSFER IN SODIUM HYDROXIDE - NICKEL SYSTEMS UNDER FREE-CONVECTION CONDITIONS. Americo F. Forestieri. August 1954. 13p. diagrs., photos., 6 tabs. (NACA RM E54E19)

Experiments were carried out under free-convection conditions in sodium hydroxide - "L" nickel systems. Nickel crucibles half full of sodium hydroxide were heated for 24 hours at 1500° F with a temperature difference of 45° F. The effect of additives such as metals, salts, oxides, and nitrides on the extent of corrosion and mass transfer was determined by measurement of the weight change of a specimen in the hot zone, and by metallographic examination of the specimen cross section. Reduction in mass transfer occurred with additives of powdered chromium and aluminum.

NACA RM E54F10

PRELIMINARY INVESTIGATION OF STRESS-RUPTURE AND TENSILE STRENGTH OF THERMENOL, AN IRON-ALUMINUM ALLOY. Charles A. Gyorgak. August 1954. 11p. diagrs., 3 tabs. (NACA RM E54F10)

An investigation determined the stress-rupture life at 1100° and 1200° F, the room-temperature tensile strength, and the bend ductility of the oxidation-resistant iron-aluminum alloy Thermenol. Stress-rupture strengths for 100-hour life were 19,300 psi at 1200° F and 35,500 psi at 1100° F. The room-temperature tensile strength was 62,050 psi with 3-percent elongation in a 3/4-inch-gage length. Angles of bend to cause failure in the longitudinal and transverse directions ranged from 34° to 56° and were approximately equal.

NACA TN 3155

IMPINGEMENT OF WATER DROPLETS ON NACA 65A004 AIRFOIL AT 8° ANGLE OF ATTACK. Rinaldo J. Brun, Helen M. Gallagher and Dorothea E. Vogt. July 1954. 27p. diagrs. (NACA TN 3155)

The trajectories of droplets in the air flowing past an NACA 65A004 airfoil at an angle of attack of 8° were determined. The amount of water in droplet form impinging on the airfoil, the area of droplet impingement, and the rate of droplet impingement per unit area on the airfoil surface were calculated from the trajectories and presented to cover a large range of flight and atmospheric conditions. These impingement characteristics are compared briefly with those previously reported for the same airfoil at an angle of attack of 4°.

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NACA TN 3178

CHARACTERISTICS OF TURBULENCE IN A BOUNDARY LAYER WITH ZERO PRESSURE GRADIENT. P. S. Klebanoff, National Bureau of Standards. July 1954. 56p. diagrs. (NACA TN 3178)

The results of an experimental investigation of a turbulent boundary layer with zero pressure gradient are presented. Measurements with the hot-wire anemometer were made of turbulent energy and turbulent shear stress, probability density and flattening factor of u-fluctuation, spectra of turbulent energy and shear stress, and turbulent dissipation. The importance of the region near the wall and the inadequacy of the concept of local isotropy are demonstrated. Attention is given to the energy balance and the intermittent character of the outer region of the boundary layer. Also several interesting features of the spectral distribution of the turbulent motions are discussed.

NACA TN 3209

HIGH-RESOLUTION AUTORADIOGRAPHY. George C. Towe, Henry J. Gomberg and J. W. Freeman, University of Michigan. July 1954. ii, 138p. diagrs., photos., 9 tabs. (NACA TN 3209)

This investigation was made to adapt wet-process autoradiography to metallurgical samples to obtain high resolution of segregated radioactive elements in microstructures. Results are confined to development of the technique, which was perfected to a resolution of less than 10 microns. The radioactive samples included carbon-14 carburized iron and steel, nickel-63 electroplated samples, a powder product containing nickel-63, and tungsten-185 in N-155 alloy.

NACA TN 3269

ADDITIONAL STATIC AND FATIGUE TESTS OF HIGH-STRENGTH ALUMINUM-ALLOY BOLTED JOINTS. E. C. Hartmann, Marshall Holt and I. D. Eaton, Aluminum Company of America. July 1954. 42p. diagrs., photos., 7 tabs. (NACA TN 3269)

Additional static and fatigue tests were made on a few types of joints in 75S-T6, 24S-T4, and 14S-T6 high-strength aluminum-alloy extruded bar in order to supplement the data in NACA Technical Note 2276. Comparisons are made with the results of these earlier tests.

BRITISH REPORTS

N-32203*

Royal Aircraft Establishment (Gt. Brit.) MECHANICAL PROPERTIES OF SOME D. T. D. COMMERCIAL ALUMINIUM ALLOY SHEET MATERIALS. D. C. Hayward. March 1954. 26p. diagrs., 5 tabs. (RAE Tech. Note Met. 195)

Compressive and tensile tests on aluminum alloy sheet D. T. D. 603, 646, 546, 610, and 687 were made longitudinally and transversely to the rolling direction. Tables of proof-strength values and the tangent-moduli graphs derived are given. Artificial aging was found for small plastic deformation, to raise the stress level of the compressive tangent-moduli curves more than the tensile tangent-moduli curves. The effect of sheet thickness on strength values, investigated for D. T. D. 546 only, showed progressive increase of tensile proof-stress with increase in thickness but under compression, strength varied irregularly with sheet thickness.

N-32204*

Royal Aircraft Establishment (Gt. Brit.) AIRCRAFT POWER SUPPLY CABLES. D. B. McKenzie. March 1954. 12p., 4 tabs. (RAE Tech. Note EL. 66)

This note deals with the modern types of aircraft cables used for the power supply circuits. It covers the pren, nypren, glasil, glasef and fire types describing their uses and limitations, and also includes a section giving the equivalent United States cables which will enable users to service N. A. T. O. aircraft with either British or American cables.

MISCELLANEOUS

NACA TN 3120

Errata No. 1 on "SPAN LOAD DISTRIBUTIONS RESULTING FROM CONSTANT VERTICAL ACCELERATION FOR THIN SWEPTBACK TAPERED WINGS WITH STREAMWISE TIPS. SUPERSONIC LEADING AND TRAILING EDGES." Isabella J. Cole and Kenneth Margolis. January 1954.

DECLASSIFIED NACA REPORTS

THE FOLLOWING REPORT HAS BEEN DECLASSIFIED FROM CONFIDENTIAL, 7/29/54.

RM L52C21

NACA RM A9E05

THE AERODYNAMIC CHARACTERISTICS THROUGHOUT THE SUBSONIC SPEED RANGE OF A THIN, SHARP-EDGED HORIZONTAL TAIL OF ASPECT RATIO 4 EQUIPPED WITH A CONSTANT-CHORD ELEVATOR. Angelo Bandettini and Verlin D. Reed. June 30, 1949. 50p. diagrs., photo. (NACA RM A9E05) (Declassified from Confidential, 7/29/54)

The report presents results of tests at Mach numbers from 0.20 to 0.94 of a thin horizontal tail without sweep having an aspect ratio of 4 and taper ratio of 0.5 and equipped with a constant-chord elevator. The tail profile was a sharp-edged, faired double wedge having a thickness-chord ratio of 0.042. The investigation was made at a constant Reynolds number of 2,000,000. The effect of compressibility on the effectiveness of the elevator in producing lift at small angles of attack and elevator deflections was small at Mach numbers less than 0.60; there was a gradual increase in effectiveness between 0.60 and 0.90 Mach numbers and a slight decrease between Mach numbers of 0.90 and 0.94.

NACA RM A9K18

THE EFFECT OF ASPECT RATIO ON THE SUBSONIC AERODYNAMIC CHARACTERISTICS OF WINGS WITH NACA 65_1-210 SECTIONS. Warren H. Nelson and Albert L. Erickson. February 3, 1950. 31p. diagrs., photos., tab. (NACA RM A9K18) (Declassified from Confidential, 7/29/54)

The lift, drag, and pitching-moment characteristics of four model wings of aspect ratios 1, 2, 4, and 6 are presented. The wings all had NACA 65_1-210 sections, taper ratios of 0.4, and 3° dihedral. The 25-percent-chord lines had no sweep. Data were obtained for a Mach number range of 0.4 to 0.9, and an angle-of-attack range of -4° to 20°. The transition location and its effect on drag are studied.

NACA RM A53I01

APPLICATIONS OF AUXILIARY AIR INJECTORS TO SUPERSONIC WIND TUNNELS. Joseph M. Spiegel, Robert U. Hofstetter and Donald M. Kuehn. November 1953. 53p. diagrs., photos. (NACA RM A53I01) (Declassified from Confidential, 7/29/54)

The use of an air injector as an auxiliary device for reducing starting and running compression ratios of wind tunnels is discussed. A one-dimensional analysis and experimental data are presented to demonstrate the advantages of the device. A design procedure is included for application of the method to existing or proposed wind tunnels.

NACA RM A53L18

EXPERIMENTAL DETERMINATION OF BOUNDARY-LAYER TRANSITION ON A BODY OF REVOLUTION AT M = 3.5. James R. Jedlicka, Max E. Wilkins and Alvin Seiff. March 1954. 56p. diagrs., photos. (NACA RM A53L18) (Declassified from Confidential, 7/29/54)

Boundary-layer-transition tests were made in free flight through still air on a small-scale fin-stabilized body of revolution of fineness ratio 30 at a Mach number of 3.5 and length Reynolds numbers of 12 and 24 million. Three types of surfaces were tested and the transition Reynolds number was found to depend critically on the surface smoothness. Angle of attack was found to influence transition strongly. This effect was correlated in terms of pressure rise along streamlines and led to a prediction of the effect of varying the body shape on sheltered-side transition. In general, the transition points were time dependent, fluctuating in one case over a range of Reynolds numbers from 4 to 20 million. Steady laminar flow was observed to a length Reynolds number of 11 million. Transition due to roughness and adverse pressure gradient occurred even though the tests were within the region of theoretical infinite laminar stability to small disturbances.

NACA RM E50F22

FABRICATION AND PROPERTIES OF HOT-PRESSED MOLYBDENUM DISILICIDE. Roger A. Long. August 24, 1950. 34p. diagrs., photos., tab. (NACA RM E50F22) (Declassified from Confidential, 7/29/54)

Hot-pressed molybdenum disilicide bodies produced by industrial methods and sources were evaluated. The outstanding characteristics reported are an elevated-temperature (2400° F) short-time tensile strength of 41,070 pounds per square inch and a 100-hour rupture stress at 1800° F in excess of 30,000 pounds per square inch, as indicated in a preliminary evaluation. The material evaluated was extremely resistant to air corrosion up to 2850° F and generally brittle at temperatures below 2200° F.

NACA RM E51D27

INSTRUMENTATION FOR RECORDING TRANSIENT PERFORMANCE OF GAS-TURBINE ENGINES AND CONTROL SYSTEMS. Gene J. Delio and Glennon V. Schwent. June 27, 1951. 27p. diagrs., photos. (NACA RM E51D27) (Declassified from Confidential, 7/29/54)

Design features are presented for the instrumentation used in a study of the transient performance of gas-turbine engines and control systems. The dynamic characteristics of the instrumentation are discussed and examples are given of typical data on the acceleration of a controlled and an uncontrolled engine.

NACA RM E51K26

PRESSURE DISTRIBUTION AND AERODYNAMIC COEFFICIENTS ASSOCIATED WITH HEAT ADDITION TO SUPERSONIC AIR STREAM ADJACENT TO TWO-DIMENSIONAL SUPERSONIC WING. I. Irving Pinkel, John S. Serafini and John L. Gregg. February 1952. 33p. diagrs., tab. (NACA RM E51K26) (Declassified from Confidential, 7/29/54)

The modifications in the pressure distributions and the aerodynamic coefficients associated with additions of heat to the two-dimensional supersonic inviscid flow field adjacent to the lower surface of a 5-percent-thickness symmetrical circular-arc wing are presented in this report. The pressure distributions are obtained by the use of a graphical method which gives the two-dimensional supersonic inviscid flow field obtained with moderate heat addition. The variation is given of the lift-drag ratio and of the aerodynamic coefficients of lift, drag, and moment with free stream Mach number, angle of attack, and parameters defining extent and amount of heat addition. The six graphical solutions used in this study included Mach numbers of 3.0 and 5.0 and angles of attack of 0° and 2°.

NACA RM E52A17

PRELIMINARY INVESTIGATION OF THE HEAT-SHOCK RESISTANT PROPERTIES OF MOLYBDENUM DISILICIDE BLADES UNDER CENTRIFUGAL LOAD. Roger A. Long and John C. Freche. May 1952. 15p. diagrs., photos., tab. (NACA RM E52A17) (Declassified from Confidential, 7/29/54)

An investigation to determine the heat-shock resistant properties of two molybdenum disilicide turbine blades under centrifugal loads imposed by turbine rotation is presented. Molybdenum disilicide turbine blades fabricated by hot-pressing techniques withstood heat-shock conditions under blade centrifugal stresses up to 5350 pounds per square inch. Additional development is required before the heat-shock resistant properties of molybdenum disilicide are satisfactory for turbine-blade application.

NACA RM E52B06

SOME FACTORS AFFECTING FABRICATION AND HIGH-TEMPERATURE STRENGTH OF MOLYBDENUM DISILICIDE. W. A. Maxwell. April 1952. 25p. diagrs., photos., 3 tabs. (NACA RM E52B06) (Declassified from Confidential, 7/29/54)

It has been demonstrated that the short-time high-temperature strength of sintered molybdenum disilicide can be greatly improved by carbon addition. Improved long-time deformation properties and decreased high-temperature plasticity accompany the carbon additions. These changes are attributed to partial deoxidation by the carbon. Large-grain, hot-pressed molybdenum disilicide having a low oxygen content was found to have superior long-time properties. Hardness and other properties were found to be variable over a wide range.

NACA RM E52D09

SOME STRESS-RUPTURE AND CREEP PROPERTIES OF MOLYBDENUM DISILICIDE IN THE RANGE 1600° TO 2000° F. W. A. Maxwell. June 1952. 19p. diagrs., photos., 2 tabs. (NACA RM E52D09) (Declassified from Confidential, 7/29/54)

An investigation of the stress-rupture and creep properties of hot-pressed molybdenum disilicide has produced the following results: 1. The long-time strength of molybdenum disilicide at high temperatures is superior to that of the high-temperature alloys and titanium carbide ceramals. 2. The use of molybdenum disilicide above 1800° F may be limited by the creep rate rather than by the stress-rupture life. 3. A comparatively convenient and satisfactory method for creep and stress-rupture testing to 2000° F has been developed.

NACA RM L9B24a

AN EXPERIMENTAL INVESTIGATION OF A GYRO-ACTUATED ROLL CONTROL SYSTEM INSTALLED IN A SUBSONIC TEST VEHICLE. Jerome M. Teitelbaum and Ernest C. Seaberg. April 20, 1949. 26p. diagrs., photos., tab. (NACA RM L9B24a) (Declassified from Confidential, 7/29/54)

Contains the results of wind-tunnel and flight tests of a gyro-actuated, roll control system installed in a sweptback four-wing subsonic test vehicle. This control system links the control surface directly to the displacement gyroscope and employs a torque motor to limit gyroscope precession. The linking of the control surfaces in this manner results in an autopilot system which gives a no-lag control response to a model displacement without resorting to velocity or acceleration-sensitive devices.

NACA RM L9F15a

LABORATORY INVESTIGATION OF AN AUTOPILOT UTILIZING A MECHANICAL LINKAGE WITH A DEAD SPOT TO OBTAIN AN EFFECTIVE RATE SIGNAL. Ernest C. Seaberg. August 17, 1949. 29p. diagrs., photos., tab. (NACA RM L9F15a) (Declassified from Confidential, 7/29/54)

The results of a laboratory investigation of a frontlash autopilot are presented in this analysis. The operation of this autopilot is based on the nonlinear principle of utilizing a dead spot in the servomotor feedback linkage to the gyroscope base reference as a means of obtaining a leading control signal. The investigation consists of oscillating-table tests in order to determine the effect of frontlash on the amplitude and phase responses of the system. Roll-simulator tests were also conducted in order to confirm the possibility of stabilization of pilotless aircraft with this type of automatic pilot, and an attempt to bracket the usable range of this autopilot was made by plotting the degree of stability as a function of the aerodynamic roll parameters.

NACA RM L50B13

INVESTIGATION AT HIGH SUBSONIC SPEEDS OF A 45° SWEPTBACK HORIZONTAL TAIL WITH PLAIN AND HORN-BALANCED CONTROL SURFACES. Harold S. Johnson and Robert F. Thompson. March 31, 1950. 44p. diagrs., photo., tab. (NACA RM L50B13) (Declassified from Confidential, 7/29/54)

A wind-tunnel investigation of a horizontal tail surface having 45° of sweepback was made through a speed range to a Mach number of 0.89. The 0.25-chord plain flap was tested with and without a horn balance. A comparison is made with the results of a previous investigation of the same model equipped with a larger horn balance. Presented are lift, drag, pitching-moment, and hinge-moment data and lift and hinge-moment parameters.

NACA RM L50F29

STATIC DIRECTIONAL STABILITY OF A TANDEM-HELICOPTER FUSELAGE. Charles C. Smith, Jr. August 9, 1950. 23p. diagrs., photo. (NACA RM L50F29) (Declassified from Confidential, 7/29/54)

An investigation has been made to determine the static directional stability of a fuselage typical of tandem helicopters. The model consisted mainly of an elliptical-cross-section body and a rear rotor pylon faired to form a large vertical tail with a very thick airfoil section. The investigation included a study of the effect of various modifications to the vertical tail surface on the directional stability of the model.

NACA RM L50I19

THEORETICAL INVESTIGATION OF A PROPORTIONAL-PLUS-FLICKER AUTOMATIC PILOT. Ernest C. Seaberg. October 19, 1950. 54p. diagrs., photo., tab. (NACA RM L50I19) (Declassified from Confidential, 7/29/54)

An analysis has been made of the stability of a supersonic canard airframe and a proportional-plus-flicker autopilot. Essentially, this autopilot maintains a zero reference about which the output is proportional to the input and a flicker response overrides this proportional response at a fixed angle of gimbal displacement on either side of the zero gyroscope reference. The analysis consists of an investigation of the calculated transient responses based on the variation of the autopilot and aerodynamic parameters. The calculations are based on the assumption that the proportional part of the system either contains a zero-phase-lag proportional autopilot or is the actual autopilot frequency response approximated by mathematical transfer function.

NACA RM L50I21

DESCRIPTION AND INVESTIGATION OF A DYNAMIC MODEL OF THE XH-17 TWO-BLADE JET-DRIVEN HELICOPTER. George W. Brooks and Maurice A. Sylvester. March 14, 1951. 49p. diagrs., photos., 6 tabs. (NACA RM L50I21) (Declassified from Confidential, 7/29/54)

A description of the NACA 1/10-scale dynamic model of the XH-17 two-blade jet-powered helicopter is presented and the investigation of the model flutter and ground-vibrations characteristics reported. At design values, rotor-blade flutter of the classical bending-torsion type was observed at speeds corresponding to full-scale tip speeds near the over-speed limit of 800 feet per second. The flutter speed could be raised by increasing the torsional frequencies of the blades and changing the blade chordwise mass distribution. The type of flutter mode depended on whether the model was externally excited. No unstable ground vibrations could be excited on the model.

NACA RM L51F06

EXPLORATORY INVESTIGATION AT HIGH AND LOW SUBSONIC MACH NUMBERS OF TWO EXPERIMENTAL 6-PERCENT-THICK AIRFOIL SECTIONS DESIGNED TO HAVE HIGH MAXIMUM LIFT COEFFICIENTS. Laurence K. Loftin, Jr. and Albert E. von Doenhoff. December 1951. 48p. diagrs., photo., 2 tabs. (NACA RM L51F06) (Declassified from Confidential, 7/29/54)

The development of a method for deriving thin airfoil sections to have high values of the low-speed maximum lift coefficient is described and the results of an experimental investigation at high and low subsonic Mach numbers of two new symmetrical airfoils of 6-percent thickness are presented. Maximum lift coefficients of about 1.3 were obtained for the two airfoils at low speeds.

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Research Abstracts

NO. 69 SEPTEMBER 7, 1954

CURRENT NACA REPORTS

NACA Rept. 1141

METHOD AND GRAPHS FOR THE EVALUATION OF AIR-INDUCTION SYSTEMS. George B. Brajnikoff. 1953. ii, 22p. diagrs., tab. (NACA Rept. 1141. Formerly TN 2697)

Graphs that allow rapid evaluation of air-induction systems from considerations of their aerodynamic parameters in combination with power-plant characteristics are presented for the supersonic Mach numbers up to 3.0. Restrictions imposed by the engine characteristics on the use of a fixed-size air inlet are discussed and illustrated by means of sample solutions. The relation between the engine characteristics, flight conditions, inlet characteristics, and inlet area for optimum performance is given.

NACA Rept. 1142

DIFFUSION OF HEAT FROM A LINE SOURCE IN ISOTROPIC TURBULENCE. Mahinder S. Uberoi and Stanley Corrsin, Johns Hopkins University. 1953, ii, 29p. diagrs., photos., tab. (NACA Rept. 1142. Formerly TN 2710)

An experimental and analytical study has been made of some features of the turbulent heat diffusion behind a line heated wire stretched perpendicular to a flowing isotropic turbulence. The mean temperature distributions have been measured with systematic variations in wind speed, size of turbulence producing grid, and downstream location of heat source. The nature of the temperature fluctuation field has been studied. A comparison of Lagrangian and Eulerian analyses for diffusion in a nondecaying turbulence yields an expression for turbulent-heat-transfer coefficient in terms of turbulence velocity and a Lagrangian "scale." A convenient form has been deduced for the criterion of interchangeability of instantaneous space and time derivatives in a flowing turbulence.

NACA TM 1365

PAPERS ON SHIMMY AND ROLLING BEHAVIOR OF LANDING GEARS PRESENTED AT STUTTGART CONFERENCE OCT. 16 AND 17, 1941. (Bericht über die Sitzung Flattern und Rollverhalten von Fahrwerken am 16./17. Oktober 1941 in Stuttgart). August 1954. ii, 233p. diagrs., photos., 2 tabs. (NACA TM 1365. Trans. from Lilienthal-Gesellschaft für Luftfahrtforschung, Berlin, Bericht 140)

This report is a compilation of 16 papers dealing with landing gear behavior and tire characteristics which were presented at a conference in Stuttgart in 1941. Four of these papers deal with the rolling stability or veering-off tendency of nose and tail wheel tricycle landing gears. Four others deal with theoretical and experimental studies of the characteristics of pneumatic tires including the side elasticity, the cornering characteristics, and the force distribution between tire and runway. The remaining eight papers deal with theoretical and experimental studies of wheel shimmy.

NACA RM 54G26

EFFECTS OF RESIN COATING METHODS AND OTHER VARIABLES ON PHYSICAL PROPERTIES OF GLASS-FABRIC REINFORCED POLYESTERS. B. M. Axilrod, J. E. Wier and J. Mandel, National Bureau of Standards. August 1954. 22p., 6 tabs. (NACA RM 54G26)

Effects of resin coating methods on properties of glass-fabric laminates with three finishes and two polyester resins were investigated. Coating methods were roller, use of dilute resin solution, resin immersion, use of monomeric styrene, and vacuum impregnation. A normal high-temperature rapid cure and a moderate-temperature slow cure were used. Laminate preparation followed a statistical design to minimize uncontrollable variables. Tests included flexural strength both dry and after water immersion, specific gravity, resin content, and voids content.

NACA RM E54F11

EXPERIMENTAL HEAT-TRANSFER AND FRICTION COEFFICIENTS FOR AIR FLOWING THROUGH STACKS OF PARALLEL FLAT PLATES. Eldon W. Sams and Walter F. Weiland, Jr. August 1954. 33p. diagrs., photo., tab. (NACA RM E54F11)

Forced-convection heat-transfer and pressure-drop data were obtained for stacks of parallel flat plates of short length-to-effective-diameter ratio. Two such stacks were alined and misalined in the direction of air flow with gap spacings between stacks of 1/32, 1/8, and 1/4 inch. Data were obtained with heat addition to the downstream stack only over a range of Reynolds number from 15,000 to 80,000 and average surface temperatures of about 680° R. The average and local heat-transfer coefficients were only slightly higher than predicted values from established round tube data. The friction data for both stacks are compared.

*AVAILABLE ON LOAN ONLY.

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NACA RM E54F29

A STUDY OF THE RADIATION FROM LAMINAR AND TURBULENT OPEN PROPANE-AIR FLAMES AS A FUNCTION OF FLAME AREA, EQUIVALENCE RATIO, AND FUEL FLOW RATE. Thomas P. Clark and David A. Bittker. August 1954. 33p. diagrs., photos., 2 tabs. (NACA RM E54F29)

For laminar flames of given equivalence ratio, radiation intensity changes linearly with fuel flow rate and photographically measured surface area. Intensity per unit area depends only on equivalence ratio. Turbulent flame radiation intensity is also proportional to fuel flow rate. Laminar and turbulent flames at identical conditions of flow, equivalence ratio, and burner diameter have about the same radiation intensities. Furthermore, the spectral intensity distributions appear to be the same for both types of flame, suggesting that the kinetics may also be the same. These results are compatible with the "extended surface" concept of turbulent flame structure, but do not rule out other theories.

NACA RM E54F29a

SPARK IGNITION OF FLOWING GASES. IV - THEORY OF IGNITION IN NONTURBULENT AND TURBULENT FLOW USING LONG-DURATION DISCHARGES. Clyde C. Swett, Jr. August 1954. 29p. diagrs., 2 tabs. (NACA RM E54F29a)

A theory of spark ignition is presented that is based on the concept that only a portion of the discharge length, a line source of ignition, is important in the ignition process. Theoretical and experimental comparisons of the energy in this heated zone reveal a relation among the variables of total spark-discharge energy, gas density and velocity, electrode spacing, spark duration, intensity of turbulence, and fuel constants. The limited data available substantiate this relation.

NACA RM L54G02

RAPID ESTIMATION OF BENDING FREQUENCIES OF ROTATING BEAMS. Robert T. Yntema. August 1954. 18p. diagrs., tab. (NACA RM L54G02)

A procedure is presented in the form of charts which permits the rapid estimation of the natural bending frequencies of helicopter rotor blades both rotating and nonrotating. Since the approach is based on the Southwell equation, an evaluation of the method with regard to such things as higher modes, blade offset, and variable mass and stiffness distribution is also given. The evaluation shows that when nonrotating beam bending modes are used, the Southwell equation yields reasonably accurate bending frequencies for rotating helicopter blades. Example comparisons of frequencies estimated using the charts with values given by the manufacturer for several actual blades show that the simplified procedure yields good practical results.

NACA TN 3197

MECHANICAL PROPERTIES AT ROOM TEMPERATURE OF FOUR CERMETS OF TITANIUM CARBIDE WITH NICKEL BINDER. Aldie E. Johnson, Jr. August 1954. 22p. diagrs., photos., tabs. (NACA TN 3197)

Room-temperature stress-strain curves are presented for compression, tension, and shear loadings on four compositions of titanium carbide with nickel binder. Values of ultimate strength, modulus of elasticity, modulus of rigidity, Poisson's ratio in the elastic region, density, and hardness for the four materials are tabulated.

NACA TN 3206

TORSIONAL VIBRATIONS OF HOLLOW THIN-WALLED CYLINDRICAL BEAMS. Edwin T. Kruszewski and Eldon E. Kordes. August 1954. 33p. diagrs., tab. (NACA TN 3206)

Theoretical analyses of the torsional vibrations of hollow thin-walled cylinders are presented. Solutions for beams of arbitrary doubly symmetrical cross section with uniform wall thickness are given for cantilever and free-free beam vibrations. Numerical results are shown for cylinders of rectangular cross section and the influence of bending stresses due to torsion and longitudinal inertia is discussed. The solutions for beams of rectangular cross section are used to investigate the accuracy of a solution based on an analysis of a four-flange box beam.

NACA TN 3212

A NONLINEAR THEORY OF BENDING AND BUCKLING OF THIN ELASTIC SHALLOW SPHERICAL SHELLS. A. Kaplan and Y. C. Fung, California Institute of Technology. August 1954. 58p. diagrs., photo., 5 tabs. (NACA TN 3212)

The problem of the finite displacement and buckling of a shallow spherical dome is investigated both theoretically and experimentally. Experimental results seem to indicate that the classical criterion of buckling is applicable to very shallow spherical domes for which the theoretical calculation was made. A transition to energy criterion for higher domes is also indicated.

NACA TN 3223

AN ANALYSIS OF SHOCK-WAVE CANCELLATION AND REFLECTION FOR POROUS WALLS WHICH OBEY AN EXPONENTIAL MASS-FLOW PRESSURE-DIFFERENCE RELATION. Joseph M. Spiegel and Phillips J. Tunnell. August 1954. 23p. diagrs. (NACA TN 3223)

Conditions are derived for cancellation and reflection of two-dimensional shock waves from porous walls with wall suction. An exponential relation between mass flow and pressure differential across the walls is assumed. Applications to three-dimensional shock waves are discussed.

NACA TN 3224

THEORETICAL INVESTIGATION OF THE EFFECTS UPON LIFT OF A GAP BETWEEN WING AND BODY OF A SLENDER WING-BODY COMBINATION. Duane W. Dugan and Katsumi Hikido. August 1954. 41p. diagrs. (NACA TN 3224)

Slender-body theory is applied to determine the effects upon lift of a gap between wing and body of a slender wing-body combination. Two cases are considered, one in which the wing and body are both inclined at the same angle with respect to the free stream, the other in which the body remains at zero angle of attack and the wing is deflected with respect to the body.

NACA TN 3226

SOME POSSIBILITIES OF USING GAS MIXTURES OTHER THAN AIR IN AERODYNAMIC RESEARCH. Dean R. Chapman. August 1954. 48p. diagrs., 4 tabs. (NACA TN 3226)

A study is made of possible uses in compressible-flow research of various gas mixtures having the same specific-heat ratio as air. Such mixtures require low wind-tunnel power and have other possible applications in compressor research and firing-range research. Certain gas mixtures can be concocted which behave at wind-tunnel temperatures dynamically similar to air at flight temperatures.

NACA TN 3229

THE SMALL-DISTURBANCE METHOD FOR FLOW OF A COMPRESSIBLE FLUID WITH VELOCITY POTENTIAL AND STREAM FUNCTION AS INDEPENDENT VARIABLES. Carl Kaplan. August 1954. 18p. (NACA TN 3229)

The equations of two-dimensional compressible flow are treated according to the Prandtl-Busemann small-disturbance method. In contrast to the usual procedure, the independent variables are the compressible velocity potential and stream function and the dependent variables are the rectangular Cartesian coordinates in the plane of flow. The six first-order differential equations corresponding to the first three iteration steps are put into complex-vector form. The particular integrals of the resulting set of three equations are then directly obtained. As an example, the general results of the analysis are applied to the case of subsonic compressible flow past a sinusoidal wall of small amplitude.

NACA TN 3232

AN ANALYSIS OF THE STABILITY AND ULTIMATE BENDING STRENGTH OF MULTIWEB BEAMS WITH FORMED-CHANNEL WEBS. Joseph W. Semonian and Roger A. Anderson. August 1954. 28p. diagrs., photos. (NACA TN 3232)

Design curves and procedures are presented for calculating the stresses at which wrinkling instability and failure occur in multiweb beams with formed-channel webs. The theory is compared with test data for multiweb beams in bending and a criterion is given for predicting whether a given beam will be susceptible to a wrinkling instability or will buckle in a local mode. The specification for riveting the web attachment flanges to the cover skins of the beams is shown to be an important factor in determining the ultimate strength of this type of construction.

NACA TN 3233

A REVIEW OF PLANING THEORY AND EXPERIMENT WITH A THEORETICAL STUDY OF PURE-PLANING LIFT OF RECTANGULAR FLAT PLATES. Charles L. Shuford, Jr. August 1954. 34p. diagrs. (NACA TN 3233)

A summary is given of the background and present status of the pure-planing flat-plate lift theories. The fundamental assumptions and applicability to actual calculation of the planing lift force are reviewed. A proposed theory based on the consideration of linear lifting-line theory less the suction component of lift plus crossflow effects is presented. A comparison of this theory with existing planing formulas and experimental data is made. The agreement between the results calculated by the proposed theory and the experimental data is satisfactory for engineering calculations of pure-planing rectangular-flat-plate lift and center of pressure.

NACA TN 3234

REDUCTION OF HELICOPTER PARASITE DRAG. Robert D. Harrington. August 1954. 8p. diagrs. (NACA TN 3234)

A reduction in helicopter parasite drag is possible but not profitable except in those cases where high speed and long range are primary requirements. For some of the factors causing drag, reduction in parasite-drag area may result in increased weight whereas, in other cases, it does not. The final design, however, must be a compromise between the reduction of drag and the increase in weight.

NACA TN 3236

WIND-TUNNEL STUDIES OF THE PERFORMANCE OF MULTIROTOR CONFIGURATIONS. Richard C. Dingeldein. August 1954. 10p. diagrs., photo. (NACA TN 3236)

The power requirements measured in static thrust and in level forward flight are presented for a coaxial and a tandem helicopter rotor configuration. The experimental measurements are compared with the results of calculations based on existing NACA single-rotor theory.

NACA TN 3237

HOVERING PERFORMANCE OF A HELICOPTER ROTOR USING NACA 8-H-12 AIRFOIL SECTIONS. Robert D. Powell, Jr. August 1954. 14p. diagrs., photos. (NACA TN 3237)

A helicopter rotor employing NACA 8-H-12 airfoil sections has been tested on the Langley helicopter test tower. Tests were made for two surface conditions, one within -0.002 inch of true airfoil contour and the other within -0.020 inch. The blades within 0.002 inch of true airfoil contour showed an average decrease of 6 to 7 percent in total torque coefficients.

NACA TN 3238

REVIEW OF INFORMATION ON INDUCED FLOW OF A LIFTING ROTOR. Alfred Gessow. August 1954. 16p. diagrs., photo., tab. (NACA TN 3238)

A brief review of the available information relating to rotor inflow is presented. The available material is summarized in a table as to flight condition, type of information, source, and the reference papers in which the data can be found. Some representative aspects of some of the reference material are discussed.

NACA TN 3239

SOME ASPECTS OF THE HELICOPTER NOISE PROBLEM. Harvey H. Hubbard and Leslie W. Lassiter. August 1954. 14p. diagrs., photo. (NACA TN 3239)

Some aspects of the helicopter noise problem are briefly discussed. These discussions deal with the nature of the problem, some tentative criteria for use in evaluating it, and the physical characteristics of noise from helicopters. Overall noise data are presented for a reciprocating-engine helicopter along with discussions of the characteristics of noise from its various components such as the engine, gearing, and rotors. Some consideration is also given to the noise from tip jet rotor systems.

NACA TN 3241

AIRFOIL SECTION CHARACTERISTICS AT HIGH ANGLES OF ATTACK. Laurence K. Loftin, Jr. August 1954. 10p. diagrs. (NACA TN 3241)

Information from the literature and from recent investigations is used to summarize briefly the effects of airfoil section parameters and flow variables on the aerodynamic characteristics of symmetrical airfoils at high angles of attack. The results indicate that airfoil thickness ratio, Reynolds number, Mach number, and surface roughness can all have an important effect on the maximum lift coefficient. Beyond the stall, changes in section thickness ratio appear to have little effect on the aerodynamic characteristics of airfoil sections.

NACA TN 3244

AERODYNAMIC CHARACTERISTICS OF THE NACA 64-010 AND 0010-1.10 40/1.051 AIRFOIL SECTIONS AT MACH NUMBERS FROM 0.30 TO 0.85 AND REYNOLDS NUMBERS FROM 4.0×10^6 TO 8.0×10^6. Laurence K. Loftin, Jr. August 1954. 17p. diagrs., tab. (NACA TN 3244)

The results of a short two-dimensional investigation to determine the aerodynamic characteristics of the NACA 64-010 and 0010-1.10 40/1.051 airfoil sections are presented. The investigation covered a Mach number range from 0.30 to 0.85 and the corresponding Reynolds number range extended from 4.0×10^6 to 8.0×10^6.

NACA TN 3253

SOME EFFECTS OF EXPOSURE TO EXHAUST-GAS STREAMS ON EMITTANCE AND THERMOELECTRIC POWER OF BARE-WIRE PLATINUM RHODIUM - PLATINUM THERMOCOUPLES. George E. Glawe and Charles E. Shepard. August 1954. 30p. diagrs., photos. (NACA TN 3253)

Thermocouples were exposed to exhaust gases from the combustion of propane, 72-octane gasoline, and JP-4 fuel. Exposure increased the emissivity of the thermocouple wire, which increased its radiation error. Two methods are presented for determining the emittance of the wires. The emissivity of a clean platinum rhodium - platinum thermocouple was approximately 0.2 in the temperature range investigated, while the emittance of an exposed thermocouple coated with exhaust residue was about 0.5. The exposure caused negligible change in the thermoelectric power of the thermocouples.

NACA TN 3254

DETERMINATION OF FLAME TEMPERATURES FROM 2000° TO 3000° K BY MICROWAVE ABSORPTION. Perry W. Kuhns. August 1954. 48p. diagrs., photo., 2 tabs. (NACA TN 3254)

Equations are developed and a procedure is outlined for obtaining flame temperatures from the attenuation of microwaves by temperature-induced free electrons. The electron-molecule collision frequency and the effective ionization potentials of alkali metals are found from the attenuation by a gaseous burner flame in the region 1900° to 2400° K. Temperature data of a liquid-propellent burner flame is presented in the region 2200° to 2900° K.

NACA TN 3257

EFFECTS OF CHEMICALLY ACTIVE ADDITIVES ON BOUNDARY LUBRICATION OF STEEL BY SILICONES. S. F. Murray and Robert L. Johnson. August 1954. 24p. diagrs., photos., tab. (NACA TN 3257)

Conventional chemically active additives and more active compounds such as peroxide were investigated. Conventional additives were not effective, but more active materials such as the peroxide did give effective lubrication. However, all the chemically active-type additives were inferior to the solvent-type additions such as the diesters previously studied.

NACA TN 3258

INVESTIGATION OF MACH NUMBER CHANGES OBTAINED BY DISCHARGING HIGH-PRESSURE PULSE THROUGH WIND TUNNEL OPERATING SUPERSONICALLY. Rudolph C. Haefeli and Harry Bernstein. August 1954. 14p. diagrs., photos., tab. (NACA TN 3258)

A series of tests was performed to obtain an indication of the transient-flow phenomena caused by discharging a chamber of high-pressure gas into a wind tunnel operating supersonically. Two types of gust

were obtained; one had a maximum Mach number with a practically zero time duration whereas the other had a maximum Mach number with a finite time duration depending on the specific geometry. Such a test facility is applicable as a supersonic longitudinal-gust tunnel for producing transient boosts in Mach number.

NACA TN 3259

INVESTIGATION OF NICKEL-ALUMINUM ALLOYS CONTAINING FROM 14 TO 34 PERCENT ALUMINUM. W. A. Maxwell and E. M. Grala. August 1954. 42p. diagrs., photos., 7 tabs. (NACA TN 3259)

Alloys containing the intermetallics NiAl and Ni_3Al were prepared by casting. The melting practice developed was most important for the preparation of sound bodies. Room- and elevated-temperature strengths, ductilities, and susceptabilities to hot-rolling were determined. The 17.5-percent-aluminum alloy had the most outstanding properties and was studied in greatest detail. Creep-rupture strength at 1350° F, impact resistance, thermal shock behavior, oxidation resistance, and effects of thermal treatment on microstructure were determined for the 17.5-percent-aluminum alloy.

NACA TN 3261

A METHOD FOR EVALUATING THE EFFECTS OF DRAG AND INLET PRESSURE RECOVERY ON PROPULSION-SYSTEM PERFORMANCE. Emil J. Kremzier. August 1954. 21p. diagrs. (NACA TN 3261)

A method for evaluating the effects of inlet pressure recovery and drag on propulsion system thrust minus drag performance from consideration of engine over-all "pumping" characteristics is presented for air-breathing engines. The equations and curves presented facilitate the choice of inlet for maximum thrust minus drag. Illustrative examples of the use of the curves are also included.

NACA TN 3284

EXAMINATION OF THE EXISTING DATA ON THE HEAT TRANSFER OF TURBULENT BOUNDARY LAYERS AT SUPERSONIC SPEEDS FROM THE POINT OF VIEW OF REYNOLDS ANALOGY. Alvin Seiff. August 1954. 38p. diagrs., tab. (NACA TN 3284)

Experimental data from six investigations of the heat transferred by a turbulent boundary layer at supersonic speeds are studied to see whether or not they are well represented by the modified Reynolds analogy. The heat-transfer data are compared with the existing data on turbulent skin friction at supersonic speeds as affected by Mach number and wall temperature ratio. The effect of the wall temperature ratio on the data is emphasized.

BRITISH REPORTS

N-32409*

Forest Products Research Lab. (Gt. Brit.)
RADIO FREQUENCY AND OTHER HEATING PROCESSES. PROGRESS REPORT ELEVEN - APRIL, 1954. AGEING TESTS ON GLUED JOINTS CURED BY RADIO FREQUENCY HEATING.
J. F. S. Carruthers and G. E. Soane. 4p. tab. (Forest Products Research Lab.)

Test specimens of glued beech plywood set by radio frequency glue line heating were tested by applying a splitting tool to each glue line and determining the maximum force required to force apart the laminations. The effect of five glues of the strength of the joints was investigated.

N-32431*

Aeronautical Research Council (Gt. Brit.)
EVAPORATION FROM THE SURFACE OF A BODY IN AN AIRSTREAM (WITH PARTICULAR REFERENCE TO THE CHEMICAL METHOD OF INDICATING BOUNDARY-LAYER TRANSITION). P. R. Owen and A. O. Ormerod. 1954. 42p. diagrs., 8 tabs. (ARC R & M 2875; ARC 14,604. Formerly RAE Aero 2431)

The problem of predicting the rate of transport of a gas from or into the surface of a two-dimensional body in an airstream is discussed. The principle object of the investigation is to provide a means of estimating the time required to obtain an experimental record of boundary-layer transition when a chemical technique is used. The methods evolved should, however, find an application to other forced diffusion phenomena.

N-32432*

Aeronautical Research Council (Gt.Brit.)
A REVIEW OF PORPOISING INSTABILITY OF SEAPLANES. A. G. Smith and H. G. White. 1954. 41p. diagrs., 5 tabs. (ARC R & M 2852; ARC 7741. Formerly MAEE H/Res/173)

A review has been made of the evidence on take-off and landing porpoising instability of seaplanes. The basic types of porpoising and their occurrence have been examined: full-scale results have been correlated with model-scale and theoretical results. Porpoising instability has been divided into three basic types, (a) forebody, (b) forebody-afterbody, and (c) step instability.

N-32433*

Aeronautical Research Council (Gt. Brit.)
SYMMETRIC FLUTTER CHARACTERISTICS OF A HYPOTHETICAL DELTA WING. D. L. Woodcock. 1954. 23p. diagrs. (ARC R & M 2839; ARC 13,378. Formerly RAE Structures 68)

This report considers the flutter characteristics of a hypothetical delta wing. It details the results of quaternary calculations showing the effect on the

reduced critical speed of the shapes and relative natural frequencies of the first two normal modes of the aircraft. From these results the stiffnesses necessary to avoid flutter are deduced for two forms of wing structure. The aerodynamic forces have been obtained by using two-dimensional derivatives multiplied by the cosine of the quarter-chord sweepback in conjunction with strip theory applied to fore-and-aft strips. This procedure is of doubtful validity for the low aspect-ratio wing considered. With this reservation, however, the results confirm the adequacy of the present Ministry of Supply wing-stiffness requirement.

N-32434*

Aeronautical Research Council (Gt.Brit.)
CHANGES IN CONTROL CHARACTERISTICS WITH CHANGES IN FLOW PATTERN AT HIGH SUBSONIC SPEEDS. TEST ON AN EC.1250 AEROFOIL WITH 25 PER CENT CONCAVE CONTROL FLAP, PARTS I AND II. R. A. Shaw. 1954. 32p. diagrs., photos., tab. (ARC R & M 2436. Formerly ARC 11,933; FM 1310; S & C 2264; 0.812; ARC 12,284)

This report describes results obtained in wind-tunnel tests where it was found that considerable changes in flow pattern and pressure distribution around an airfoil with control flap occurred in certain conditions for a small increase in speed or change in incidence or control angle. The changes were found first between M = 0.85 and 0.87, when the shock-stalled flow, which had developed at lower speeds, was replaced, on one surface only, by streamline flow extending almost to the trailing edge.

N-32435*

Aeronautical Research Council (Gt. Brit.)
NOTES ON THE DYNAMIC RESPONSE OF AN AIRCRAFT TO GUSTS AND ON THE VARIATION OF GUST VELOCITY ALONG THE FLIGHT PATH WITH SPECIAL REFERENCE TO MEASUREMENTS IN LANCASTER P.D.119. Anne Burns. 1954. 18p. diagrs. (ARC R & M 2759; ARC 12,797. Formerly RAE Structures 47)

A collection of records showing the time histories of strains and accelerations at various parts of a Lancaster flying in clear turbulent air is presented and discussed. The records include specimens taken in cloud at moderate altitudes and in clear air at low altitudes. The amount of oscillation (fundamental) excited by a gust appears to be affected by the variation of gust velocity across the span and the amount of oscillation excited does not appear to show any marked decrease as the airspeed of the aircraft is increased.

N-32436*

Aeronautical Research Council (Gt.Brit.)
AILERON REVERSAL AND WING DIVERGENCE OF SWEPT WINGS. E. G. Broadbent and Ola Mansfield. 1954. 26p. diagrs., 6 tabs. (ARC R & M 2817; ARC 11,148. Formerly RAE Structures 9)

A method of solution for the aileron reversal speed of a swept wing (with emphasis on sweepback) is developed on the lines of strip and semirigid theories. The influence of the degree of sweep, wing torsional and flexural stiffness, wing plan form, and aileron plan form is investigated. Families of curves are given for extended variation of these parameters which may be used for the direct estimation of the reversal speed of a given wing by interpolation. A solution is given for the wing divergence speed of a swept wing.

N-32437*

Aeronautical Research Council (Gt. Brit.)
NOTES ON THE INDUCED DRAG OF A WIND-TAIL COMBINATION. C. H. Naylor. 1954. 10p. diagrs., tab. (ARC R & M 2528. Formerly ARC 9974; Perf. 223)

An expression has been derived for the factor to be applied to ideal induced drag to allow for wing-tail interference. This factor is primarily dependent on the wing-tail lift and span ratios. It is of the order of 1:1 for a normal aircraft when the tailplane carries 10 percent of the weight of the aircraft, and can reach unexpectedly large values of high speed. Charts, generalized curves, and sufficient information are included to permit rapid evaluation of the factor for any particular case.

N-32438*

Aeronautical Research Council (Gt. Brit.)
WING PARACHUTES FOR RECOVERY FROM THE SPIN. PART I - GENERAL DESIGN REQUIREMENTS. G. E. Pringle and T. V. Somerville. PART II - WAKE PHENOMENA. D. J. Harper, J. R. Mitchell, J. Picken and G. E. Pringle. 1954. 10p. diagrs., tab. (ARC R & M 2543; ARC 8388; ARC 10,762. Formerly RAE Tech. Note Aero 1559; Tech. Note Aero 1881)

The wing parachutes of a tailless aircraft prototype failed to open when streamed in an accidental spin. This gave a clue to the existence of a marked wake effect when a parachute is deployed on a tow cable behind a stalled wing. The wake effect is such as to reduce the critical closing speed of the parachute. The effect measured in a wind tunnel diminishes as the cable is lengthened. It is recommended that the cables be made as long as possible up to 1-1/2 spans in length; here the danger of entanglement becomes real.

N-32439*

Aeronautical Research Council (Gt.Brit.)
FURTHER EXPERIMENTS ON AN NACA 23021 AEROFOIL WITH A 15 PER CENT HANDLEY PAGE SLOTTED FLAP IN THE COMPRESSED AIR TUNNEL. R. Jones and A. H. Bell. 1954. 16p. diagrs., 6 tabs. (ARC R & M 2519. Formerly ARC 9864; Perf.206 S & C 2041)

The NACA 23021 airfoil was tested with a form of flap and slot which was modified by a rounding-off of the trailing edge of the main wing on the lower surface and of the leading edge of the flap, thus making the gap on the lower surface appreciably larger. The model was tested at R = 0.75 to 7.1×10^6 over the usual incidence range with flap

settings of 0° to 80°. The results are very similar to those obtained on an earlier model. An overall check of apparatus and model was obtained by closing the gap at 60° flap angle and repeating with satisfactory results some of the tests on the original model.

N-32440*

Aeronautical Research Council (Gt. Brit.)
PUBLISHED REPORTS AND MEMORANDA OF THE AERONAUTICAL RESEARCH COUNCIL. 1954. 6p. (ARC R & M 2450)

N-32441*

Aeronautical Research Council (Gt. Brit.)
STATIONARY RIG EXPERIMENTS ON THE HEAT EXTRACTING POWER OF CLOSED THERMOSYPHON COOLING HOLES. H. W. Hahnemann. 1954. 44p. diagrs., tab. (ARC CP 152)

Information is given on heat flow in closed sodium-filled holes in turbine blades. The rig was a tube filled with fluid, transferring heat upwards by free convection from an electrically heated lower section to a water cooled upper section. The high Grashof numbers obtained in closed thermosyphon holes in actual turbine blades were approached by using tubes of large diameter, and measurements were made with mercury, water, and oil as the heat transporting fluid in order to cover a wide range of Grashof and Prandtl numbers. A formula correlating the results for the three different fluids was obtained.

N-32442*

Aeronautical Research Council (Gt.Brit.)
THE INFLUENCE OF SURFACE WAVES ON THE STABILITY OF A LAMINAR BOUNDARY LAYER WITH UNIFORM SUCTION. D. A. Spence and D. G. Randall. 1954. 29p. diagrs. (ARC CP 161)

In order to estimate the destabilizing effect of waves likely to be encountered on wing surfaces which will be used with boundary layer suction, calculations have been made of the effect of small sinusoidal surface waves on the stability of the asymptotic suction profile. Curves are presented of the percentage increases in local suction flow, necessary to maintain the stability of the boundary layer at the same level as on a completely flat surface for various values of local suction flow, height: wave length ratio, and Reynolds number based on wave length. It is found that for the lower local suction flow or the larger height: wave length ratio the larger the necessary percentage increase in local suction flow.

N-32443*

Aeronautical Research Council (Gt. Brit.)
THE MEASUREMENT OF POSITION ERROR AT HIGH SPEEDS AND ALTITUDE BY MEANS OF A TRAILING STATIC HEAD. K. W. Smith. 1954. 34p. diagrs., photo. (ARC CP 160)

The static position error of a service wing-tip leading edge pressure head installation has been measured on a Meteor VII by means of a trailing static head, developed especially for use at high speeds. These tests cover an altitude range from zero to 38,000 ft, and include measurements in "g" turns. The maximum Mach number reached was 0.84. For comparative purposes the static error was also measured at ground level by the aneroid method.

N-32444*

Aeronautical Research Council (Gt. Brit.)
CALIBRATION OF THE R. A. E. NO. 18 (9 IN. x 9 IN.) SUPERSONIC WIND TUNNEL. PART I - PRELIMINARY INVESTIGATIONS. W. T. Lord and D. Beastall. 1954. 44p. diagrs., 6 tabs. (ARC CP 162)

A detailed account is given of the investigations performed in the RAE No. 18 (9-inch by 9-inch, continuous flow, variable density) supersonic wind tunnel prior to an extensive calibration of the tunnel. Variables which have an important effect on the behavior of the flow are discussed, and preliminary experiments to determine their significance are described. Results of the investigations serve to define the course of the complete calibration, and may provide a useful guide to future calibrations of similar supersonic tunnels. The calibration program is outlined: Part II will deal with tests at atmospheric stagnation pressure, and further tests at various stagnation pressures are proposed.

N-32445*

Aeronautical Research Council (Gt. Brit.)
CALIBRATION OF THE R. A. E. NO. 18 (9 IN. x 9 IN.) SUPERSONIC WIND TUNNEL. PART II - TESTS AT ATMOSPHERIC STAGNATION PRESSURE. W. T. Lord, G. K. Hunt, R. J. Pallant and J. Turner. 1954. 24p. diagrs., 3 tabs. (ARC CP 163)

This report presents distributions of Mach number in the empty working section of the R. A. E. No. 18 (9-inch by 9-inch) supersonic wind tunnel at nominal Mach numbers of 1.4, 1.5, 1.6, 1.8, and 1.9, for condensation-free flow at atmospheric stagnation pressure and at a stagnation temperature of 35°. The major contributions to the nonuniformity of the flow are from the disturbances which arise from the junctions of the windows with the side walls of the tunnel. An indication of the boundaries of the working section for each Mach number is given.

N-32446*

Aeronautical Research Council (Gt.Brit.)
TABULATION OF THE BLASIUS FUNCTION WITH BLOWING AND SUCTION. H. W. Emmons and D. C. Leigh. 1954. 81p. diagrs., 3 tabs. (ARC CP 157)

The present solutions cover the whole possible range of blowing and suction values. It was in connection with the solution of a combustion problem that the present solutions were obtained. Previous

calculations were given to four decimal places. These hand computed tables generally agree to better than 5 in the last place with the present one. Calculations were done on the Electronic Delay Storage Automatic Calculator.

MISCELLANEOUS

N-25500

EFFECTS OF ROUGHNESS AND SUCTION ON TRANSITION FROM LAMINAR TO TURBULENT FLOW. Hugh L. Dryden. 12p. diagrs. (Reprint from Mémoires sur la Mécanique des Fluides, Ministére de l'Air, Publications Scientifiques et Techniques, p. 49-60, 1954)

The effect of roughness in reducing the gains attainable through the use of suction is described. Boundary layer stability, theoretical results for boundary-layer suction, effects of roughness on transition, experimental data on the effect of suction on transition, and combined effects of roughness and suction are topics included. It is concluded that only an extensive program carefully planned in the light of our present knowledge of roughness effects can settle the question as to whether the theoretically predicted stabilization of the flow can be obtained in practice.

NACA TN 2494

Errata No. 2 on "LIFT AND MOMENT ON OSCILLATING TRIANGULAR AND RELATED WINGS WITH SUPERSONIC EDGES." Herbert C. Nelson. September 1951.

NACA TN 3184

Errata No. 1 on "BUCKLING OF LONG SQUARE TUBES IN COMBINED COMPRESSION AND TORSION AND COMPARISON WITH FLAT-PLATE BUCKLING THEORIES." Roger W. Peters. May 1954.

UNPUBLISHED PAPERS

N-29537*

Univ. of Minn., Institute of Technology. THERMAL STRESSES IN BOX BEAMS - A THEORETICAL AND EXPERIMENTAL STUDY OF STRESSES IN ALUMINUM ALLOY BOX SECTIONS UNDER GIVEN TEMPERATURE DISTRIBUTIONS. Joseph A. Wise and Paul Andersen. January 1954. 130p. diagrs., photos. (Univ. of Minn., Institute of Technology)

A theoretical and experimental study of stresses in thin shell box sections due to thermal gradients is presented. The basic theory is first developed for plate-like sections then for box sections. Three specimens were tested in an attempt to verify the theory. It was concluded that the basic theory has received some support from these tests, but much more extended research is necessary to establish it completely.

DECLASSIFIED NACA REPORTS

THE FOLLOWING REPORTS HAVE BEEN DECLASSIFIED FROM CONFIDENTIAL, 8/18/54

RM E9D08
RM L7E15
RM L7I01
RM L8A28d
RM L8F21
RM L8G14
RM L9C23
RM L9H16a
RM L9I28a

NACA RM A7J05

WIND-TUNNEL INVESTIGATION AT A MACH NUMBER OF 1.53 OF AN AIRPLANE WITH A TRIANGULAR WING. Richard Scherrer and William R. Wimbrow. January 23, 1948. 74p. diagrs., photos., 2 tabs. (NACA RM A7J05) (Declassified from Confidential, 8/18/54)

Models of a tailless pursuit-type supersonic airplane were tested in the Ames 1- by 3-foot supersonic wind tunnel No. 1. The basic configuration and several modifications were tested in pitch and yaw and with deflections of the constant-chord control surfaces. The control effectiveness was found to be independent of angle of attack and was found to vary linearly with control deflection. The variation of drag with lift was small. All of the configurations tested were longitudinally stable, but most were directionally unstable.

NACA RM E8F07

DESIGN AND PERFORMANCE OF EXPERIMENTAL AXIAL-DISCHARGE MIXED-FLOW COMPRESSOR. II - PERFORMANCE OF IMPELLER. Ward W. Wilcox. August 12, 1948. 21p. diagrs., photo. (NACA RM E8F07) (Declassified from Confidential, 8/18/54)

Results are presented of preliminary tests on an axial-discharge mixed-flow impeller that was designed to combine the compactness, reliability, and wide operating range of mixed-flow compressor with high flow capacity per unit of frontal area that characterizes the axial-flow compressors. At design tip speed of 1480 feet per second, maximum flow capacity of 18.7 pounds per second, peak adiabatic efficiency of 0.78, and peak total-pressure ratio of 3.7 were obtained. Flow capacity per unit of frontal area for this axial discharge impeller is much greater than that of current commercial mixed-flow compressors but is somewhat less than that for the axial-flow compressors having the highest flow capacity per unit frontal area.

NACA RM L7I04

PRELIMINARY TANK TESTS OF NACA HYDRO-SKIS FOR HIGH-SPEED AIRPLANES. John R. Dawson and Kenneth L. Wadlin. November 26, 1947. 19p. diagrs., photos. (NACA RM L7I04) (Declassified from Confidential, 8/18/54)

Contains results from tank landings and take-off tests with a dynamic model of a hypothetical jet-propelled airplane equipped with NACA hydro-skis. These results show stable take-offs and landings for the model, although the resistance is high. The resistance, which is not considered necessarily inherent, appears to be acceptable for airplanes equipped with rocket motors. It is concluded that hydro-skis suitable for flush retraction into streamline fuselages offer a practicable means for taking off and landing high-speed airplanes on the water.

NACA RM L7K14

FLIGHT TESTS TO DETERMINE THE EFFECT OF AIRFOIL SECTION PROFILE AND THICKNESS RATIO ON THE ZERO-LIFT DRAG OF LOW-ASPECT-RATIO WINGS AT SUPERSONIC SPEEDS. Ellis Katz. February 9, 1948. 19p. diagrs., photos. (NACA RM L7K14) (Declassified from Confidential, 8/18/54)

Experimental determination of the zero-lift drag at low supersonic speeds of low-aspect-ratio wings with: (1) nonswept round-nose sections having varying degrees of thickness ratio from 0.03 to 0.09 and (2) swept and nonswept wings having round-nose, circular-arc, and diamond sections of 0.09 thickness ratio.

NACA RM L7K24

HIGH-SPEED WIND-TUNNEL TESTS OF A 1/16-SCALE MODEL OF THE D-558 RESEARCH AIRPLANE. BASIC LONGITUDINAL STABILITY OF THE D-558-1. John B. Wright. May 12, 1948. 19p. diagrs., tab. (NACA RM L7K24) (Declassified from Confidential, 8/18/54)

This report contains the results of pitching-moment, lift, and drag measurements with a 1/16-scale model of the D-558-1, with no nose-inlet flow, with both the tail removed and with the tail at a constant setting. The tests were conducted through a Mach number range up to 0.96 in the Langley 8-foot high-speed tunnel. Only a limited analysis has been made. It is indicated that the airplane can experience large changes in static longitudinal stability beyond a Mach number of 0.86. At a Mach number of 0.9 there is a tendency for the airplane to become unstable at low lift coefficients followed by large stable tendency at higher speeds. A part of this change in stability is indicated to be destabilizing effects from wing-fuselage characteristics.

NACA RM L8A05

FLIGHT TESTS TO DETERMINE THE DRAG OF FIN-STABILIZED PARABOLIC BODIES AT TRANSONIC AND SUPERSONIC SPEEDS. Sidney R. Alexander, Leo T. Chauvin and Charles B. Rumsey. April 21, 1948. 24p. diagrs., photos. (NACA RM L8A05) (Declassified from Confidential, 8/18/54)

Two fin-stabilized parabolic bodies of revolution of fineness ratios 7.87 and 12 were flight tested over the transonic and supersonic range. Curves of measured total drag coefficient plotted against Mach number are presented together with estimates of total drag coefficient for several Mach numbers to indicate the reasonable accuracy that can be expected from such predictions. The tests also proved the effectiveness of a simple "drag-separation" type booster arrangement.

NACA RM L8A07

FREE-FLIGHT INVESTIGATION OF THE ROLLING EFFECTIVENESS OF A WING-SPOILER ARRANGEMENT AT HIGH SUBSONIC, TRANSONIC, AND SUPERSONIC SPEEDS. Carl A. Sandahl. May 17, 1948. 10p. diagrs., photo. (NACA RM L8A07) (Declassified from Confidential, 8/18/54)

An investigation of the rolling effectiveness of a wing-spoiler arrangement has been conducted by the use of rocket-propelled test vehicles in free flight. The results obtained for the configuration tested, which probably was not an optimum, indicated that rolling effectiveness was a maximum at about $M = 0.91$, decreased abruptly in the Mach number range from 0.92 to about 1.0, and continued to decrease with increasing Mach number to the maximum attained ($M = 1.73$).

NACA RM L8A12

FORCE, STATIC LONGITUDINAL STABILITY, AND CONTROL CHARACTERISTICS OF A 1/16-SCALE MODEL OF THE BELL XS-1 TRANSONIC RESEARCH AIRPLANE AT HIGH MACH NUMBERS. Axel T. Mattson and Donald L. Loving. June 23, 1948. 49p. diagrs., tab. (NACA RM L8A12) (Declassified from Confidential, 8/18/54)

This report contains results obtained to determine the effects of compressibility at high Mach numbers on a 1/16-scale model of the Bell XS-1 transonic research airplane. These results are presented for several model configurations through a Mach number range from 0.4 to approximately 0.925. Presented in the report are the lift, drag, and pitching-moment variations with Mach numbers for angles of attack of 0° and 3° for various stabilizer incidences and elevator deflections. The incremental drag, lift, and pitching-moment characteristics are presented for a fuselage speed retarder.

NACA RM L8A22

QUALITATIVE MEASUREMENTS OF RELATIVE FLAP EFFECTIVENESS AT TRANSONIC SPEEDS ON A SERIES OF FIVE THIN AIRFOILS WITH 25-PERCENT-CHORD FLAPS AND VARIOUS AMOUNTS OF SWEEPBACK. Harold L. Crane and Milton D. McLaughlin. May 17, 1948. 24p. diagrs., photos. (NACA RM L8A22) (Declassified from Confidential, 8/18/54)

Tests were made by the wing-flow method on a series of 3-percent-thick models which had sweepback combinations of leading edge and flap hinge line ranging from 0° to 45°. Full-span flaps were tested in all

cases, and, in addition, a half-span flap was tested on a 45° sweptback model. The Mach number range was from 0.5 to 1.1, and at M = 0.8 the Reynolds number range was approximately 700,000 to 1,500,000. The tests showed that the sweptback flaps were less effective but had a smaller decrease in effectiveness with speed. In no case was there an abrupt change in effectiveness or a complete loss of or reversal of effectiveness.

NACA RM L8A28

CURRENT STATUS OF LONGITUDINAL STABILITY. Charles J. Donlan. May 24, 1948. 16p. diagrs. (NACA RM L8A28) (Declassified from Confidential, 8/18/54)

The problems of static and dynamic longitudinal stability both at high speeds and at low speeds are discussed and data are presented which indicate recent progress made in the solution of these problems.

NACA RM L8A28b

DRAG MEASUREMENTS AT TRANSONIC SPEEDS OF TWO BODIES OF FINENESS RATIO 9 WITH DIFFERENT LOCATIONS OF MAXIMUM BODY DIAMETER. Jim Rogers Thompson and Max C. Kurbjun. July 22, 1948. 17p. diagrs., photos. (NACA RM L8A28b) (Declassified from Confidential, 8/18/54)

Contains total drag measurements by the free-fall method for two bodies of fineness ratio 9 with the maximum diameter located 16.7 percent ahead of and behind the body midpoint. The results are compared with those of previous tests to show the effect of location of maximum body diameter on drag between Mach numbers of 0.85 to 1.08 and to provide some information on the mechanism of the abrupt drag rise which occurs between Mach numbers of 0.95 and 1.00.

NACA RM L8A28e

LANDING CHARACTERISTICS OF HIGH-SPEED WINGS. Herbert A. Wilson, Jr. and Laurence K. Loftin, Jr. September 21, 1948. 21p. diagrs. (NACA RM L8A28e) (Declassified from Confidential, 8/18/54)

The results of investigations of the maximum lift characteristics of wings for airplanes designed to fly at transonic Mach numbers are summarized. It is concluded that maximum lift coefficients of about 1.3 to 1.6 can be obtained for wings of this type with the high-lift devices investigated, leading-edge flaps improve the characteristics of the wings, and the drag at high lifts is of importance in determining the landing characteristics.

NACA RM L8B03

LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A SEMISPAN AIRPLANE MODEL AT TRANSONIC SPEEDS AS OBTAINED BY THE TRANSONIC-BUMP METHOD. Joseph Weil and M. Leroy Spearman. July 19, 1948. 23p. diagrs., tab. (NACA RM L8B03) (Declassified from Confidential, 8/18/54)

Tests were made using the transonic-bump method to determine the longitudinal stability and control characteristics in the transonic range of a semispan airplane model similar to a proposed research vehicle. A comparison was made with results obtained for the same model by the NACA wing-flow method. The model was mounted on a pivot and was free to trim at zero pitching moment. The lift coefficient and angle of attack for trim at various stabilizer settings were obtained for four center-of-gravity positions. The tests were made through a Mach number range from 0.60 to 1.20.

NACA RM L8B06

HIGH-SPEED WIND-TUNNEL TESTS OF A 1/16-SCALE MODEL OF THE D-558 RESEARCH AIRPLANE. D-558-1 SPEED-REDUCTION BRAKE AND SYMMETRICAL-PROFILE WING CHARACTERISTICS. John B. Wright. June 15, 1948. 22p. diagrs., tab. (NACA RM L8B06) (Declassified from Confidential, 8/18/54)

Contains a limited analysis of the results of pitching-moment, lift, and drag measurements with a 1/16-scale model of the D-558-1 through a Mach number range up to 0.96 in the Langley 8-foot high-speed tunnel. Tests of the model were made with speed-reduction brakes on the fuselage sides fully deflected. Tests were also made with the model (without brakes) utilizing a wing of symmetrical profile. Included for comparison are data for the model without the brakes and for the model with a cambered wing.

NACA RM L8B18

TANK SPRAY TESTS OF A JET-POWERED MODEL FITTED WITH NACA HYDRO-SKIS. Kenneth L. Wadlin and John A. Ramsen. July 22, 1948. 19p. diagrs., photos. (NACA RM L8B18) (Declassified from Confidential, 8/18/54)

Contains tank results of take-off tests with a powered dynamic model of a hypothetical jet-propelled high-speed airplane, fitted with NACA hydro-skis, and having flush turbojet intakes on the upper part of the fuselage near the nose. It was concluded that take-offs can be made without spray entering the intakes by using very small longitudinal strips. The tendency of the turbojet air inflow to draw spray into the intakes is slight. Jet power increased trims during the high-speed part of the take-off run.

NACA RM L8B19

LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A SEMISPAN AIRPLANE MODEL WITH A SWEPTBACK WING AND TAIL FROM TESTS AT TRANSONIC SPEEDS BY THE NACA WING-FLOW METHOD. Richard H. Sawyer and Lindsay J. Lina. July 23, 1948. 42p. diagrs., photos., tab. (NACA RM L8B19) (Declassified from Confidential, 8/18/54)

The angle of attack and lift coefficient obtained under trimmed (zero pitching-moment) conditions with fixed controls are presented for Mach numbers from 0.50 to 1.07 for a semispan airplane model having a 45° sweptback wing and tail. The effects of

Reynolds number and the effectiveness of a wing flap similar to a dive-recovery flap on a straight wing also were investigated briefly. Comparison is made with previous tests of the model equipped with, first, an unswept wing and tail and, second, with an unswept wing and sweptback tail.

NACA RM L8B26

PRELIMINARY FREE-FLIGHT INVESTIGATION OF THE EFFECT OF AIRFOIL SECTION ON AILERON ROLLING EFFECTIVENESS AT TRANSONIC AND SUPERSONIC SPEEDS. Carl A. Sandahl. June 25, 1948. 6p. diagrs. (NACA RM L8B26) (Declassified from Confidential, 8/18/54)

Results have been obtained by means of a free-flight technique utilizing rocket propulsion which indicate that aileron-rolling-effectiveness characteristics are affected adversely by variations in airfoil section which produce large increases in the trailing-edge angle.

NACA RM L8C23

HIGH-SPEED WIND-TUNNEL TESTS OF A 1/16-SCALE MODEL OF THE D-558 RESEARCH AIRPLANE. LONGITUDINAL STABILITY AND CONTROL OF THE D-558-1. John B. Wright. July 8, 1948. 47p. diagrs., tab. (NACA RM L8C23) (Declassified from Confidential, 8/18/54)

This paper contains the results of pitching-moment and lift measurements with a 1/16-scale model of the D-558-1, with no nose-inlet flow, and at several stabilizer and elevator settings. The tests were conducted up to a Mach number of 0.96 in the Langley 8-foot high-speed tunnel. Only a limited analysis of the various stability and control parameters is presented.

NACA RM L8C25

AERODYNAMIC LOSSES IN LOW-PRESSURE TAILPIPE EXHAUST DUCTS FOR ROCKET-PROPELLED AIRCRAFT. W. K. Hagginbothom and J. G. Thibodaux. July 20, 1948. 15p. diagrs., photos. (NACA RM L8C25) (Declassified from Confidential, 8/18/54)

An evaluation of the aerodynamic losses involved in the use of exhaust ducts for rocket-propelled aircraft was obtained from thrust stand tests. The aerodynamic losses created by the use of low-pressure tailpipe exhaust ducts for rocket-propelled aircraft are within practical limits insofar as overall propulsion requirements for pilotless-aircraft models are concerned.

NACA RM L8D21

PRELIMINARY INVESTIGATION OF VARIOUS AILERONS ON A 42° SWEPTBACK WING FOR LATERAL CONTROL AT TRANSONIC SPEEDS. Thomas R. Turner, Vernard E. Lockwood and Raymond D. Vogler. September 7, 1948. 35p. diagrs., photo. (NACA RM L8D21) (Declassified from Confidential, 8/18/54)

Contains the rolling-moment characteristics for a reflection-plane model with 42.8° leading-edge sweep, aspect ratio 4.0, and taper ratio 0.50 for several aileron configurations (chord and contour change) in the transonic speed range. The paper also includes some rolling-moment characteristics for spoilers, wing-tip aileron, and leading-edge flaps through the transonic speed range at Mach numbers from 0.5 to 1.15.

NACA RM L8E14

LIMITED MEASUREMENTS OF STATIC LONGITUDINAL STABILITY IN FLIGHT OF DOUGLAS D-558-1 AIRPLANE (BUAERO NO. 37971). Walter C. Williams. June 24, 1948. 10p. diagrs., photos., tab. (NACA RM L8E14) (Declassified from Confidential, 8/18/54)

Contains a few measurements of the variation of elevator angle and elevator force with Mach number at 30,000 feet altitude up to a Mach number of 0.85. These data show that the airplane possessed positive static longitudinal stability up to a Mach number of 0.80. A trim change in the nose-down direction occurred for Mach numbers above 0.82.

NACA RM L8E14a

FLIGHT MEASUREMENT OF THE STABILITY CHARACTERISTICS OF THE DOUGLAS D-558-1 AIRPLANE (BUAERO NO. 37971) IN SIDESLIPS. Walter C. Williams. April 18, 1949. 23p. diagrs., photos. (NACA RM L8E14a) (Declassified from Confidential, 8/18/54)

Measurements have been made of the stability characteristics of the D-558-1 airplane in steadily increasing sideslips at various Mach numbers from 0.50 to 0.80 at 10,000 feet altitude and at Mach numbers from 0.50 to 0.84 at 30,000 feet altitude. The results of these tests show that the apparent directional stability of the airplane is high and increases with increasing Mach number and dynamic pressure. The dihedral effect is positive at all speeds, there is little or no change in pitching moment with sideslip, and the cross-wind force is positive.

NACA RM L8E27

FLIGHT TESTS OF A TWO-DIMENSIONAL WEDGE DIFFUSER AT TRANSONIC AND SUPERSONIC SPEEDS. M. A. Faget. August 11, 1948. 21p. diagrs., photos. (NACA RM L8E27) (Declassified from Confidential, 8/18/54)

A two-dimensional wedge diffuser suitable for use in a ducted-airfoil ram jet was flight tested. Test results at flight speeds from $M = 0.7$ to $M = 1.4$ are presented. A velocity survey at the exit of the diffuser showed a large wake effect from the island which was faired behind the central wedge. Curves showing diffuser-exit Mach numbers, velocity, pressure, and mass flow are all smooth throughout the transonic region indicating the diffusion process to be fairly insensitive to passage through the transonic region.

NACA RM L8F24

APPLICATION OF ONE PART OF VON KARMAN'S TWO-DIMENSIONAL TRANSONIC SIMILARITY LAW TO DRAG DATA OF NACA 65-SERIES WINGS. Kenneth B. Amer. August 24, 1948. 9p. diagrs. (NACA RM L8F24) (Declassified from Confidential, 8/18/54)

Application of one part of Von Kármán's two-dimensional transonic similarity law to drag data of wings having NACA 65-006, 65-009, and 65_1-012 profiles and aspect ratios of 7.6 in the transonic range shows satisfactory correlation. The presence of various factors in the flow which were not considered in the derivation of the law from the potential flow equation did not appreciably affect the degree of correlation.

NACA RM L8G29a

DETERMINATION BY THE FREE-FALL METHOD OF THE LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A 1/4-SCALE MODEL OF THE BELL XS-1 AIRPLANE AT TRANSONIC SPEEDS. James T. Matthews, Jr. and Charles W. Mathews. November 9, 1948. 19p. diagrs., photo., tab. (NACA RM L8G29a) (Declassified from Confidential, 8/18/54)

Report presents results of a free-fall test to determine longitudinal stability and control characteristics of a 1/4-scale model of the Bell XS-1 airplane. The model attained a Mach number of 0.98. Time histories given show variations of elevator position, normal and transverse accelerations, longitudinal retardation, and Mach number throughout the fall. Variations with Mach number of lift coefficient, drag coefficient, and lift-to-drag ratio are also presented. Observations on and explanations of the behavior of the model are included.

NACA RM L8G30

LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A SEMISPAN MODEL OF A SUPERSONIC AIRPLANE CONFIGURATION AT TRANSONIC SPEEDS FROM TESTS BY THE NACA WING-FLOW METHOD. Norman S. Silsby and James M. McKay. November 8, 1948. 30p. diagrs., photos., tab. (NACA RM L8G30) (Declassified from Confidential, 8/18/54)

The investigation was made by the NACA wing-flow method of the longitudinal stability and control characteristics in the transonic range of a semispan model of a supersonic airplane configuration having a long slender fuselage and straight wing and tail with faired double-wedge airfoil sections 4.6 percent thick, aspect ratio 4.0, and taper ratio 2.

NACA RM L8H05

HIGH-SPEED WIND-TUNNEL TESTS OF A 1/16-SCALE MODEL OF THE D-558 RESEARCH AIRPLANE - DYNAMIC PRESSURE AND COMPARISON OF POINT AND EFFECTIVE DOWNWASH AT THE TAIL OF THE D-558-1. Harold L. Robinson. November 4, 1948. 27p. diagrs. (NACA RM L8H05) (Declassified from Confidential, 8/18/54)

The results indicate that the downwash changes that occur at the tail location of the D-558-1 airplane are not the cause for the instability reported in previous papers. The tests include a Mach number range of 0.40 to 0.94 and a lift-coefficient range of -0.3 to 0.7. The rate of change of point downwash with lift coefficient decreases at high speeds and low lift coefficient, thus causing a stabilizing effect. The appendices of this paper give a method of correlating stability with downwash and also give a method of including tail drag when measuring downwash by the tail-on and tail-off methods.

NACA RM L8H06a

EFFECT OF DOWNWASH ON THE ESTIMATED ELEVATOR DEFLECTION REQUIRED FOR TRIM OF THE XS-1 AIRPLANE AT SUPERSONIC SPEEDS. James T. Matthews, Jr. November 1, 1948. 11p. diagrs. (NACA RM L8H06a) (Declassified from Confidential, 8/18/54)

Contains estimation of elevator deflections required for trim at supersonic speeds of the XS-1 including the effect of downwash determined from linearized theory. Results indicate that increasing up-elevator deflection is required in level flight as the Mach number increases from 1.1 to about 1.6 with a slight reduction of up elevator occurring between 1.6 and 2.0. The reasons for these trends have been analyzed and are presented in the paper.

NACA RM L8I23

ADDITIONAL FREE-FLIGHT TESTS OF THE ROLLING EFFECTIVENESS OF SEVERAL WING-SPOILER ARRANGEMENTS AT HIGH SUBSONIC, TRANSONIC, AND SUPERSONIC SPEEDS. H. Kurt Strass. November 24, 1948. 16p. diagrs., photos. (NACA RM L8I23) (Declassified from Confidential, 8/18/54)

Additional results of an aerodynamic-control-effectiveness investigation using free-flight, rocket-propelled test vehicles have been obtained recently which show some results of chordwise spoiler location and a comparison of a sharp-edge spoiler with a wedge-type spoiler at the 0.8-chord location and a plain, full-span, 0.2-chord aileron with a deflection equal to 4.4°.

NACA RM L8J21

THE EFFECT OF AIR JETS SIMULATING CHINES OR MULTIPLE STEPS ON THE HYDRODYNAMIC CHARACTERISTICS OF A STREAMLINE FUSELAGE. Bernard Weinflash. January 7, 1949. 37p. diagrs., photos., 2 tabs. (NACA RM L8J21) (Declassified from Confidential, 8/18/54)

Preliminary tests were made to determine the effect of forced ventilation on the hydrodynamic characteristics of a streamline fuselage of a hypothetical transonic airplane. This forced ventilation consisted of air ejected at about 300 feet per second through small orifices distributed over the fuselage bottom in various patterns simulating chines and/or multiple steps. Data are presented on the resistance, trim, and effective hydrodynamic lift for the basic model and **for**

each of the jet configurations. All of the jet configurations caused appreciable improvement in hydrodynamic performance, especially at higher speeds.

NACA RM L8K01

EFFECT OF WING SWEEP, TAPER, AND THICKNESS RATIO ON THE TRANSONIC DRAG CHARACTERISTICS OF WING-BODY COMBINATIONS. Jim Rogers Thompson and Charles W. Mathews. December 31, 1948. 29p. diagrs., photos., 2 tabs. (NACA RM L8K01) (Declassified from Confidential, 8/18/54)

Contains free-fall measurements of the transonic drag characteristics of three wing-body combinations having 35° sweptback wings with thickness ratios of 0.09 and 0.12 and taper ratios of 1:1 and 1.467:1. Results are compared with measurements for four related configurations reported previously and with theoretical calculations to show the effects of wing sweep, taper, and thickness ratio on the transonic drag characteristics of wing-body combinations and their component parts.

NACA RM L8K02

AERODYNAMIC CHARACTERISTICS AT SUBSONIC AND TRANSONIC SPEEDS OF A 42.7° SWEPTBACK WING MODEL HAVING AN AILERON WITH FINITE TRAILING-EDGE THICKNESS. Thomas R. Turner, Vernard E. Lockwood and Raymond D. Vogler. January 12, 1949. 24p. diagrs., photo. (NACA RM L8K02) (Declassified from Confidential, 8/18/54)

This paper contains the aerodynamic characteristics for a reflection-plane model having 42.7° leading-edge sweep, an aspect ratio of 4.0, and a taper ratio of 0.50 with an aileron of various finite trailing-edge thicknesses. The aerodynamic characteristics which include aileron rolling moments were obtained through the transonic-speed range from a Mach number of 0.5 to 1.15. The tests were performed in transonic flow over a bump on the tunnel floor and in subsonic flow on one of the tunnel side walls.

NACA RM L8K03

STABILITY RESULTS OBTAINED WITH DOUGLAS D-558-1 AIRPLANE (BUAERO NO. 37971) IN FLIGHT UP TO A MACH NUMBER OF 0.89. William H. Barlow and Howard C. Lilly. April 22, 1949. 16p. diagrs., photos. (NACA RM L8K03) (Declassified from Confidential, 8/18/54)

Contains flight measurements of trim characteristics in straight flight for two stabilizer settings for D-558-1 airplane up to a Mach number of 0.89. Also shows elevator angle per unit normal-force coefficient and elevator control force per unit acceleration up to a Mach number of 0.82. The buffet boundary is well defined up to a Mach number of 0.84 and is shown in comparison with that of the XS-1 airplane with the same wing section, 65-110.

NACA RM L8K23a

THEORETICAL ANALYSIS OF THE ROLLING MOTIONS OF AIRCRAFT USING A FLICKER-TYPE AUTOMATIC ROLL STABILIZATION SYSTEM HAVING A DISPLACEMENT-PLUS-RATE RESPONSE. Howard J. Curfman, Jr. January 12, 1949. 29p. diagrs., 2 tabs. (NACA RM L8K23a) (Declassified from Confidential, 8/18/54)

A general analysis of the steady-state rolling oscillations of aircraft using the displacement-plus-rate response, flicker-type automatic roll stabilization system is presented, and charts are included for finding the amplitude and period of these oscillations for any aircraft. The addition of the rate-sensitive element to the displacement-response, flicker-type system reduces the amplitude and increases the frequency of the steady-state oscillations. Current trends in pilotless-aircraft designs indicate that small amplitude residual oscillations are possible. The analysis shows close agreement with roll-simulator tests.

NACA RM L8K29

AN INVESTIGATION OF AILERON OSCILLATIONS AT TRANSONIC SPEEDS ON NACA 23012 AND NACA 65-212 AIRFOILS BY THE WING-FLOW METHOD. Harold L. Crane. December 29, 1948. 9p. diagrs., photo. (NACA RM L8K29) (Declassified from Confidential, 8/18/54)

An investigation is being conducted to determine the feasibility of studying aileron buzz by means of the wing-flow method. Two semispan models which had an aspect ratio of 6 and a taper ratio of 2 with quarter-chord half-span mass-balanced ailerons have been used. One had an NACA 23012 airfoil section and the second, an NACA 65-212 airfoil section. The ailerons on both models were subject to buzz over a small range of Mach number near 0.9. Data obtained by wing-flow testing agreed reasonably well with full-scale flight results.

NACA RM L8L07

ESTIMATION OF LIFT AND DRAG OF AIRFOILS AT NEAR SONIC SPEEDS AND IN THE PRESENCE OF DETACHED SHOCK WAVES. John P. Mayer. February 23, 1949. 23p. diagrs. (NACA RM L8L07) (Declassified from Confidential, 8/18/54)

A semiempirical method of estimating the forces on airfoils at near sonic speeds and in the presence of detached shock waves is presented. Fairly good agreement with the trend of existing experimental data is found at Mach numbers from 0.95 to 2.3 for sharp-nose airfoils at speeds and angles of attack above those at which shock detachment occurs and for blunt-nose airfoils where shock waves always are detached. Computed values of the forces on two-dimensional wings are in good agreement with wind-tunnel data on three-dimensional wings at high angles of attack. The approximate method is in agreement with Von Kármán transonic similarity laws.

NACA RM L9J12
National Advisory Committee for Aeronautics. LOW-SPEED STATIC LATERAL STABILITY CHARACTERISTICS OF A CANARD MODEL HAVING A 60° TRIANGULAR WING AND HORIZONTAL TAIL. William R. Bates. November 23, 1949. 29p. diagrs., tab. (NACA RM L9J12) (Declassified from Confidential, 8/18/54)

Contains results of force tests and flow surveys made in the Langley free-flight tunnel to determine the stability characteristics of a canard model having 60° triangular plan-form wing and horizontal tail. Tests were made with the horizontal tail used as a fixed nose elevator or floating freely at various tab deflections. Various vertical-tail configurations were also studied. Unusual directional stability characteristics were obtained from the results.

NACA RM L9J28

LOW-SPEED INVESTIGATION OF DEFLECTABLE WING-TIP AILERONS ON AN UNTAPERED 45° SWEPTBACK SEMISPAN WING WITH AND WITHOUT AN END PLATE. Jack Fischel and James M. Watson. December 14, 1949. 32p. diagrs., photo. (NACA RM L9J28) (Declassified from Confidential, 8/18/54)

Contains results and discussion of a low-speed investigation of triangular- and parallelogram-plan-form deflectable wing-tip ailerons on an untapered 45° sweptback semispan wing with and without a rectangular end plate (simulating a vertical fin) mounted on the wing inboard of the ailerons. Lift and lateral-control data were obtained through a large angle-of-attack range and a large aileron-deflection range for each aileron plan form on the plain wing and the wing with end plate. Aileron plan form had little or no effect, whereas the end plate had measurable effect on lift, drag, and rolling-moment data. These ailerons should provide adequate control over the entire angle-of-attack range.

NACA RM L9K10a

AERODYNAMIC CHARACTERISTICS OF A WING WITH QUARTER-CHORD LINE SWEPT BACK 35°, ASPECT RATIO 6, TAPER RATIO 0.6, AND NACA 65A006 AIRFOIL SECTION. TRANSONIC-BUMP METHOD. William C. Sleeman, Jr. and William D. Morrison, Jr. December 12, 1949. 32p. diagrs., photos., tab. (NACA RM L9K10a) (Declassified from Confidential, 8/18/54)

This paper presents the results of an investigation by the transonic-bump method of a wing-fuselage combination employing a 35° sweptback wing with aspect ratio 6, taper ratio 0.6, and an NACA 65A006 airfoil section. Lift, drag, pitching moment, and root bending moment were obtained for the wing-alone and wing-fuselage configurations over a Mach number range of 0.60 to 1.18. Effective downwash angles and dynamic-pressure characteristics in the region of a probable tail location were also obtained and are presented for a range of tail heights at one tail length.

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Research Abstracts

NO.70 SEPTEMBER 21, 1954

CURRENT NACA REPORTS

NACA Rept. 1135

EQUATIONS, TABLES, AND CHARTS FOR COMPRESSIBLE FLOW. Ames Research Staff. 1953. iii, 69p. diagrs., 25 charts, 2 tabs. (NACA Rept. 1135. Formerly TN 1428)

This report, which is a revision and extension of TN 1428, presents a compilation of equations, tables, and charts useful in the analysis of high-speed flow of a compressible fluid. The equations provide relations for continuous one-dimensional flow, normal and oblique shock waves, and Prandtl-Meyer expansions for both perfect and imperfect gases. The tables present useful dimensionless ratios for continuous one dimensional flow and for normal shock waves as functions of Mach number for air considered as a perfect gas. One series of charts presents the characteristics of the flow of air (considered a perfect gas) for oblique shock waves and for cones in a supersonic airstream. A second series shows the effects of caloric imperfections on continuous one-dimensional flow and on the flow through normal and oblique shock waves.

NACA Rept. 1153

ON THE APPLICATION OF TRANSONIC SIMILARITY RULES TO WINGS OF FINITE SPAN. John R. Spreiter. 1953. ii, 21p. diagrs. (NACA Rept. 1153. Formerly TN 2726)

The transonic aerodynamic characteristics of wings of finite span are discussed from the point of view of a unified small perturbation theory for subsonic, transonic, and supersonic flows about thin wings. This approach avoids certain ambiguities which appear if one studies transonic flows by means of equations derived under the more restrictive assumption that the local velocities are everywhere close to sonic velocity. The relation between the two methods of analysis of transonic flow is examined, the similarity rules and known solutions of transonic flow theory are reviewed, and the asymptotic behavior of the lift, drag, and pitching-moment characteristics of wings of large and small aspect ratio is discussed. It is shown that certain methods of data presentation are advantageous for the effective display of these characteristics.

NACA TM 1374

KINETIC TREATMENT OF THE NUCLEATION IN SUPERSATURATED VAPORS. (Kinetische Behandlung der Keimbildung in ubersattigten Dampfen). R. Becker and W. Döring. September 1954. 43p. diagrs. (NACA TM 1374. Trans. from Annalen der Physik, Ser. 5, v. 24, 1935, p. 719-752).

The equations of the individual processes of self nucleation are utilized through an electrical analogy to obtain the nucleation frequency. This process is shown to be shorter and less subject to error than that of previous investigators since the appearance of indeterminant integration constants is completely avoided. With the nucleation frequencies of crystals and spheres the Ostwald law of stages is reviewed and modified. In the final section the general resistance image is discussed and mention is made of the relation of the electrical network and Volmers formula.

NACA TN 3199

STRESS DISTRIBUTIONS CAUSED BY THREE TYPES OF LOADING ON A CIRCULAR SEMIMONOCOQUE CYLINDER WITH FLEXIBLE RINGS. Harvey G. McComb, Jr. September 1954. 54p. diagrs. (NACA TN 3199)

Equations are derived for the stress distributions caused by three types of loading on infinitely long, circular, semimonocoque cylinders with flexible rings. The results are given as formulas for the stringer loads and shear flows in the shell due to each type of loading. For each loading case these formulas can be used to construct tables of influence coefficients giving stringer loads and shear flows in the neighborhood of the load due to a unit magnitude of that load.

NACA TN 3231
National Advisory Committee for Aeronautics.
BENDING TESTS ON BOX BEAMS HAVING SOLID- AND OPEN-CONSTRUCTION WEBS. Aldie E. Johnson, Jr. August 1954. 25p. diagrs., photos., 2 tabs. (NACA TN 3231)

The results of an exploratory experimental investigation of the effects of replacing alternate webs in a multiweb beam by open, post-stringer construction are reported. Post-stringer (either upright or inclined posts) construction is shown to perform the function of comparable-weight, solid, fabricated webs in the stabilization of the compression cover of a beam in bending both before and after buckling.

NACA TN 3235
National Advisory Committee for Aeronautics.
LOW-SPEED YAWED-ROLLING AND SOME OTHER ELASTIC CHARACTERISTICS OF TWO 56-INCH-DIAMETER, 24-PLY-RATING AIRCRAFT TIRES. Walter B. Horne, Bertrand H. Stephenson and Robert F. Smiley. August 1954. 108p. diagrs., photos., 6 tabs. (NACA TN 3235)

*AVAILABLE ON LOAN ONLY.

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The low-speed (up to 4 miles per hour) cornering characteristics of two 56 x 16, type VII, extra-high-pressure, 24-ply-rating tires were determined for a range of vertical loadings, yaw angles, and tire inflation pressures. Locked-wheel drag tests were also made for one vertical load condition. The quantities measured included cornering force, drag force, self-alining torque, pneumatic caster, vertical tire deflection, rolling radius, and relaxation length. Some supplementary tests were made which included measurements of tire footprint area, vertical-load-deflection characteristics, and the variation of tire radius and width with inflation pressure.

NACA TN 3303

TURBULENT-HEAT-TRANSFER MEASUREMENTS AT A MACH NUMBER OF 3.03. Maurice J. Brevoort and Bernard Rashis. September 1954. 21p. diagrs., tab. (NACA TN 3303)

A three-dimensional axially symmetric plug nozzle was used to obtain flat-plate data on turbulent-heat-transfer coefficients and recovery factors. The test results of this paper are for Mach number 3.03 and for a Reynolds number range of 5.6×10^6 to 6.5×10^7. The heat-transfer-coefficient results are in good agreement with theoretical analyses and the recovery-factor results are in good agreement with extrapolations of lower Reynolds number data.

MISCELLANEOUS

N-22929

Advisory Group for Aeronautical Research and Development. DIFFUSION FLAMES IN THE LABORATORY. John Barr. March 1954. 10p. diagrs. (Advisory Group for Aeronautical Research and Development. AG11/M7)

A survey of five recent reviews of diffusion flames is given. All the flames discussed are related to each other or can be obtained in a similar burner by varying the fuel type, the fuel and air flows or the static pressure. This survey tended to emphasize our lack of knowledge and the need for further research concerning the factors governing the structure, length and occurrence of diffusion flames.

UNPUBLISHED PAPERS

N-13524*

EXPERIMENTAL INVESTIGATION OF ICING PHENOMENA. (Experimentelle Untersuchung von Vereisungserscheinungen) Domenic Melcher. April 1954. 36p. diagrs., photos. (Trans. from Zeitschrift für angewandte Mathematik und Physik, v. 2, no. 6, 1951, p. 421-443)

An examination is made of the mechanism of icing phenomena. Artificial rime deposits of various types were produced and measurements made to establish the quantitative dependence of the deposit on temperature, H_2O-content, wind speed, and material of the body to be iced. The growth of the rime on metallic surfaces was observed under the polarizing microscope. An arrangement is described for studying rime in the open air, the purpose of which was to discover whether natural icing is a result of temperature effects. In addition, the influence of the electric field on the type of deposit was examined and measured.

DECLASSIFIED NACA REPORTS

THE FOLLOWING REPORTS HAVE BEEN DECLASSIFIED FROM CONFIDENTIAL, 8/23/54

RM L9K23
RM L50B24a
RM L50C21a
RM L50D04
RM L50F28

THE FOLLOWING REPORTS HAVE BEEN DECLASSIFIED FROM CONFIDENTIAL, 8/31/54

RM A51B14
RM L50J05a
RM L51A08

NACA RM A6G24

THE SUBSONIC AERODYNAMIC CHARACTERISTICS OF TWO DOUBLE-WEDGE AIRFOIL SECTIONS SUITABLE FOR SUPERSONIC FLIGHT. Joseph Solomon and Floyd W. Henney. May 12, 1947. 33p. diagrs., photos. (NACA RM A6G24) (Declassified from Confidential, 8/18/54)

High-speed wind tunnel tests have been made to investigate the aerodynamic characteristics at subsonic speeds of two symmetrical double-wedge airfoil sections of 4- and 6-percent thickness. Section coefficients of lift, drag, and quarter-chord pitching moment are presented for a moderate range of angles of attack at Mach numbers up to approximately 0.93. Comparisons are made between the significant characteristics of the double-wedge airfoils and those of the NACA 65-206 airfoils as an index of the merit of the former at subsonic speeds.

NACA RM A7G15

AN EXPERIMENTAL INVESTIGATION AT SUPERSONIC SPEEDS OF ANNULAR DUCT INLETS SITUATED IN A REGION OF APPRECIABLE BOUNDARY LAYER. Wallace F. Davis, George B. Brajnikoff, David L. Goldstein and Joseph M. Spiegel. September 24, 1947. 41p. diagrs., photos. (NACA RM A7G15) (Declassified from Confidential, 8/18/54)

The recovery of total pressure after diffusion to a low subsonic velocity was found to be approximately two-thirds of that through a normal shock wave occurring at the same free-stream Mach number. The cause of this low-pressure recovery is the interaction between the boundary layer and the back pressure in the diffuser. Compression at a local Mach number comparable to that of the supersonic stream will result in large losses in total pressure if the compression occurs in the presence of an appreciable boundary layer.

NACA RM A8A13

PRESSURE RECOVERY AT SUPERSONIC SPEEDS THROUGH ANNULAR DUCT INLETS SITUATED IN A REGION OF APPRECIABLE BOUNDARY LAYER. I - ADDITION OF ENERGY TO THE BOUNDARY LAYER. Wallace F. Davis and George B. Brajnikoff. April 1, 1948. 22p. diagrs., photos. (NACA RM A8A13) (Declassified from Confidential, 8/18/54)

This report contains the results of an experimental investigation made at Mach numbers between 1.36 and 2.01 of the total-pressure recovery attainable with a model having a nozzle upstream of an annular duct inlet for the purpose of ejecting high-velocity air into the boundary layer of the flow along the forebody. A comparison of the total-pressure recovery effective in producing thrust is made between a hypothetical engine that recirculates air to the intake and one that does not. It was found that for the assumed conditions recirculation would increase the effective recovery about 8 percent.

NACA RM A8B16

AN EXPERIMENTAL INVESTIGATION OF NACA SUBMERGED INLETS AT HIGH SUBSONIC SPEEDS. I - INLETS FORWARD OF THE WING LEADING EDGE. Charles F. Hall and F. Dorn Barclay. June 9, 1948. 64p. diagrs., photos. (NACA RM A8B16) (Declassified from Confidential, 8/24/54)

Results are given of an experimental investigation of NACA submerged inlets with deflectors on a fighter airplane model at Mach numbers from 0.30 to 0.875. Data are presented showing the characteristics of the model without inlets and with inlets 16.7-percent wing-root chord forward of the wing leading edge. The results indicate that the ram recovery at the entrance was affected greatly by variations in mass-flow coefficient and only slightly by Mach number and angle-of-attack variations.

NACA RM A8C22

INVESTIGATION AT SUPERSONIC SPEED (M = 1.53) OF THE PRESSURE DISTRIBUTION OVER A 63° SWEPT AIRFOIL OF BICONVEX SECTION AT ZERO LIFT. Charles W. Frick and John W. Boyd. June 10, 1948. 33p. diagrs., photos. (NACA RM A8C22) (Declassified from Confidential, 8/18/54)

The results of an investigation at supersonic speed (M = 1.53) of the distribution of pressure at zero lift over the surface of a 63° swept airfoil of biconvex section (7 percent thick) are presented. The measured pressures are compared with theoretical values calculated from thin airfoil theory.

NACA RM A8F08

PRESSURE RECOVERY AT SUPERSONIC SPEEDS THROUGH ANNULAR DUCT INLETS SITUATED IN A REGION OF APPRECIABLE BOUNDARY LAYER. II - EFFECT OF AN OBLIQUE SHOCK WAVE IMMEDIATELY AHEAD OF THE INLET. George B. Brajnikoff. August 9, 1948. 15p. diagrs., photos. (NACA RM A8F08) (Declassified from Confidential, 8/18/54)

This report contains the results of an experimental investigation made at Mach numbers between 1.36 and 2.01 of the total-pressure recovery attainable with a model having a ramp ahead of an annular inlet for the purpose of reducing the entrance Mach number by means of an oblique shock wave. It was found that the recovery improved considerably with increasing ramp angle and that a model with a 15° ramp produced approximately four-fifths of the recovery through a normal shock wave occurring at the free-stream Mach number. Use of ramp angles greater than 15° resulted in unsteady flow through the induction system and a reduction in recovery.

NACA RM A8F21

AN EXPERIMENTAL INVESTIGATION AT LARGE SCALE OF SEVERAL CONFIGURATIONS OF AN NACA SUBMERGED AIR INTAKE. Norman J. Martin and Curt A. Holzhauser. October 19, 1948. 68p. diagrs., photos., 7 tabs. (NACA RM A8F21) (Declassified from Confidential, 8/18/54)

Results of an experimental investigation in the Ames 40- by 80-foot wind tunnel of NACA submerged inlets installed on a full-scale model of a fighter airplane are presented. Tests at various inlet-velocity ratios and angles of attack indicated the same favorable characteristics that had been noted at small scale. A small difference in the magnitude of pressure recovery measured at full scale and small scale was mainly accounted for by differences of boundary-layer thickness. The effect on pressure recovery of systematic changes of ramp divergence is also presented.

NACA RM A8F22

INVESTIGATION AT SUPERSONIC SPEED (M = 1.53) OF THE PRESSURE DISTRIBUTION OVER A 63° SWEPT AIRFOIL OF BICONVEX SECTION AT SEVERAL ANGLES OF ATTACK. John W. Boyd, Elliott D. Katzen and Charles W. Frick. September 24, 1948. 41p. diagrs., photos., tab. (NACA RM A8F22) (Declassified from Confidential, 8/18/54)

The results of an investigation at supersonic speed (M = 1.53) of the distribution of pressure at angles of attack over the surface of a 63° swept airfoil of biconvex section (7 percent thick) are presented. The measured pressures are compared with theoretical values calculated from supersonic lifting-surface theory.

NACA RM A8I16

AERODYNAMIC CHARACTERISTICS AT SUBSONIC AND SUPERSONIC MACH NUMBERS OF A THIN TRIANGULAR WING OF ASPECT RATIO 2. I - MAXIMUM THICKNESS AT 20 PERCENT OF THE CHORD. Robert E. Berggren and James L. Summers. November 19, 1948. 41p. diagrs., photos. (NACA RM A8I16) (Declassified from Confidential, 8/18/54)

This report presents the results of wind-tunnel tests to determine the variation with Mach number, from 0.50 to 1.49, of the lift, drag, and pitching-moment characteristics of a 5-percent-thick symmetrical double-wedge section triangular wing. The results are compared with results of tests of similar wings from other sources and with the characteristics calculated by current analytical methods.

NACA RM A8I20

AERODYNAMIC CHARACTERISTICS AT SUBSONIC AND SUPERSONIC MACH NUMBERS OF A THIN TRIANGULAR WING OF ASPECT RATIO 2. II - MAXIMUM THICKNESS AT MIDCHORD. Harold J. Walker and Robert E. Berggren. December 3, 1948. 41p. diagrs., photos. (NACA RM A8I20) (Declassified from Confidential, 8/18/54)

This report presents the results of wind-tunnel tests to determine the variation with Mach number between limits of 0.50 and 1.49 of the lift, drag, and pitching-moment characteristics of a 5-percent-thick triangular wing. The results are compared with the characteristics calculated by analytical methods. The effects upon the characteristics due to change in location of maximum profile thickness are also discussed.

NACA RM A8I29

RAM-RECOVERY CHARACTERISTICS OF NACA SUBMERGED INLETS AT HIGH SUBSONIC SPEEDS. Charles F. Hall and Joseph L. Frank. November 17, 1948. 44p. diagrs., photos. (NACA RM A8I29) (Declassified from Confidential, 8/18/54)

Results are presented of an experimental investigation of the characteristics of NACA submerged inlets on a model of a fighter airplane for Mach numbers from 0.30 to 0.875. The effects on the ram-recovery ratio at the inlets of Mach number, angle of attack, boundary-layer thickness on the fuselage, inlet location, and boundary-layer deflectors are shown. The data indicate only a slight decrease in ram-recovery ratio for the inlets ahead of or just behind the wing leading edge as Mach number increased, but showed large decreases at high Mach numbers for the inlets aft of the point of maximum thickness of the wing.

NACA RM A8L16

INVESTIGATION OF DOWNWASH AND WAKE CHARACTERISTICS AT A MACH NUMBER OF 1.53. I - RECTANGULAR WING. Edward W. Perkins and Thomas N. Canning. March 1, 1949. 29p. diagrs. (NACA RM A8L16) (Declassified from Confidential, 8/18/54)

The results of an experimental investigation of the downwash and wake characteristics behind a rectangular plan-form wing of aspect ratio 3.5 are presented. The airfoil section was a 5-percent-thick, symmetrical double wedge. The tests were made at a Mach number of 1.53 and a Reynolds number of 1.25 million. A comparison between experimental and theoretical values of the downwash angles is made.

NACA RM A9D20

INVESTIGATION OF DOWNWASH AND WAKE CHARACTERISTICS AT A MACH NUMBER OF 1.53. II - TRIANGULAR WING. Edward W. Perkins and Thomas N. Canning. June 6, 1949. 31p. diagrs. (NACA RM A9D20) (Declassified from Confidential, 8/18/54)

The results of an experimental investigation of the downwash and wake characteristics for a triangular plan-form wing of aspect ratio 2.04 are presented. The wing had a 5-percent-thick, symmetrical, double-wedge airfoil section. The tests were made at a Mach number of 1.53 and a Reynolds number of 2 million. A comparison between experimental and theoretical values of $(d\epsilon/d\alpha)_{\alpha=0}$ showed that the agreement was good within that part of the flow field where the theory predicts downwash for positive angles of attack of the wing. Within the remainder of the flow field the agreement was only fair. At finite angles of attack the measured downwash angles depart markedly from the values predicted by the theory.

NACA RM A9F16

A COMPARISON OF TWO SUBMERGED INLETS AT SUBSONIC AND TRANSONIC SPEEDS. Emmet A. Mossman. September 15, 1949. 31p. diagrs., photos. (NACA RM A9F16) (Declassified from Confidential, 8/18/54)

A qualitative experimental study of the effects of ramp-wall divergence on ram-pressure recovery has been made at Mach numbers up to 0.96. It is shown that the use of ramp-wall divergence considerably extends the Mach number range for satisfactory submerged-inlet operation. The increase in Mach number for satisfactory pressure recovery is attributed to a less severe interaction between the shock waves and the ramp boundary layer.

NACA RM A9F20

AN EXPERIMENTAL INVESTIGATION AT LARGE SCALE OF SINGLE AND TWIN NACA SUBMERGED SIDE INTAKES AT SEVERAL ANGLES OF SIDESLIP. Norman J. Martin and Curt A. Holzhauser. August 1, 1949. 31p. diagrs., photo. (NACA RM A9F20) (Declassified from Confidential, 8/18/54)

Results of an experimental investigation in the Ames 40- by 80-foot wind tunnel of single and twin NACA submerged-intake installations on a full-scale model of a fighter airplane at several angles of sideslip are presented. The effect of sideslip on the pressure-recovery and flow characteristics is shown. The effect of sideslip on pressure recovery and duct airflow instability was small.

NACA RM A9G15

THE EFFECT OF THE PROPELLER SLIPSTREAM ON THE CHARACTERISTICS OF SUBMERGED INLETS. Noel K. Delany. September 9, 1949. 41p. diagrs., photos. (NACA RM A9G15) (Declassified from Confidential, 8/18/54)

Wind-tunnel tests were made of submerged air inlets in the fuselage behind the propeller and forward of the wing of a 1/4-scale model of a hypothetical fighter airplane powered by a turbine-propeller unit. The results are presented for ramps with parallel and with divergent walls, and show the effect of propeller operation on the ram-recovery ratio at the entrance of the duct and at the simulated entrance of the compressor. The propeller used in these tests had dual rotation and had eight blades with thin shanks.

NACA RM A9H11

REDUCTION OF PROFILE DRAG AT SUPERSONIC VELOCITIES BY THE USE OF AIRFOIL SECTIONS HAVING A BLUNT TRAILING EDGE. Dean R. Chapman. November 1, 1949. 31p. diagrs., photo. (NACA RM A9H11) (Declassified from Confidential, 8/18/54)

A preliminary theoretical and experimental investigation has been made on the aerodynamic characteristics of blunt-trailing-edge airfoils at supersonic velocities. The theoretical considerations indicate that properly designed airfoils with moderately blunt trailing edges can have less profile drag, greater lift-curve slope, and a higher maximum lift-drag ratio than conventional sections. These predictions have been substantiated by experimental measurements on airfoils of 10-percent-thickness ratio at Mach numbers of 1.5 and 2.0, and at Reynolds numbers between 0.2 and 1.2 million.

NACA RM A9L01

WIND-TUNNEL INVESTIGATION AT MACH NUMBERS FROM 0.50 TO 1.20 OF AN ALL-MOVABLE TRIANGULAR WING OF ASPECT RATIO 4 ALONE AND WITH A BODY. Louis S. Stivers, Jr. and Alexander W. Malick. February 2, 1950. 45p. diagrs., photos., tab. (NACA RM A9L01) (Declassified from Confidential, 8/23/54)

Aerodynamic characteristics from wind-tunnel tests of semispan models are presented for an all-movable triangular wing alone and with a body (body attitude 0°). The wing had an aspect ratio of 4 and had doubly symmetrical double-wedge sections with maximum thickness-chord ratios of 0.08 in the streamwise direction. The tests were made at Mach numbers from 0.50 to about 0.98 and from 1.09 to 1.29. The corresponding Reynolds numbers varied from about 0.8×10^6 to 1.1×10^6. The experimental results are compared with calculated characteristics based on linear theory.

NACA RM A9L29

TESTS OF A SMALL-SCALE NACA SUBMERGED INLET AT TRANSONIC MACH NUMBERS. L. Stewart Rolls and George A. Rathert, Jr. February 23, 1950. 18p. diagrs., photos. (NACA RM A9L29) (Declassified from Confidential, 8/23/54)

The pressure-recovery characteristics of an NACA submerged inlet have been measured qualitatively in the Mach number range 0.60 to 1.08 by the wing-flow method. High ram-recovery ratios were maintained up to test-station Mach numbers of 1.03 to 1.08 where, for mass-flow ratios below 0.5, an abrupt loss in pressure recovery was measured.

NACA RM A50A04

STALL CHARACTERISTICS OBTAINED FROM FLIGHT 10 OF NORTHROP X-4 NO. 2 AIRPLANE (USAF NO. 46-677). Melvin Sadoff and Thomas R. Sisk. February 27, 1950. 25p. diagrs., photos., tab. (NACA RM A50A04) (Declassified from Confidential, 8/23/54)

Some limited results of stall characteristics have been obtained on a Northrop X-4 airplane. The results indicated that the motions of the airplane following the stall were mild and recovery was effected rapidly and completely with the use of down-elevon deflections. It was shown that the relative mildness of the stalls was probably due to the flat-top type of lift-curve characteristic of the 0010-64 airfoil section used, the plan form, and to the effect of sideslip on the stalling characteristics. It was further indicated that the low values of maximum normal-force coefficients obtained in gradual stall maneuvers could have been increased if corrective control had been used.

NACA RM A50C13

PRELIMINARY INVESTIGATION OF THE TRANSONIC CHARACTERISTICS OF AN NACA SUBMERGED INLET. John A. Axelson and Robert A. Taylor. June 5, 1950. 44p. diagrs., photos. (NACA RM A50C13) (Declassified from Confidential, 8/23/54)

Ram-recovery and pressure-distribution results for an NACA submerged inlet investigated on a transonic bump in the Ames 16-foot high-speed wind tunnel are presented for Mach numbers from 0.70 to 1.15, for simulated angles of attack of 0°, 4°, and 8°, and for mass-flow ratios between 0.25 and 0.68. The results indicate favorable ram-recovery characteristics for the inlet over the entire test range of Mach numbers, with the minimum ram recovery occurring around 1.05 Mach number.

NACA RM A50D27

LONGITUDINAL-STABILITY CHARACTERISTICS OF THE NORTHROP X-4 AIRPLANE (USAF NO. 46-677). Melvin Sadoff and Thomas R. Sisk. June 29, 1950. 24p. diagrs., photos., tab. (NACA RM A50D27) (Declassified from Confidential, 8/23/54)

The results obtained from several recent flights on the Northrop X-4 No. 2 airplane are presented. Information is included on the longitudinal-stability characteristics in straight flight over a Mach number range of 0.38 to about 0.63, the stability characteristics in accelerated flight over a Mach number range of 0.43 to 0.79, and the short-period longitudinal-oscillation characteristics at Mach numbers of 0.49 and 0.78. A description and a limited analysis of a pitch-up which was encountered during the accelerated stability tests at a Mach number of 0.79 and a normal-force coefficient of about 0.45 are also included.

NACA RM A50E26

INVESTIGATION AT HIGH SUBSONIC SPEEDS OF METHODS OF ALLEVIATING THE ADVERSE INTERFERENCE AT THE ROOT OF A SWEPT-BACK WING. Lee E. Boddy. August 10, 1950. 31p. diagrs., photos. (NACA RM A50E26) (Declassified from Confidential, 8/23/54)

Tests were made of a model having the 50-percent-chord line of the wing unswept or swept back 35°. The tests with the swept-back wing included modifications to the body contour and to the wing section in the region of the wing-body juncture. The divergence Mach number of the swept-back wing agreed fairly well with that predicted from tests of the unswept wing using the simple cosine concepts. Either of the modifications increased the drag-divergence Mach number of the swept-back wing about 0.01.

NACA RM A50I01

SUMMARY REPORT OF RESULTS OBTAINED DURING DEMONSTRATION TESTS OF THE NORTHROP X-4 AIRPLANES. Melvin Sadoff and Thomas R. Sisk. December 13, 1950. 46p. diagrs., photos., tab. (NACA RM A50I01) (Declassified from Confidential, 8/23/54)

The results obtained during the demonstration flight tests of the Northrop X-4 No. 1 and No. 2 airplanes are presented. Information is included on the static and the dynamic longitudinal- and lateral-stability characteristics, the stalling characteristics, and the buffet boundary.

NACA RM A50I14a

INVESTIGATION OF THE DOWNWASH AND WAKE BEHIND A TRIANGULAR WING OF ASPECT RATIO 4 AT SUBSONIC AND SUPERSONIC MACH NUMBERS. Harold J. Walker and Louis S. Stivers, Jr. December 12, 1950. 32p. diagrs. (NACA RM A50I14a) (Declassified from Confidential, 8/23/54)

Downwash and wake characteristics for a thin, symmetrical, triangular wing are presented for angles of attack up to 10° and for Mach numbers from 0.50 to 1.29, corresponding to Reynolds numbers between 0.8×10^6 and 1.1×10^6. Downwash angles are shown for locations between the 25- and the 75-percent-semispan stations at a distance of about 0.8 root-chord length downstream from the trailing edge of the wing. The location and thickness of the wake are given for the 50-percent-semispan station at a distance of 3.44 root-chord lengths downstream from the trailing edge. A number of comparisons between the results from experiment and theory are also included.

NACA RM A50J09

LIFT AND MOMENT CHARACTERISTICS AT SUBSONIC MACH NUMBERS OF FOUR 10-PERCENT-THICK AIRFOIL SECTIONS OF VARYING TRAILING-EDGE THICKNESS. James L. Summers and William A. Page. December 20, 1950. 32p. diagrs., photos. (NACA RM A50J09) (Declassified from Confidential, 8/31/54)

The results of a wind-tunnel investigation from 0.3 to 0.9 Mach number of the lift and moment characteristics of four 10-percent-thick circular-arc airfoil sections having trailing-edge thicknesses of 0, 25, 50, and 100 percent of the maximum thickness are presented. It was observed that increases in the trailing-edge thickness resulted in increases in maximum lift coefficient and lift-curve slope at all Mach numbers and in increases in lift-divergence Mach number at all lift coefficients. Kármán vortex streets were produced by the thick trailing-edge sections indicating the presence of fluctuating lifts and high drags. It was further noted that a splitter plate at the trailing edge and in the chord plane eliminated the vortex streets.

NACA RM A50J09b

WIND-TUNNEL INVESTIGATION AT MACH NUMBERS FROM 0.50 TO 1.29 OF AN UNSWEPT TAPERED WING OF ASPECT RATIO 2.67 WITH LEADING- AND TRAILING-EDGE FLAPS - TRAILING-EDGE FLAPS DEFLECTED. Louis S. Stivers, Jr. and Alexander W. Malick. December 13, 1950. 45p. diagrs., photo., 5 tabs. (NACA RM A50J09b) (Declassified from Confidential, 8/31/54)

Aerodynamic characteristics are presented for an unswept wing having an aspect ratio of 2.67, a taper ratio of 0.5, and full-span, 25-percent-chord, plain, trailing-edge flaps. Sections of the wing were 8-percent chord thick from the 25- to the 75-percent-chord points tapering to sharp leading and trailing edges. The data were determined from wind-tunnel tests of the semispan model for a range of angles of attack from -3° to 12° and for a range of flap deflections from -10° to 60° at Mach numbers from 0.50 to about 0.98 and from 1.09 to 1.29. The corresponding Reynolds numbers varied from about 0.94×10^6 to 1.27×10^6.

NACA RM A50K10

WIND-TUNNEL INVESTIGATION AT MACH NUMBERS FROM 0.50 TO 1.29 OF AN UNSWEPT, TAPERED WING OF ASPECT RATIO 2.67 WITH LEADING- AND TRAILING-EDGE FLAPS - LEADING-EDGE FLAPS DEFLECTED. Louis S. Stivers, Jr. and Alexander W. Malick. February 26, 1951. 37p. diagrs., photo., 5 tabs. (NACA RM A50K10) (Declassified from Confidential, 8/31/54)

Results of a wind-tunnel investigation are presented for a semispan model of an unswept wing having an aspect ratio of 2.67, a taper ratio of 0.5, and full-span, 25-percent-chord, plain, leading-edge flaps. Sections of the wing in the streamwise direction were uniform 8-percent chord thick from the 25- to the 75-percent-chord points tapering to sharp leading and trailing edges. The data were obtained for a range of angles of attack from -3° to 12° and for a range of flap deflections from -20° to 10° at Mach numbers from about 0.50 to 0.95 and from 1.09 to 1.29. The corresponding Reynolds numbers varied from about 0.94×10^6 to about 1.27×10^6.

NACA RM A50K15

THE EFFECTS OF CENTRALLY MOUNTED WING-TIP TANKS ON THE SUBSONIC AERODYNAMIC CHARACTERISTICS OF A WING OF ASPECT RATIO 10 WITH 35° OF SWEEPBACK. Bruce E. Tinling and W. Richard Kolk. February 21, 1951. 44p. diagrs., photos., 2 tabs. (NACA RM A50K15) (Declassified from Confidential, 8/31/54)

This report presents results of a wind-tunnel investigation of the effects of centrally mounted wing-tip tanks on the aerodynamic characteristics of a wing having an aspect ratio of 10 with 35° of sweepback of the quarter-chord line. Three tip tanks of equal volume having fineness ratios of 10, 6.67, and 5 were tested. The effects of a vane near the tank-wing juncture were also investigated. Lift, drag, and pitching-moment data are presented. The Reynolds number of the tests was varied from 2,000,000 to 10,000,000 at a Mach number of 0.25, and the Mach number was varied from 0.25 to 0.90 at a Reynolds number of 2,000,000.

NACA RM A50K27

THE EFFECTS OF MACH NUMBER AND REYNOLDS NUMBER ON THE AERODYNAMIC CHARACTERISTICS OF SEVERAL 12-PERCENT-THICK WINGS HAVING 35° OF SWEEPBACK AND VARIOUS AMOUNTS OF CAMBER. Bruce E. Tinling and W. Richard Kolk. February 23, 1951. 68p. diagrs., photo., tab. (NACA RM A50K27) (Declassified from Confidential, 8/31/54)

Six semispan model wings with 35° of sweepback were tested: three of aspect ratio 10, and three of aspect ratio 5. The thickness distribution of the wing sections was the same from root to tip and there was no twist. The streamwise sections of the three wings of each aspect ratio were the NACA 65_1A012, the NACA 64_1A312, and the NACA 64_1A612. Lift, drag, and pitching-moment data are presented. The Reynolds number of the tests was varied from 2,000,000 to 10,000,000 at a Mach number of 0.25, and the Mach number was varied from 0.25 to 0.92 at a Reynolds number of 2,000,000.

NACA RM A50K27b

WIND-TUNNEL INVESTIGATION AT MACH NUMBERS FROM 0.50 TO 1.29 OF AN UNSWEPT, TAPERED WING OF ASPECT RATIO 2.67 WITH LEADING- AND TRAILING-EDGE FLAPS - FLAPS DEFLECTED IN COMBINATION. Louis S. Stivers, Jr. and Alexander W. Malick. February 26, 1951. 41p. diagrs., photo., 7 tabs. (NACA RM A50K27b) (Declassified from Confidential, 8/31/54)

Aerodynamic characteristics from wind-tunnel tests of a semispan model are presented for an unswept wing having an aspect ratio of 2.67, a taper ratio of 0.5, and full-span, 0.25 chord, plain, leading- and trailing-edge flaps. Sections of the wing were uniform 0.08 chord thick from the 0.25 to the 0.75 chord points and tapered to sharp leading and trailing edges. The data are presented for a range of angles of attack from -3° to 12° and for ranges of leading-edge-flap deflection from -20° to 10° and of trailing-edge-flap deflection from 0° to 60°. The Mach numbers ranged from about 0.50 to 0.98 and from 1.09 to 1.29 with corresponding Reynolds numbers varying from about 0.94×10^6 to 1.27×10^6.

NACA RM A50L12

PRELIMINARY INVESTIGATION OF THE DELAY OF TURBULENT FLOW SEPARATION BY MEANS OF WEDGE-SHAPED BODIES. George B. McCullough, Gerald E. Nitzberg and John A. Kelly. March 1, 1951. 28p. diagrs., photos. (NACA RM A50L12) (Declassified from Confidential, 8/31/54)

A wind-tunnel investigation of pyramidal, wedge-like bodies as devices for delaying separation of a turbulent boundary layer was conducted. The flow fields of individual wedges mounted on a flat plate and of multiple wedges applied to a two-dimensional airfoil were studied. Substantial increases of maximum lift and reductions of drag at high lift coefficients were realized at the expense of doubling the zero-lift drag. A brief investigation of vane-type vortex generators gave comparable increases of maximum lift with about one-half the incremental drag of the wedges at zero lift.

NACA RM A51A12

THE TRANSONIC CHARACTERISTICS OF 17 RECTANGULAR, SYMMETRICAL WING MODELS OF VARYING ASPECT RATIO AND THICKNESS. Warren H. Nelson and John B. McDevitt. May 10, 1951. 91p. diagrs., photos. (NACA RM A51A12) (Declassified from Confidential, 8/31/54)

An investigation utilizing the transonic-bump technique was made to determine the aerodynamic characteristics of transonic Mach numbers of 17 rectangular wings having aspect ratios of 6, 4, 2, and 1, and NACA 63A0XX sections with thickness-to-chord ratios of 10, 8, 6, 4, and 2 percent. The Mach number range was 0.4 to 1.1, corresponding under the test conditions to a Reynolds number range from 1.25 to 2.05 million. These data are presented without analysis.

NACA RM A51B16

EXPERIMENTAL DOWNWASH AND WAKE CHARACTERISTICS AT SUBSONIC AND SUPERSONIC MACH NUMBERS BEHIND AN UNSWEPT, TAPERED WING OF ASPECT RATIO 2.67 WITH LEADING- AND TRAILING-EDGE FLAPS. Harold J. Walker, Louis S. Stivers, Jr. and Luther Beard, Jr. April 20, 1951. 43p. diagrs. (NACA RM A51B16) (Declassified from Confidential, 8/31/54)

Results of a wind-tunnel investigation are presented which show the effects of flap deflection and Mach number on the downwash and wake characteristics at distances of 1.80 and 4.74 mean aerodynamic chord lengths, respectively, downstream from the midchord line of a semispan model of an unswept, tapered wing of aspect ratio 2.67 with full-span, 25-percent-chord, plain, leading- and trailing-edge flaps. Sections of the wing were 8-percent chord thick from the 25- to the 75-percent-chord points, and tapered to sharp leading and trailing edges. The data were obtained for flap deflections ranging from -20° to 40° at Mach numbers from 0.50 to 1.29. The corresponding Reynolds numbers varied from 0.94×10^{6} to 1.27×10^{6}.

NACA RM A51C14

A SEMIEMPIRICAL METHOD FOR CALCULATING THE PITCHING MOMENT OF BODIES OF REVOLUTION AT LOW MACH NUMBERS. Edward J. Hopkins. May 17, 1951. 27p. diagrs., tab. (NACA RM A51C14) (Declassified from Confidential, 8/31/54)

A semiempirical method, in which potential theory is arbitrarily combined with an approximate viscous theory, for calculating the aerodynamic pitching moments for bodies of revolution is presented. The method can also be used for calculating the lift and drag forces. The calculated and experimental force and moment characteristics of 15 bodies of revolution are compared.

NACA RM E7F13

INVESTIGATION OF SHOCK DIFFUSERS AT MACH NUMBER 1.85. III - MULTIPLE-SHOCK AND CURVED-CONTOUR PROJECTING CONES. W. E. Moeckel and J. F. Connors. August 13, 1947. 23p. diagrs., photos. (NACA RM E7F13) (Declassified from Confidential, 8/18/54)

The configurations tested were; a cone designed to produce three oblique shocks ahead of the diffuser inlet in combination with a straight and curved inlet section; a cone generated by a parabolic arc, also in combination with a curved and a straight inlet section; a cone-inlet combination designed by the method of characteristics to produce an isentropic entrance flow at an angle of attack of 0°; and a 30° single-shock cone in combination with a perforated inlet section. The effect of angle of attack was also investigated for the isentropic configuration.

NACA RM E7K21

COMPARISON OF HOVERING PERFORMANCE OF HELICOPTERS POWERED BY JET-PROPULSION AND RECIPROCATING ENGINES. Virginia L. Brightwell, Max D. Peters and J. C. Sanders. June 11, 1948. 39p. diagrs., 3 tabs. (NACA RM E7K21) (Declassified from Confidential, 8/18/54)

An analysis was made to compare the fuel consumptions of three jet engines and one reciprocating engine used to power helicopters in hovering flight at sea level. The calculations showed that the conventional reciprocating engine permitted much longer hovering time than the jet-propulsion engines investigated, but because the jet-propulsion engines were lighter than the reciprocating engine, the jet-propelled helicopters could lift greater disposable loads.

NACA RM E8C16

STUDY OF STRESS STATES IN GAS-TURBINE DISK AS DETERMINED FROM MEASURED OPERATING-TEMPERATURE DISTRIBUTIONS. J. Elmo Farmer, M. B. Millenson and S. S. Manson. July 21, 1948. 41p. diagrs., photos. (NACA RM E8C16) (Declassified from Confidential, 8/18/54)

Results are presented of an experimental investigation to determine the temperature distribution in an aircraft-engine gas-turbine disk. High axial- and radial-temperature gradients were found to exist both when the engine was accelerated as rapidly as possible to maximum speed and power output and when it was gradually brought to these conditions in a manner typical of normal service operation. Calculated stresses based on the measured temperature distributions are presented.

NACA RM E8K24

COMPARISON OF PERFORMANCE OF AN-F-58 AND AN-F-32 FUELS IN J33-A-23 TURBOJET ENGINE. H. D. Wilsted and J. C. Armstrong. June 2, 1949. 33p. photos., diagrs., tab. (NACA RM E8K24) (Declassified from Confidential, 8/18/54)

Performance of fuels corresponding to specifications AN-F-58 and AN-F-32 was investigated using a J33-A-23 turbojet engine. Comparatively, AN-F-58 fuel indicated equal performance in terms of engine thrust and fuel consumption, improved altitude starting, improved blow-out limits, higher but non-detrimental carbon-deposition rate, and iron oxide contamination. If contaminating iron oxide can be excluded from the engine, AN-F-58 fuel is considered satisfactory.

NACA RM E8K26

EXPERIMENTAL PRESSURE DISTRIBUTIONS OVER WING TIPS AT MACH NUMBER 1.9. I - WING TIP WITH SUBSONIC LEADING EDGE. James M. Jagger and Harold Mirels. January 27, 1949. 28p. diagrs., photo. (NACA RM E8K26) (Declassified from Confidential, 8/18/54)

An investigation was conducted at Mach number of 1.91 to determine spanwise pressure distribution over a wing tip in a region influenced by a sharp subsonic leading edge swept back at 70°. Except for pressure distribution on the top surface in the immediate vicinity of the subsonic leading edge, the maximum difference between linearized theory and experimental data was 2-1/2 percent (of free-stream dynamic pressure) for angles of attack up to 4° and 7 percent for angles of attack up to 8°. Pressures on the top surface nearest the subsonic edge indicated local expansions beyond values predicted by linearized theory.

NACA RM E8L24
National Advisory Committee for Aeronautics.
ALTITUDE PERFORMANCE OF AN-F-58 FUELS IN J33-A-21 SINGLE COMBUSTOR. Ralph T. Dittrich and Joseph L. Jackson. April 8, 1949. 23p. diagrs., 2 tabs. (NACA RM E8L24) (Declassified from Confidential, 8/18/54)

Three fuels conforming to AN-F-58 specification were investigated in order to determine the influence of boiling temperatures and aromatic content on altitude performance in single combustor of a 4600-pound-thrust turbojet engine. Combustion efficiencies of the three AN-F-58 fuels were approximately equal at each simulated engine condition for altitudes from 5,000 to 50,000 feet, 90-percent normal rated engine speed, and flight Mach numbers of 0.0 and 0.6.

NACA RM E9D06

CARBON DEPOSITION FROM AN-F-58 FUELS IN A J33 SINGLE COMBUSTOR. Jerrold D. Wear and Howard W. Douglass. June 24, 1949. 27p. diagrs., photos., 2 tabs. (NACA RM E9D06) (Declassified from Confidential, 8/18/54)

Effects of change in boiling temperature and aromatic content of AN-F-58 fuels on carbon deposition and change in simulated engine operating conditions on carbon deposition were evaluated in a J33 single combustor. Effect of carbon deposits in the combustor on altitude operational limits was investigated. Carbon deposition increased with increase in boiling temperature at constant aromatic content and with increase in aromatic content of the AN-F-58 fuels. Operational limits occurred at slightly lower altitudes when the combustor assembly contained carbon deposits than when it did not.

NACA RM E9H15

DOWNWASH IN VORTEX REGION BEHIND TRAPEZOIDAL-WING TIP AT MACH NUMBER 1.91. J. L. Cummings, H. Mirels and L. E. Baughman. November 10, 1949. 39p. diagrs., photos. (NACA RM E9H15) (Declassified from Confidential, 8/18/54)

Results of an experimental investigation to determine downwash and wake characteristics in region of trailing vortex system behind a trapezoidal-wing tip at Mach number 1.91 are presented. The wing was cut along inner Mach line from the tip and had a 5-percent-thick symmetrical diamond cross section. For small angles of attack, the experimental spanwise variation of $-d\epsilon/d\alpha$ (where ϵ is the downwash angle and α is the angle of attack) was generally similar to the variation predicted by linearized theory. At higher angles of attack, differences between the experimental and theoretical variations were attributed to a modification of the spanwise distribution of shed vorticity and a distortion of the shed vortex sheet.

NACA RM E9H17

ANALYTICAL DETERMINATION OF EFFECT OF WATER INJECTION ON POWER OUTPUT OF TURBINE-PROPELLER ENGINE. Albert O. Ross and Merle C. Huppert. November 3, 1949. 29p. diagrs. (NACA RM E9H17) (Declassified from Confidential, 8/18/54)

An analysis is presented to show the effect of evaporative cooling of the charge air during compression on the performance of a turbine-propeller engine incorporating a centrifugal compressor. Calculations were made with water as the cooling agent for compressor tip speeds of 1200, 1500, and 1800 feet per second. Results indicated that a power augmentation of 200 percent is possible at a compressor tip speed of 1800 feet per second if sufficient water is evaporated during compression to saturate the air at the compressor outlet.

NACA RM E9I22a

EXPERIMENTAL PRESSURE DISTRIBUTIONS OVER WING TIPS AT MACH NUMBER 1.9. II - WING TIP WITH SUBSONIC TRAILING EDGE. Harold Mirels and James M. Jagger. December 21, 1949. 23p. diagrs., photo. (NACA RM E9I22a) (Declassified from Confidential, 8/18/54)

An investigation was conducted at Mach number 1.90 to determine experimental pressure distribution over a wing tip in region influenced by sharp subsonic trailing edge. Experimental pressure distribution in region influenced by subsonic trailing edge was generally in poor agreement with linearized theory. Difference between theory and experiment was attributed to separation associated with adverse pressure gradient predicted by linearized theory for this region.

NACA RM E50D05

EXPERIMENTAL INVESTIGATION OF SUPERSONIC FLOW WITH DETACHED SHOCK WAVES FOR MACH NUMBERS BETWEEN 1.8 AND 2.9. W. E. Moeckel. July 5, 1950. 56p. diagrs., photos., 4 tabs. (NACA RM E50D05) (Declassified from Confidential, 8/23/54)

An experimental investigation of the flow near the nose of plane and axially symmetric bodies was conducted to check the predictions of theory. The location of the detached wave was determined for a variety of nose forms over a range of Mach numbers from 1.8 to 2.9. At a Mach number of 1.9, the form of the detached wave and the pressure distribution near the nose were also investigated. In addition, the relation between shock location and flow spillage was determined for several nose inlets. Most of the experimental results agreed to good approximation with the results predicted by the one-dimensional continuity method.

NACA RM E50D19

EFFECT OF INLET TEMPERATURE AND HUMIDITY ON THRUST AUGMENTATION OF TURBOJET ENGINE BY COMPRESSOR-INLET INJECTION. Thomas B. Shillito and James L. Harp, Jr. July 3, 1950. 46p. diagrs., photos. (NACA RM E50D19) (Declassified from Confidential, 8/23/54)

An investigation was conducted to determine the effect of inlet temperature and humidity on turbojet-engine performance with water-alcohol injection at the compressor inlet. At a constant total liquid flow (fuel flow plus injected flow) the augmented thrust ratio increased with compressor-inlet temperature. At a given inlet temperature and injection rate, the thrust decreased slightly with increasing humidity.

NACA RM E50E03a

EXPERIMENTAL INVESTIGATION OF SPREADING CHARACTERISTICS OF CHOKED JETS EXPANDING INTO QUIESCENT AIR. Morris D. Rousso and Fred D. Kochendorfer. August 9, 1950. 39p. diagrs., photos., tab. (NACA RM E50E03a. Now RM E51F18) (Declassified from Confidential, 8/23/54)

The boundaries of single and twin jets discharging into quiescent air are presented for several values of nozzle-outlet pressure ratio and spacing between nozzles. The effects of jet temperature, Reynolds number, and humidity on jet spreading are briefly evaluated. The results indicate that for a jet temperature ratio of 2.6 the pressure boundaries are slightly smaller than those of corresponding unheated jets and that the effects of Reynolds number and humidity are negligible.

NACA RM E50F12

INVESTIGATION OF PERFORATED CONVERGENT-DIVERGENT DIFFUSERS WITH INITIAL BOUNDARY LAYER. Maynard I. Weinstein. August 15, 1950. 26p. diagrs., photo. (NACA RM E50F12) (Declassified from Confidential, 8/23/54)

An experimental investigation was made at Mach number 1.90 of the performance of a series of perforated convergent-divergent supersonic diffusers operating with initial boundary layer, which was induced and controlled by lengths of cylindrical inlets affixed to the diffusers. Supercritical mass-flow and peak total-pressure recoveries were decreased slightly by use of the longest inlets (4 inlet diameters in length). Combinations of cylindrical inlets, perforated diffusers, and a subsonic diffuser were evaluated as simulated wind tunnels having second throats. Comparisons with noncontracted configurations of similar scale indicated conservatively computed power reductions of 25 percent.

NACA RM E50H10

DOWNWASH IN VORTEX REGION BEHIND RECTANGULAR HALF-WING AT MACH NUMBER 1.91. John L. Cummings and Rudolph C. Haefeli. October 26, 1950. 43p. diagrs., photos., tab. (NACA RM E50H10) (Declassified from Confidential, 8/23/54)

Results of an experimental investigation to determine downwash and wake characteristics in region of trailing vortex system behind a rectangular half-wing at Mach number 1.91 are presented. The wing had a 5-percent thick symmetric diamond cross section beveled to a knife edge at the tip. At small angles of attack, downwash angles were in close agreement with predictions of linearized theory based on the assumption of an undistorted vortex sheet. At higher angles of attack, the flow was greatly influenced by the rolling up of the vortex sheet.

NACA RM E50H28

COMBUSTION EFFICIENCY AND ALTITUDE OPERATIONAL LIMITS OF THREE LIQUID HYDROCARBON FUELS HAVING HIGH VOLUMETRIC ENERGY CONTENT IN A J33 SINGLE COMBUSTOR. Edward G. Stricker. November 6, 1950. 22p. diagrs., tab. (NACA RM E50H28) (Declassified from Confidential, 8/23/54)

Combustion efficiency and altitude operational limits were determined in a J33 single combustor for AN-F-58 fuel and three liquid hydrocarbon fuels having high volumetric energy content (decalin, tetralin, and monomethylnaphthalene) at simulated altitude and combustor inlet-air conditions. At the conditions investigated, the combustion efficiency for the four fuels generally decreased with an increase in volumetric energy content. The altitude operational limits for decalin and tetralin fuels were higher than for AN-F-58 fuel; monomethylnaphtalene fuel gave the lowest altitude operational limit.

NACA RM E50H29

INVESTIGATION OF POWER REQUIREMENTS FOR ICE PREVENTION AND CYCLICAL DE-ICING OF INLET GUIDE VANES WITH INTERNAL ELECTRIC HEATERS. Uwe von Glahn and Robert E. Blatz. December 1, 1950. 49p. diagrs., photos. (NACA RM E50H29) (Declassified from Confidential, 8/23/54)

An investigation was conducted to determine the electric power requirements for turbojet-engine inlet guide vanes with continuous heating and with cyclical de-icing for a range of icing conditions. Minimum total power requirements for continuous heating and dyclical de-icing are presented in terms of average surface datum temperature. An analysis is included to extend the experimentally obtained continuous heating data to vane sizes and icing conditions other than those investigated. Cyclical de-icing provides a total power saving as high as 79 percent over continuous heating for a typical engine installation. Heat-on periods of 10 seconds or less with heat-off periods of 60 seconds are recommended for cyclical de-icing.

NACA RM E50I08

ICING CHARACTERISTICS AND ANTI-ICING HEAT REQUIREMENTS FOR HOLLOW AND INTERNALLY MODIFIED GAS-HEATED INLET GUIDE VANES. Vernon H. Gray and Dean T. Bowden. December 5, 1950. 49p. diagrs., photos. (NACA RM E50I08) (Declassified from Confidential, 8/23/54)

Gas temperatures and flow rates required for anti-icing a two-dimensional cascade of turbojet inlet guide vanes were determined for hollow and internally modified vanes. The pressure losses caused by icing on unheated guide vanes were also determined. Less heat was required for anti-icing internally modified blades than for the hollow blades. Pressure losses across the cascade were greater at an inlet temperature of 22° F than at 0° F because of the characteristic shapes of ice deposits at the two temperatures.

NACA RM E50K14

SUPERSONIC TUNNEL INVESTIGATION BY MEANS OF INCLINED-PLATE TECHNIQUE TO DETERMINE PERFORMANCE OF SEVERAL NOSE INLETS OVER MACH NUMBER RANGE OF 1.72 TO 2.18. Jerome L. Fox. February 14, 1951. 27p. diagrs., photos. (NACA RM E50K14) (Declassified from Confidential, 8/31/54)

A suspended flat plate was used to continuously vary the Mach number in the NACA Lewis 18- by 18-inch Mach number 1.91 supersonic tunnel. Useful range of the tunnel was extended over range of Mach numbers from 1.72 to 2.18. Maximum variations in Mach number of the flow produced at vicinity of nose inlets at zero angle of attack were ±0.01 and flow angularities were less than approximately 0.35°. The technique was applied to determination of pressure recovery and mass-flow characteristics of four supersonic nose inlets over Mach number range produced.

NACA RM E50L08

INVESTIGATION OF THREE TYPES OF SUPERSONIC DIFFUSER OVER A RANGE OF MACH NUMBERS FROM 1.75 TO 2.74. L. Eugene Baughman and Lawrence I. Gould. March 12, 1951. 37p. diagrs., photos. (NACA RM E50L08) (Declassified from Confidential, 8/31/54)

An investigation was conducted to determine the off-design pressure recovery, mass-flow, and thrust characteristics of a normal-shock diffuser, two single-shock spike diffusers, and three convergent-divergent perforated diffusers operating in the Mach number range between 1.75 and 2.74.

NACA RM L6I11

DRAG MEASUREMENTS OF A 34° SWEPT-FORWARD AND SWEPT-BACK NACA 65-009 AIRFOIL OF ASPECT RATIO 2.7 AS DETERMINED BY FLIGHT TESTS AT SUPERSONIC SPEEDS. Sidney R. Alexander. February 20, 1947. 11p. diagrs., photos. (NACA RM L6I11) (Declassified from Confidential, 8/18/54)

The data were obtained by tracking rocket-propelled winged bodies moving at supersonic speeds. The test results show that for the comparable Mach number range investigated (M = 0.9 - 1.30) both the 34° swept-forward and swept-back airfoils produced lower values of zero-lift drag than the unswept airfoil. At Mach numbers between 1.0 and 1.3, the drag of the swept-back wing was about 50 percent and that of the swept-forward wing about 65 percent of the unswept wing.

NACA RM L6K21

LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A SEMISPAN AIRPLANE MODEL WITH A SWEPT-BACK TAIL FROM TESTS AT TRANSONIC SPEEDS BY THE NACA WING-FLOW METHOD. John A. Zalovcik and Richard H. Sawyer. March 28, 1947. 30p. diagrs., photos., tab. (NACA RM L6K21) (Declassified from Confidential, 8/18/54)

The model was mounted in such a way as to permit it to assume a position of zero pitching moment about the center of gravity at 27 percent of the mean aerodynamic chord. Measurements were made of lift and angle of attack for trim for several stabilizer and elevator settings. Because of the chordwise variation of Mach number in the test region, the effective Mach number for the wing of the model was lower than that for the tail of the model.

NACA RM L6L09

OBSERVATIONS ON AN AILERON-FLUTTER INSTABILITY ENCOUNTERED ON A 45° SWEPT-BACK WING IN TRANSONIC AND SUPERSONIC FLIGHT. Marvin Pitkin, William N. Gardner and Howard J. Curfman, Jr. April 11, 1947. 23p. diagrs., photos. (NACA RM L6L09) (Declassified from Confidential, 8/18/54)

Flight data are presented showing the free-floating and oscillatory characteristics of the wing and aileron. It is shown that aileron vibration occurred at flight velocities corresponding to a Mach number range from 1.03 to 1.4. The frequencies of the aileron and wing oscillations were identical at a given Mach number, were of the order of 100 cycles per second, and increased with Mach number. The test data indicate that aileron compressibility flutter is delayed in appearance but not prevented by sweepback.

NACA RM L6L24

DRAG OF A WING-BODY CONFIGURATION CONSISTING OF A SWEPT-FORWARD TAPERED WING MOUNTED ON A BODY OF FINENESS RATIO 12 MEASURED DURING FREE FALL AT TRANSONIC SPEEDS. Jim Rogers Thompson and Charles W. Mathews. March 13, 1947. 15p. diagrs., photos. (NACA RM L6L24) (Declassified from Confidential, 8/18/54)

The total drag and the drag of the wing were measured separately. These measurements were made to determine optimum aerodynamic shapes and configurations for use in the transonic and supersonic velocity ranges, and show that the drag of the complete configuration rose almost linearly from 0.07 of atmospheric pressure per unit of frontal area at a Mach number of 0.90 to 0.30 of atmospheric pressure at a Mach number of 1.02.

NACA RM L6L30

DRAG MEASUREMENTS OF A SWEPT-BACK WING HAVING INVERSE TAPER AS DETERMINED BY FLIGHT TESTS AT SUPERSONIC SPEEDS. Sidney R. Alexander. April 8, 1947. 12p. diagrs., photo. (NACA RM L6L30) (Declassified from Confidential, 8/18/54)

The test results showed that for the comparable Mach number range investigated (M = 1.0 to 1.275), the tapered wing produced values of drag coefficient that averaged about 30 percent lower than those of the 34° swept-back untapered wing and about 20 percent higher than those of the 45° swept-back untapered wing. At Mach numbers of 1.1 and 1.2, the tapered wing revealed drag coefficients of 0.0195 and 0.0225, the latter value being the maximum value obtained for this arrangement. The data were obtained by radar tracking of the rocket-propelled winged body moving at supersonic speeds.

NACA RM L7A03

FORCE AND LONGITUDINAL CONTROL CHARACTERISTICS OF A 1/16 – SCALE MODEL OF THE BELL XS-1 TRANSONIC RESEARCH AIRPLANE AT HIGH MACH NUMBERS. Axel T. Mattson. May 21, 1947. 32p. diagrs., photo., tab. (NACA RM L7A03) (Declassified from Confidential, 8/18/54)

The results given do not present completely the force and longitudinal control characteristics of the model. General trends are illustrated, however, which can be qualitatively analyzed for level-flight Mach numbers up to 0.93. A large increase in drag coefficient occurs beyond a Mach number of 0.78. At a Mach number of approximately 0.825 an initial lift force break occurs. This force break, up to a Mach number of approximately 0.875, is not severe, although elevator-control effectiveness is decreasing. At a Mach number of 0.9, use of the stabilizer as a trim control is required.

NACA RM L7E08

MEASUREMENTS OF THE EFFECTS OF THICKNESS RATIO AND ASPECT RATIO ON THE DRAG OF RECTANGULAR-PLAN-FORM AIRFOILS AT TRANSONIC SPEEDS. Jim Rogers Thompson and Charles W. Mathews. June 20, 1947. 17p. diagrs., photo. (NACA RM L7E08) (Declassified from Confidential, 8/18/54)

In the present paper results are presented for two airfoils of the series (those having NACA 65-012 sections and aspect ratios of 7.6 and 5.1) and are compared with results for other airfoils of the series which were previously reported. At sonic and low supersonic speeds the pressure-drag coefficient was found to vary in proportion to the square of the thickness ratio between values of thickness ratio of 0.09 and 0.12 but between values of thickness ratio of 0.06 and 0.09 the exponent was somewhat less than 2.

NACA RM L7E26

FLIGHT TESTS TO DETERMINE THE EFFECT OF TAPER ON THE ZERO-LIFT DRAG OF WINGS AT LOW SUPERSONIC SPEEDS. Sidney R. Alexander and Robert L. Nelson. July 13, 1947. 19p. diagrs., photos. (NACA RM L7E26) (Declassified from Confidential, 8/18/54)

At a constant leading-edge sweep of 45° no orderly variation of drag coefficient with taper ratio occurs, the variation being dependent upon the Mach number. Maximum thickness, leading-edge, and trailing-edge sweep are all important in determining the drag coefficient of a tapered wing. A comparison is made between the results of theoretical drag calculations of tapered wings and applicable experimental values derived herein.

NACA RM L7G02

A TORSIONAL STIFFNESS CRITERION FOR PREVENTING FLUTTER OF WINGS OF SUPERSONIC MISSILES. Bernard Budiansky, Joseph N. Kotanchik and Patrick T. Chiarito. August 28, 1947. 14p. diagrs., tab. (NACA RM L7G02) (Declassified from Confidential, 8/18/54)

Failures probably due to flutter were encountered in NACA flight tests of several rocket-powered, drag-research missiles that were intended to attain Mach numbers of about 1.4. The wing failures of these missiles led to the development of a simple, semi-rational torsional stiffness criterion for preventing flutter of uniform, sweptback or unswept missile wings that attain supersonic speeds. Results of missile flights at speeds up to Mach number 1.4 demonstrate the usefulness of the formula.

NACA RM L7K20

WIND-TUNNEL INVESTIGATION OF A WING-FUSELAGE COMBINATION WITH EXTERNAL STORES. H. Norman Silvers and Kenneth P. Spreemann. July 9, 1948. 55p. diagrs. (NACA RM L7K20) (Declassified from Confidential, 8/18/54)

Contains drag measurements of several external-store installations specifically designed to delay the advent of airplane buffet due to stores which has been recognized in wing-tunnel data as a sharp increase of the drag coefficient of the external-store installation. Results indicate that of the arrangements tested the highest store drag rise Mach number may be obtained by locating the store maximum thickness at large chordwise distance from the wing maximum thickness or by attaching the store flush to the wing lower surface, thus eliminating the pylon suspension system typical of current installations.

NACA RM L8A28a

FACTORS AFFECTING LATERAL STABILITY AND CONTROLLABILITY. John P. Campbell and Thomas A. Toll. May 13, 1948. 19p. diagrs. (NACA RM L8A28a) (Declassified from Confidential, 8/18/54)

The effects on dynamic lateral stability and controllability of some of the important aerodynamic and mass characteristics are discussed and methods are presented for estimating the various stability parameters to be used in the calculation of the dynamic lateral stability of airplanes with swept and low-aspect-ratio wings.

NACA RM L8H31

AN INVESTIGATION OF THE LOW-SPEED STATIC STABILITY CHARACTERISTICS OF COMPLETE MODELS HAVING SWEPTBACK AND SWEPT FORWARD WINGS. M. Leroy Spearman and Paul Comisarow. November 19, 1948. 51p. diagrs., tab. photos. (NACA RM L8H31) (Declassified from Confidential, 8/18/54)

An investigation has been conducted in the Langley 300 mph 7- by 10-foot tunnel to determine the static stability characteristics at low speeds of complete models with various swept wings so that comparisons might be made with available theoretical and emphirical methods of predicting the stability characteristics. Longitudinal and lateral stability characteristics, flaps up and down, were obtained for models having 0°, 15°, 30°, and 45° sweptforward and sweptback wings.

NACA RM L8J28

SUMMARY OF RESULTS OF TUMBLING INVESTIGATIONS MADE IN THE LANGLEY 20-FOOT FREE-SPINNING TUNNEL ON 14 DYNAMIC MODELS. Ralph W. Stone, Jr. and Robert L. Bryant. December 31, 1948. 91p. diagrs., photos., 23 tabs. (NACA RM L8J28) (Declassified from Confidential, 8/18/54)

The tumbling characteristics of dynamic models of 14 specific airplane designs tested in the Langley 20-foot free-spinning tunnel for various loadings and configurations have been summarized. Both tailless and conventional airplane configurations were considered. Sweep angles varied from 15° forward to a 60° delta wing. Aspect ratios varied from 1.27 to 10.6. Consideration has also been given to the problem of accelerations encountered during a tumble, pilot escape, and use of wing-tip parachutes for termination of the tumbling motion.

NACA RM L9A17

PRELIMINARY TANK INVESTIGATION OF THE USE OF SINGLE MONOPLANE HYDROFOILS FOR HIGH-SPEED AIRPLANES. Douglas A. King and John A. Rockett. March 22, 1949. 35p. diagrs., photos., 6 tabs. (NACA RM L9A17) (Declassified from Confidential, 8/18/54)

Presents results of hydrodynamic take-off and landing tests of a model of a hypothetical high-speed airplane fitted with a variety of single hydrofoils mounted near the center of gravity. Instability occurred during take-off when the hydrofoil of any configuration emerged. The hydrodynamic resistance was greater than that of conventional hulls.

NACA RM L9A21

AERODYNAMIC CHARACTERISTICS OF A WING WITH QUARTER-CHORD LINE SWEPT BACK 45°, ASPECT RATIO 4, TAPER RATIO 0.6, AND NACA 65A006 AIRFOIL SECTION. TRANSONIC-BUMP METHOD. Joseph Weil and Kenneth W. Goodson. February 24, 1949. 28p. diagrs., photo., tab. (NACA RM L9A21) (Declassified from Confidential, 8/18/54)

This paper presents the results of an investigation by the transonic-bump method of a wing-fuselage combination employing a wing with the quarter-chord line swept back 45°, with aspect ratio 4, taper ratio 0.6, and an NACA 65A006 airfoil section. Lift, drag, pitching moment, and root bending moment were obtained for the isolated wing and wing-body configurations in a Mach number range between 0.6 and 1.18. Effective downwash angles and dynamic-pressure characteristics in the region of the tail plane were also obtained and are presented for a range of tail heights at one tail length. The effects of two wing-fence arrangements were also investigated.

NACA RM L9A31

STABILITY AND CONTROL DATA OBTAINED FROM FIRST FLIGHT OF X-4 AIRPLANE. Hubert M. Drake. February 7, 1949. 11p. diagrs., photos., tab. (NACA RM L9A31) (Declassified from Confidential, 8/18/54)

Results are presented from the first flight of NACA instrumented Northrop X-4 semitailless research airplane. Data presented include rudder and elevon position, and angle of sideslip for various airspeeds up to 290 miles per hour indicated and 11,000 feet pressure altitude. The airplane exhibited a slight degree of static longitudinal instability for certain conditions.

NACA RM L9B02

FULL-SCALE INVESTIGATION OF A WING WITH THE LEADING EDGE SWEPT BACK 47.5° AND HAVING CIRCULAR-ARC AND FINITE-TRAILING-EDGE-THICKNESS AILERONS. Roy H. Lange. March 11, 1949. 16p. diagrs., photo. (NACA RM L9B02) (Declassified from Confidential, 8/18/54)

The results of an investigation in the Langley full-scale tunnel to determine the aerodynamic characteristics of a wing with the leading edge swept back 47.5° and having a 20-percent-chord, 50-percent-span outboard-flap-type aileron are presented in this paper. The wing had circular-arc airfoil sections, and the aileron was investigated for the circular-arc contour and for a flat-sided contour with finite trailing-edge thickness. The aileron effectiveness was determined and the data are presented for a Reynolds number of 4.3×10^6 and a Mach number of about 0.07.

NACA RM L9B08

SOME WIND-TUNNEL EXPERIMENTS ON SINGLE DEGREE OF FREEDOM FLUTTER OF AILERONS IN THE HIGH SUBSONIC SPEED RANGE. Sherman A. Clevenson. March 30, 1949. 33p. diagrs., photo., 3 tabs. (NACA RM L9B08) (Declassified from Confidential, 8/18/54)

Results of tests of three wing models with various aileron configurations are presented. Density had little effect on the initial magnitude or initial Mach number of buzz. Buzz frequency decreased with decrease of density. Initial buzz Mach number decreases with increasing angle of attack. Mass balancing and changes of spring stiffness of the ailerons in these tests had little effect on buzz. Increasing the aileron mass moment of inertia lowers the buzz frequency. Placing the aileron at the wing tip delays the onset of buzz. A comparison of the test results with two empirical analyses is made.

NACA RM L9B10a

THE EFFECT OF REAR CHINE STRIPS ON THE TAKE-OFF CHARACTERISTICS OF A HIGH-SPEED AIRPLANE FITTED WITH NACA HYDRO-SKIS. John A. Ramsen. March 17, 1949. 7p. diagrs., photo. (NACA RM L9B10a) (Declassified from Confidential, 8/18/54)

Results are presented from tank take-off tests of a dynamic model of a hypothetical high-speed airplane fitted with NACA hydro-skis and having the transverse curvature of the lower rear portion of the fuselage broken by small longitudinal chine strips. For the configuration tested, both trim and resistance were considerably reduced by the addition of the strips from the speed at which the ski emerged to the speed at which the rear of the fuselage came clear of the water. Results indicate that fuselage shape has a large effect on the take-off characteristics for a hydro-ski configuration in which the rear of the fuselage acts as a planing surface.

NACA RM L9B23a

MEASUREMENTS OF AERODYNAMIC CHARACTERISTICS OF A 35° SWEPTBACK NACA 65-009 AIRFOIL MODEL WITH 1/4-CHORD HORN-BALANCED FLAP BY THE NACA WING-FLOW METHOD. Harold I. Johnson and B. Porter Brown. April 18, 1949. 59p. diagrs., photo. (NACA RM L9B23a) (Declassified from Confidential, 8/18/54)

Contains lift, pitching-moment, and hinge-moment data obtained from wing-flow tests of a low-aspect-ratio sweptback airfoil model having a full-span 1/4-chord horn-balanced flap. Mach number range was 0.55 to 1.15. Data are compared with results obtained from previous tests of an equivalent plain-flap model. Conclusion is that horn balance appears satisfactory for $M < 0.95$ but will not be useful between $M \approx 0.95$ and $M = 1.15$.

NACA RM L9B25

AERODYNAMIC CHARACTERISTICS OF A WING WITH QUARTER-CHORD LINE SWEPT BACK 35°, ASPECT RATIO 4, TAPER RATIO 0.6, AND NACA 65A006 AIRFOIL SECTION. TRANSONIC-BUMP METHOD. William C. Sleeman, Jr. and Robert E. Becht. April 21, 1949. 29p. diagrs., photo., tab. (NACA RM L9B25) (Declassified from Confidential, 8/18/54)

This paper presents the results of an investigation by the transonic-bump method of a wing-fuselage combination employing a wing with quarter-chord line swept back 35°, aspect ratio 4, taper ratio 0.6, and NACA 65A006 airfoil section. Lift, drag, pitching moment, and root bending moment were obtained for the wing-alone and wing-body configurations over a Mach number range of 0.6 to 1.18. Effective downwash angles and dynamic-pressure characteristics in the region of a probable tail location were also obtained and are presented for a range of tail heights at one tail length.

NACA RM L9C01

APPARATUS FOR OBTAINING A SUPERSONIC FLOW OF VERY SHORT DURATION AND SOME DRAG MEASUREMENTS OBTAINED WITH ITS USE. John E. Yeates, Jr., F. J. Bailey, Jr. and T. J. Voglewede. July 23, 1951. 23p. diagrs., photos. (NACA RM L9C01) (Declassified from Confidential, 8/18/54)

Contains description of a vacuum-actuated supersonic nozzle and a comparison of drag data obtained from free-fall tests and models tested using this equipment. The comparison indicates that the apparatus gives drag values in good agreement with free-fall, free-flight, and wind-tunnel tests and it should also give good results for comparative drag studies for which this equipment was primarily designed.

NACA RM L9C11

STUDY BY NACA WING-FLOW METHOD OF TRANSONIC DRAG CHARACTERISTICS OF A BLUNT-NOSE BODY OF REVOLUTION AND COMPARISON WITH RESULTS FOR A SHARP-NOSE BODY. J. Ford Johnston and Mitchell Lopatoff. April 26, 1949. 26p. diagrs., photos. (NACA RM L9C11) (Declassified from Confidential, 8/18/54)

Contains studies by NACA wing-flow method of pressure distributions and pressure drag of a body of revolution with NACA 1-50-100 nose inlet at zero inlet flow at Mach numbers from 0.70 to 1.10. Comparison is made with pressure-drag characteristics of a sharp-nose body having same rear end. Consideration of component front- and rear-end drag contributions suggests general picture of body-drag variation in transonic speed range.

NACA RM L9C18

PRESSURE-DISTRIBUTION DATA FOR THE NACA 64_1-012 AND 64_1A012 AIRFOILS AT HIGH SUBSONIC MACH NUMBERS. Milton D. Humphreys. May 6, 1949. 37p. photos., diagrs., 8 tabs. (NACA RM L9C18) (Declassified from Confidential, 8/18/54)

Pressure-distribution tests and schlieren photographs of the NACA 64_1012 and 64_1A012 airfoils indicated that the primary effect of increasing the trailing-edge angle from 9° to 14° was to decrease the loading over the rear portion of the airfoil. The effect was more pronounced with increasing Mach numbers and lift coefficients.

NACA RM L9C25

ERROR IN AIRSPEED MEASUREMENT DUE TO STATIC-PRESSURE FIELD AHEAD OF SHARP-NOSE BODIES OF REVOLUTION AT TRANSONIC SPEEDS. Edward C. B. Danforth and J. Ford Johnston. August 19, 1949. 31p. diagrs., photos. (NACA RM L9C25) (Declassified from Confidential, 8/18/54)

Contains measurements of static-pressure error at several distances ahead of two sharp-nose bodies of revolution at zero angle of attack in the transonic speed range by the NACA wing-flow method. By application of the linearized subsonic theory and the transonic similarity rule to the data contained herein, the position error at any reasonable distance ahead of any sharp-nose body of revolution with an approximately parabolic nose profile and fineness ratio greater than about 4.5 can be predicted at any Mach number.

NACA RM L9D01

PRELIMINARY WIND-TUNNEL INVESTIGATION AT HIGH-SUBSONIC SPEEDS OF PLANING-TAIL, BLENDED, AND AIRFOIL-FOREBODY SWEPT HULLS. John M. Riebe and Richard G. MacLeod. September 12, 1949. 33p. diagrs., photos., 3 tabs. (NACA RM L9D01) (Declassified from Confidential, 8/23/54)

A preliminary investigation was made in the Langley high-speed 7- by 10-foot tunnel to determine the high subsonic aerodynamic characteristics of three different types of flying-boat hull: namely, a planing-tail hull, a blended hull, and an airfoil-forebody swept hull. For comparative purposes a body of revolution representative of the fuselage of a modern high-speed airplane was also included. The hull and fuselage data presented include the forces and moments of a 51.3° sweptback wing; the models were tested as reflection-plane half-models on the side wall of the tunnel. The results include the lift, drag, and pitching-moment coefficients through angles of attack from -1° to 4° up to Mach numbers to 0.99.

NACA RM L9D06

WIND-TUNNEL INVESTIGATION AT HIGH SUBSONIC SPEEDS OF THE LATERAL-CONTROL CHARACTERISTICS OF AN AILERON AND A STEPPED SPOILER ON A WING WITH LEADING EDGE SWEPT BACK 51.3°. Leslie E. Schneiter and John R. Hagerman. June 7, 1949. 34p. diagrs., photo. (NACA RM L9D06) (Declassified from Confidential, 8/18/54)

Contains results and discussion of an investigation to a Mach number of about 0.9 of the lateral-control characteristics of a 20-percent-chord by 39-percent-semispan plain sealed aileron and a 60-percent-span stepped spoiler on a semispan-wing model of aspect ratio 3.0 and leading edge swept back 51.3°. The general wing aerodynamic characteristics were also determined in this investigation.

NACA RM L9D06a

MEASUREMENT OF THE DYNAMIC LATERAL STABILITY OF THE DOUGLAS D-558-1 AIRPLANE (BUAERO NO. 37971) IN RUDDER KICKS AT A MACH NUMBER OF 0.72. Hubert M. Drake. May 31, 1949. 10p. diagrs., photos. (NACA RM L9D06a) (Declassified from Confidential, 8/18/54)

Contains results of flight measurements of the dynamic lateral stability of the Douglas D-558-1 airplane at a Mach number of 0.72 and a pressure altitude of 8500 feet.

NACA RM L9D07

INVESTIGATIONS AT SUPERSONIC SPEEDS OF 22 TRIANGULAR WINGS REPRESENTING TWO AIRFOIL SECTIONS FOR EACH OF 11 APEX ANGLES. Eugene S. Love. May 10, 1949. 100p. diagrs., photos., 3 tabs. (NACA RM L9D07) (Declassified from Confidential, 8/18/54)

The results of tests of 22 triangular wings, representing two leading-edge shapes for each of 11 apex angles, at Mach numbers of 1.62, 1.92, and 2.40 are presented and compared with theory. All wings have a common thickness ratio of 8 percent and a common location of maximum thickness point of 18 percent. Lift, drag, and pitching moment are given for all wings at each Mach number. The relation of transition in the boundary layer, shocks on the wing surfaces, and characteristics of the pressure distributions is discussed for several wings.

NACA RM L9D11

FLIGHT INVESTIGATION OF THE JETTISONABLE-NOSE METHOD OF PILOT ESCAPE USING ROCKET-PROPELLED MODELS. Reginald R. Lundstrom and Burke R. O'Kelly. June 2, 1949. 27p. diagrs., photos., 2 tabs. (NACA RM L9D11) (Declassified from Confidential, 8/18/54)

Results of an investigation at a Mach number of 0.87 of the jettisonable-nose method of pilot escape, using rocket-propelled models, is presented. With a fin-stablized nose section the accelerations produced are well within human tolerance. The drag-weight ratios of nose and rear bodies were such that the deceleration of the nose was less than that of the rear body. The shielding effect of the nose on the rear body was appreciable, and forcible separation appears necessary.

NACA RM L9D13

MEASUREMENTS OF AILERON EFFECTIVENESS OF BELL X-1 AIRPLANE UP TO A MACH NUMBER OF 0.82. Hubert M. Drake. June 20, 1949. 7p. diagrs. (NACA RM L9D13) (Declassified from Confidential, 8/18/54)

Contains results of flight measurements of the aileron effectiveness of the Bell X-1 airplane up to a Mach number of 0.82. The data indicate that Mach number has little effect on the aileron effectiveness up to a Mach number of 0.82.

NACA RM L9D20

THE EFFECT OF AIR-JET AND STRIP MODIFICATIONS ON THE HYDRODYNAMIC CHARACTERISTICS OF THE STREAMLINE FUSELAGE OF A TRANSONIC AIRPLANE. Bernard Weinflash, Kenneth W. Christopher and Charles L. Shuford, Jr. June 3, 1949. 32p. diagrs., photos. (NACA RM L9D20) (Declassified from Confidential, 8/18/54)

Specific free-to-trim tests were made on a 1/12-size model of a streamline fuselage modified by patterns of air jets or strips on the fuselage bottom. The effects of spacing of jets, length of jet rows, and direction of jets were determined for a simulated chine configuration. Tests were also made of a

simulated multiple-step configuration. The effect of air flow on both the chine and step configurations was studied. In addition, the effect of substituting narrow breaker strips for the rows of jets in the chine configuration and in three multiple-step configurations was investigated. Data are presented on resistance, trim, effective hydrodynamic lift, and spray.

NACA RM L9D20a

MEASURED CHARACTERISTICS OF THE DOUGLAS D-558-1 AIRPLANE (BUAERO NO. 37971) IN TWO LANDINGS. Hubert M. Drake. June 3, 1949. 8p. diagrs., photos. (NACA RM L9D20a) (Declassified from Confidential, 8/18/54)

Records were obtained of two landings which indicate approach and landing speeds of 150 and 115 percent of the estimated minimum speed. The rates of descent just prior to the start of the landing flare were about 1200 to 1800 feet per minute.

NACA RM L9E10

EFFECTS OF MACH NUMBER AND SWEEP ON THE DAMPING-IN-ROLL CHARACTERISTICS OF WINGS OF ASPECT RATIO 4. Richard E. Kuhn and Boyd C. Myers, II. June 27, 1949. 28p. diagrs., photo. (NACA RM L9E10) (Declassified from Confidential, 8/18/54)

The damping-in-roll characteristics of three wings of aspect ratio 4 and taper ratio 0.6 with sweep angles of 3.6°, 32.6°, and 46.7° at the quarter-chord line and the NACA 65A006 section have been determined through the Mach number range from 0.4 to 0.91 and angle-of-attack range from 0° to 6.5° in the Langley high-speed 7- by 10-foot tunnel by the free-roll method. Rolling-moment and rate-of-roll data for each wing are presented for an angle-of-attack range from 0° to 6.5° and aileron angles of 0°, ±4°, and ±8°. Aileron effectiveness and the damping-in-roll parameter C_{l_p} are presented for these conditions along with a comparison with theory.

NACA RM L9E19

AERODYNAMIC CHARACTERISTICS OF SEVERAL 6-PERCENT-THICK AIRFOILS AT ANGLES OF ATTACK FROM 0° TO 20° AT HIGH SUBSONIC SPEEDS. Bernard N. Daley and Douglas R. Lord. July 14, 1949. 63p. diagrs., photos. (NACA RM L9E19) (Declassified from Confidential, 8/18/54)

Gives aerodynamic characteristics obtained from experimental two-dimensional tests of eight 6-percent-thick symmetrical airfoils of the supersonic and subsonic type at angles of attack from 0° to 20° and at Mach numbers from 0.3 to about 0.9. Results indicate generally improved characteristics for the circular-arc and wedge-type airfoils when the maximum thickness was located forward. The variations with Mach number of the lift, drag, and pitching-moment coefficients are generally similar for the supersonic- and subsonic-type airfoils tested.

NACA RM L9E25

AERODYNAMIC CHARACTERISTICS OF A WING WITH QUARTER-CHORD LINE SWEPT BACK 45°, ASPECT RATIO 4, TAPER RATIO 0.3, AND NACA 65A006 AIRFOIL SECTION. TRANSONIC-BUMP METHOD. Boyd C. Myers, II and Thomas J. King, Jr. July 20, 1949. 28p. diagrs., photo., tab. (NACA RM L9E25) (Declassified from Confidential, 8/18/54)

This paper presents the results of an investigation by the transonic-bump method of a wing-fuselage combination employing a wing with quarter-chord line swept back 45° with aspect ratio 4, taper ratio 0.3, and NACA 65A006 airfoil. Lift, drag, pitching moment, and root bending moment were obtained for the isolated wing and wing-fuselage configurations over a Mach number range 0.70 to 1.18. Effective downwash angles and dynamic-pressure characteristics in the region of the tail plane were also obtained and are presented for a range of tail heights at one tail length. In order to expedite publishing of these data only a brief analysis has been made.

NACA RM L9F14

EFFECT OF SWEEPBACK ON THE LOW-SPEED STATIC AND ROLLING STABILITY DERIVATIVES OF THIN TAPERED WINGS OF ASPECT RATIO 4. William Letko and Walter D. Wolhart. August 9, 1949. 36p. diagrs., photo. (NACA RM L9F14) (Declassified from Confidential, 8/18/54)

Contains results of an investigation made in the rolling-flow test section of the Langley stability tunnel to determine the effects of sweepback on the static and rolling derivatives of a series of wings each of which had a taper ratio of 0.6 and an aspect ratio of 4. The wings were of NACA 65A006 section and had sweepback angles of their quarter-chord line of 3.6°, 32.6°, and 46.7°. Most of the results are for wings tested in combination with a fuselage. The damping-in-roll results are compared with those obtained from free rotation of the models in the Langley 7- by 10-foot tunnel, and some comparisons are made with theory.

NACA RM L9F15

DAMPING-IN-ROLL CHARACTERISTICS OF A 42.7° SWEPT-BACK WING AS DETERMINED FROM A WIND-TUNNEL INVESTIGATION OF A TWISTED SEMISPAN WING. Vernard E. Lockwood. August 8, 1949. 23p. diagrs. (NACA RM L9F15) (Declassified from Confidential, 8/18/54)

This paper presents the results of a damping-in-roll investigation of a sweptback wing as determined from tunnel tests of a twisted semispan wing. The wing of the investigation had a leading-edge sweep of 42.7°, a taper ratio of 0.5, an aspect ratio of 4.0, and a circular-arc airfoil section normal to the 50-percent chord line. The tests were made in the transonic speed range between Mach numbers 0.6 and 1.15 in the Langley high-speed 7- by 10-foot tunnel by utilizing the transonic bump and at a Mach number of 1.9 in the Langley 9- by 12-inch supersonic blowdown tunnel.

NACA RM L9F21

RESULTS OBTAINED FROM SECOND FLIGHT OF X-4 AIRPLANE (A.F. NO. 46-676). Walter C. Williams. July 18, 1949. 13p. diagrs., photos., tab. (NACA RM L9F21) (Declassified from Confidential, 8/18/54)

Results are presented from the second flight of the NACA instrumented Northrop X-4 semitailless research airplane. Data presented include static-longitudinal-stability measurements and a time history of a landing approach and landing with the center of gravity at 19.7 percent mean aerodynamic chord. The airplane exhibited positive static longitudinal stability and low damping of the lateral oscillation.

NACA RM L9F28a

AN NACA VANE-TYPE ANGLE-OF-ATTACK INDICATOR FOR USE AT SUBSONIC AND SUPERSONIC SPEEDS. Jesse L. Mitchell and Robert F. Peck. August 16, 1949. 10p. diagrs., photos. (NACA RM L9F28a) (Declassified from Confidential, 8/18/54)

A description is presented of a vane-type angle-of-attack indicator developed by the NACA for use at supersonic and subsonic speeds. A brief history of the development and a wind-tunnel calibration are given, together with a discussion of the corrections to be applied to the indicated readings.

NACA RM L9F29

TESTS OF LIFTING SURFACES ON CONICAL AND CYLINDRICAL PORTIONS OF A BODY AT SUBSONIC MACH NUMBERS AND AT A MACH NUMBER OF 1.2. Robert S. Osborne and John B. Wright. September 2, 1949. 22p. diagrs. (NACA RM L9F29) (Declassified from Confidential, 8/18/54)

Tests have been conducted at a Mach number of 1.2 and at several subsonic speeds to determine the possibilities of using a subsonic conical-flow field in a supersonic free stream to delay the onset of adverse compressibility effects on lifting surfaces.

NACA RM L9F29a

LATERAL-CONTROL INVESTIGATION OF FLAP-TYPE CONTROLS ON A WING WITH QUARTER-CHORD LINE SWEPT BACK 45°, ASPECT RATIO 4, TAPER RATIO 0.6, AND NACA 65A006 AIRFOIL SECTION. TRANSONIC-BUMP METHOD. Raymond D. Vogler. August 15, 1949. 22p. diagrs. (NACA RM L9F29a) (Declassified from Confidential, 8/18/54)

This paper presents the results of a lateral-control investigation of a 30-percent-chord flap-type control of various spanwise magnitudes on a wing of 45° of sweepback of the quarter-chord line, an aspect ratio of 4, a taper ratio of 0.6, and an NACA 65A006 airfoil section. Rolling and pitching moments and lift of the semispan wing fuselage were obtained through a Mach number range of 0.6 to 1.20.

NACA RM L9G06a

INVESTIGATION OF THE NACA 4-(5)(08)-03 TWO-BLADE PROPELLER AT FORWARD MACH NUMBERS TO 0.925. James B. Delano and Melvin M. Carmel. September 15, 1949. 61p. diagrs., photo. (NACA RM L9G06a) (Declassified from Confidential, 8/23/54)

The paper presents propeller characteristics for the NACA 4-(5)(08)-03 two-blade propeller for forward Mach numbers up to 0.925 for blade angles from 20° to 70°.

NACA RM L9G20a

RESULTS OBTAINED FROM THIRD FLIGHT OF NORTHROP X-4 AIRPLANE (A.F. NO. 46-676). Walter C. Williams. September 9, 1949. 13p. diagrs., photos., tab. (NACA RM L9G20a) (Declassified from Confidential, 8/18/54)

Results are presented from the third flight of the NACA instrumented Northrop X-4 semitailless research airplane. Data presented are steady sideslip characteristics at 175 miles per hour which show that directional stability is positive and high and lateral stability is positive.

NACA RM L9G22

THE STATIC-PRESSURE ERROR OF WING AND FUSELAGE AIRSPEED INSTALLATIONS OF THE X-1 AIRPLANES IN TRANSONIC FLIGHT. Harold R. Goodman and Roxanah B. Yancey. July 22, 1949. 20p. diagrs. (NACA RM L9G22) (Declassified from Confidential, 8/18/54)

Contains measurements of the static-pressure error of the airspeed installations of the X-1 airplanes obtained from flight tests made in the Mach number range of 0.8 to 1.32. The static-pressure error was measured at a point ahead of the fuselage nose and at a point ahead of the wing tip. Data are presented showing the variation of the static-pressure error with Mach number, airplane lift coefficient, and wing thickness.

NACA RM L9G22a

AERODYNAMIC CHARACTERISTICS OF A DELTA WING WITH LEADING EDGE SWEPT BACK 45°, ASPECT RATIO 4, AND NACA 65A006 AIRFOIL SECTION. TRANSONIC-BUMP METHOD. William C. Sleeman, Jr. and Robert E. Becht. September 6, 1949. 29p. diagrs., photo., tab. (NACA RM L9G22a) (Declassified from Confidential, 8/18/54)

This paper presents the results of an investigation by the transonic-bump method of a wing-fuselage combination employing a delta wing with leading edge swept back 45°, aspect ratio 4, and an NACA 65A006 airfoil section. Lift, drag, pitching moment, and root bending moment were obtained for the wing-alone and wing-fuselage configurations over a Mach number range of 0.60 to 1.18. Effective downwash angles and dynamic-pressure characteristics in the region of a probable tail location were also obtained and are presented for a range of tail heights at one tail length.

NACA RM L9G25a

STABILITY AND CONTROL DATA OBTAINED FROM FOURTH AND FIFTH FLIGHTS OF THE NORTHROP X-4 AIRPLANE (A.F. NO. 46-676). George M. Valentine. August 4, 1949. 22p. diagrs., photos., tab. (NACA RM L9G25a) (Declassified from Confidential, 8/18/54)

Results are presented from the fourth and fifth flights of the NACA instrumented Northrop X-4 semitailless research airplane. Data presented from steady level runs from 140 to 340 miles per hour which showed the airplane to be longitudinally stable, stick fixed, in the clean configuration and in the gear-down flaps-retracted configuration. Data also are presented from steady sideslip characteristics at 175 to 280 miles per hour which show that the directional stability is positive and high and lateral stability is positive.

NACA RM L9G27

AERODYNAMIC CHARACTERISTICS OF A WING WITH QUARTER-CHORD LINE SWEPT BACK 60°, ASPECT RATIO 4, TAPER RATIO 0.6, AND NACA 65A006 AIRFOIL SECTION. TRANSONIC-BUMP METHOD. Thomas J. King, Jr. and Boyd C. Myers, II. September 6, 1949. 32p. diagrs., photos., tab. (NACA RM L9G27) (Declassified from Confidential, 8/18/54)

The paper presents the results of an investigation by the transonic-bump method of a wing-fuselage combination employing a wing with quarter-chord line swept back 60° with aspect ratio 4, taper ratio 0.6, and 65A006 airfoil. Lift, drag, pitching-moment, and root-bending moment characteristics were obtained for the isolated-wing and wing-fuselage configurations over a Mach number range from 0.60 to 1.18. In addition, the effect of a fence, mounted at the mean aerodynamic chord, is also discussed. Effective downwash angles and dynamic-pressure characteristics in the region of the tail plane were also obtained and are presented for a range of tail heights at one tail length. In order to expedite publishing of these data only a brief analysis has been made.

NACA RM L9H04

INVESTIGATION OF EXTENSIBLE WING-TIP AILERONS ON AN UNTAPERED SEMISPAN WING AT 0° AND 45° SWEEPBACK. John R. Hagerman and William M. O'Hare. September 20, 1949. 40p. diagrs.; photo., tab. (NACA RM L9H04) (Declassified from Confidential, 8/18/54)

Contains results and discussion of a low-speed lateral control investigation of three different plan forms of extensible wing-tip ailerons on each of two untapered wing configurations, one unswept with aspect ratio of 3.13 and the other swept back 45° with aspect ratio of 1.59. The results indicate that the extensible ailerons had satisfactory rolling effectiveness at moderate and high values of lift coefficient but insufficent rolling effectiveness at low values of lift coefficient for satisfactory application to an airplane. However, these ailerons may be suitable for use on some types of missiles. The extensible ailerons produced yawing moments comparable to those produced by conventional flap-type ailerons.

NACA RM L9H16

WIND-TUNNEL INVESTIGATION AT LOW TRANSONIC SPEEDS OF THE EFFECTS OF NUMBER OF WINGS ON THE LATERAL-CONTROL EFFECTIVENESS OF AN RM-5 TEST VEHICLE. Harold S. Johnson. November 29, 1949. 15p. diagrs., photo., tab. (NACA RM L9H16) (Declassified from Confidential, 8/18/54)

Contains results of a wind-tunnel investigation conducted to determine the effects of number of wings on the rolling characteristics of an RM-5 test vehicle through a speed range to a Mach number of 0.9.

NACA RM L9H22

AERODYNAMIC CHARACTERISTICS OF A WING WITH UNSWEPT QUARTER-CHORD LINE, ASPECT RATIO 4, TAPER RATIO 0.6, AND NACA 65A006 AIRFOIL SECTION. TRANSONIC-BUMP METHOD. Kenneth W. Goodson and William D. Morrison, Jr. October 21, 1949. 32p. diagrs., photos., tab. (NACA RM L9H22) (Declassified from Confidential, 8/18/54)

This paper presents the results of an investigation by the transonic-bump method of a wing-fuselage combination employing a wing with unswept quarter-chord line, aspect ratio 4, taper ratio 0.6, and NACA 65A006 airfoil section. Lift, drag, pitching moment, and root bending moment were obtained for the wing-alone and wing-body configurations over a Mach number range of 0.6 to 1.18. Effective downwash angles and dynamic-pressure characteristics in the region of the tail plane were also obtained and are presented for a range of tail heights at one tail length.

NACA RM L9H29a

INVESTIGATION OF SOME TURBULENT-BOUNDARY-LAYER VELOCITY PROFILES AT A TUNNEL WALL WITH MACH NUMBERS UP TO 1.2. Marshall P. Tulin and Ray H. Wright. November 9, 1949. 22p. diagrs. (NACA RM L9H29a) (Declassified from Confidential, 8/18/54)

Turbulent-boundary-layer profiles at large Reynolds numbers, of the order of 40,000 based on the momentum thickness, and at Mach numbers up to 1.2 are presented and analyzed. The effects of compressibility on the profiles and on the displacement and momentum thicknesses are discussed. The turbulent boundary layer under a normal shock is investigated.

NACA RM L9I01

A FREE-FLIGHT TECHNIQUE FOR MEASURING DAMPING IN ROLL BY USE OF ROCKET-POWERED MODELS AND SOME INITIAL RESULTS FOR RECTANGULAR WINGS. James L. Edmondson and E. Claude Sanders, Jr. December 20, 1949. 25p. diagrs., photos. (NACA RM L9I01) (Declassified from Confidential, 8/18/54)

A simplified method for obtaining damping in roll experimentally at transonic and supersonic speeds through use of a simple rocket-powered model employing canted nozzles to apply a torque has been developed. A description of the method and results of the initial flight tests of rectangular wings with aspect ratio 3.71 are presented.

NACA RM L9I06

INVESTIGATION OF THE NACA 4-(3)(08)-03 TWO-BLADE PROPELLER AT FORWARD MACH NUMBERS TO 0.925. James B. Delano and Francis G. Morgan, Jr. November 2, 1949. 30p. diagrs., photos. (NACA RM L9I06) (Declassified from Confidential, 8/23/54)

Propeller characteristics are presented for the NACA 4-(3)(08)-03 blade propeller for forward Mach numbers up to 0.925 for blade angles of 55°, 60°, and 65°. A comparison of results for this propeller with those for the NACA 4-(5)(08)-03 propeller is presented to show the effect of design camber on propeller performance.

NACA RM L9I06a

STATIC STABILITY OF FUSELAGE HAVING A RELATIVELY FLAT CROSS SECTION. William R. Bates. December 9, 1949. 29p. diagrs., tab. (NACA RM L9I06a) (Declassified from Confidential, 8/18/54)

Contains results of force tests and flow surveys made in the Langley free-flight tunnel to determine the static stability characteristics of several fuselages having a relatively flat cross section and a high fineness ratio.

NACA RM L9I07

INVESTIGATION OF THE NACA 4-(4)(06)-04 TWO-BLADE PROPELLER AT FORWARD MACH NUMBERS TO 0.925. James B. Delano and Daniel E. Harrison. October 28, 1949. 39p. diagrs., photos. (NACA RM L9I07) (Declassified from Confidential, 8/23/54)

The paper presents propeller characteristics for the NACA 4-(4)(06)-04 two-blade propeller for forward Mach numbers up to 0.925 for blade angles from 20° to 70°.

NACA RM L9I08

AERODYNAMIC CHARACTERISTICS OF A WING WITH QUARTER-CHORD LINE SWEPT BACK 45°, ASPECT RATIO 6, TAPER RATIO 0.6, AND NACA 65A006 AIRFOIL SECTION. TRANSONIC-BUMP METHOD. Kenneth W. Goodson and Albert G. Few, Jr. November 1, 1949. 34p. diagrs., photos., tab. (NACA RM L9I08) (Declassified from Confidential, 8/18/54)

This paper presents the results of an investigation by the transonic-bump method of a wing-alone and a wing-fuselage combination employing a wing with quarter-chord line swept back 45°, aspect ratio 6, taper ratio 0.6, and NACA 65A006 airfoil section. Lift, drag, pitching moment, and root bending moment were obtained for the wing-alone and wing-fuselage configurations over a Mach number range from 0.60 to 1.18. Effective downwash angles and dynamic-pressure characteristics in the region of the tail plane were also obtained and are presented for a range of tail heights at one tail length.

NACA RM L9I28

AN EMPIRICAL CRITERION FOR FIN STABILIZING JETTISONABLE NOSE SECTIONS OF AIRPLANES. Stanley H. Scher. December 8, 1949. 21p. diagrs., photo., tab. (NACA RM L9I28) (Declassified from Confidential, 8/18/54)

The present paper summarizes the results of investigations in the Langley 20-foot free-spinning tunnel which show the inherent instability of models of jettisonable nose sections. A criterion is presented from which, for a given center-of-gravity position, the fin area required for stabilization of airplane nose sections can be determined.

NACA RM L9J04

EFFECT OF AIRFOIL SECTION AND TIP TANKS ON THE AERODYNAMIC CHARACTERISTICS AT HIGH SUBSONIC SPEEDS OF AN UNSWEPT WING OF ASPECT RATIO 5.16 AND TAPER RATIO 0.61. H. Norman Silvers and Kenneth P. Spreemann. December 1, 1949. 30p. diagrs., photos., 2 tabs. (NACA RM L9J04) (Declassified from Confidential, 8/18/54)

An investigation of a wing of aspect ratio 5.16 and of taper ratio 0.61 with two airfoil sections and a tip tank was made in the Langley high-speed 7- by 10-foot tunnel over a Mach number range that generally extended from 0.60 to 0.90. In addition to the effect of airfoil section and tip tank on the lift, drag, and pitching-moment coefficients of the wing alone and the wing-tank combination, tests included the effect of two modifications to the trailing edge of one section and horizontal stabilizing fins on the tip tank. Pitching moment and lift of the tank alone in the presence of the wing with one airfoil section were also measured.

NACA RM L9J05

INVESTIGATION AT MACH NUMBER 1.62 OF THE PRESSURE DISTRIBUTION OVER A RECTANGULAR WING WITH SYMMETRICAL CIRCULAR-ARC SECTION AND 30-PERCENT-CHORD TRAILING-EDGE FLAP. K. R. Czarnecki and James N. Mueller. January 25, 1950. 81p. diagrs., photos. (NACA RM L9J05) (Declassified from Confidential, 8/23/54)

Contains the results of an investigation at a Mach number of 1.62 and a Reynolds number range of 0.55 to 1.07×10^6 of the pressure distributions over a rectangular wing having a 9-percent-thick circular-arc section and a 30-percent-chord trailing-edge flap. The characteristics of the air flow at two spanwise stations, one in the two-dimensional flow region and the other in the region influenced by the airfoil tip, are discussed.

NACA RM L9J13

WIND-TUNNEL INVESTIGATION AT LOW SPEED TO DETERMINE AERODYNAMIC PROPERTIES OF A JETTISONABLE NOSE SECTION WITH CIRCULAR CROSS SECTION. Roscoe H. Goodwin. May 19, 1950. 38p. diagrs., photos. (NACA RM L9J13) (Declassified from Confidential, 8/23/54)

The aerodynamic properties of a model of a jettisonable nose section with a circular cross section were determined at low speed from an investigation in the Langley 20-foot free-spinning tunnel. Force and moment measurements were made of the nose section in various positions removed from the fuselage and in a position simulating its final condition of free fall (not under the influence of the fuselage). For each location of the nose, the measurements were obtained for the nose with and without stabilizing fins attached for 0° and 5° angle of attack.

NACA RM L9J13a

THE PATH AND MOTION OF SCALE MODELS OF JETTISONABLE NOSE SECTIONS AT SUPERSONIC SPEEDS AS DETERMINED FROM AN INVESTIGATION IN THE LANGLEY FREE-FLIGHT APPARATUS. Lawrence J. Gale. May 23, 1950. 35p. diagrs., photos., 2 tabs. (NACA RM L9J13a) (Declassified from Confidential, 8/23/54)

An investigation has been conducted on models of two different designs of jettisonable nose sections wherein the nose sections have been projected at supersonic speeds (Mach number ranged from 1.2 to 1.4) in the Langley free-flight apparatus. Both nose designs in the original unstabilized condition turned away from a nose-first flight attitude and calculations indicated that a pilot within corresponding full-scale nose sections would encounter large accelerations (12 negative g for 0.014 sec for one nose design and 26 negative g for 0.013 sec for the other design) as a result of this instability. Both nose designs with fins installed appeared stable, and calculations indicated that the equivalent motion in a corresponding full-scale nose section would not subject the pilot to large accelerations (6 transverse g).

NACA RM L9J19

THE EFFECT OF TIP TANKS ON THE ROLLING CHARACTERISTICS AT HIGH SUBSONIC MACH NUMBERS OF A WING HAVING AN ASPECT RATIO OF 3 WITH QUARTER-CHORD LINE SWEPT BACK 35°. Richard E. Kuhn and Boyd C. Myers, II. January 17, 1950. 27p. diagrs., photo., 2 tabs. (NACA RM L9J19) (Declassified from Confidential, 8/23/54)

An investigation of the effect of two wing-tip mounted tank configurations on the rolling characteristics of a swept wing through the Mach number range from 0.4 to 0.91 and in the angle-of-attack range from 0.3° to 6.5° was conducted by the free-roll method. An additional tank configuration was tested through the Mach number range at a constant angle of attack of 0.3°. Tanks mounted directly on the tip increased both the aileron effectiveness and the damping in roll. Pylon-mounted tanks gave a much smaller increase in both of these quantities. The variation of damping in roll with Mach number was similar and slightly greater than the wing alone for all configurations tested at a constant angle of attack of 0.3°.

NACA RM L9J27

MEASUREMENTS OF THE DRAG AND PRESSURE DISTRIBUTION ON A BODY OF REVOLUTION THROUGHOUT TRANSITION FROM SUBSONIC TO SUPERSONIC SPEEDS. Jim Rogers Thompson. January 16, 1950. 36p. diagrs., photos., 2 tabs. (NACA RM L9J27) (Declassified from Confidential, 8/23/54)

The drag and pressure distribution on a body of revolution of fineness ratio 12 were measured by the free-fall method at large scale under actual flight conditions throughout a range of Mach number from 0.75 to 1.27. Analysis shows in detail the mechanism of the abrupt drag rise which occurs near the speed of sound and demonstrates that the theoretical method of NACA TN 1768 satisfactorily predicts the shape of the pressure distribution over the test body at supersonic speeds. Limited information on skin friction is presented.

NACA RM L9K02

INVESTIGATION OF EFFECT OF SPAN AND SPANWISE LOCATION OF PLAIN AND STEPPED SPOILER AILERONS ON LATERAL CONTROL CHARACTERISTICS OF A WING WITH LEADING EDGE SWEPT BACK 51.3°. Jack Fischel and Alexander D. Hammond. January 18, 1950. 59p. diagrs., photos. (NACA RM L9K02) (Declassified from Confidential, 8/23/54)

Contains results and discussion of a low-speed lateral control investigation of a 51.3° sweptback wing equipped with plain and stepped spoiler ailerons having various spans and spanwise locations. The various ailerons were tested on the wing alone and on the wing with a simulated fuselage, an 0.487-span drooped nose, an 0.487-span split flap, and with various combinations thereof through a large angle-of-attack range.

NACA RM L9K03

MAXIMUM-LIFT INVESTIGATION AT MACH NUMBERS FROM 0.05 TO 1.20 OF A WING WITH LEADING EDGE SWEPT BACK 42°. Thomas R. Turner. February 14, 1950. 21p. diagrs. (NACA RM L9K03) (Declassified from Confidential, 8/23/54)

This paper contains the aerodynamic characteristics in pitch up to maximum lift for a reflection-plane model having 42° leading-edge sweep, an aspect ratio of 4, and a taper ratio of 0.625. The Mach number varied from 0.05 to 1.20 with the Reynolds number varying from 350,000 to 5,000,000. The higher Mach numbers were obtained by means of the transonic bump.

NACA RM L9K04a

A STUDY OF THE DYNAMIC STABILITY OF THE BELL X-1 RESEARCH AIRPLANE. Edward C. Polhamus. January 10, 1950. 16p. diagrs., tab. (NACA RM L9K04a) (Declassified from Confidential, 8/23/54)

The period and damping of the lateral oscillation of the Bell X-1 research airplane have been calculated for a range of Mach numbers and wing loadings for an altitude of 30,000 feet. The effect of changes in the magnitude of some of the parameters has been investigated and a comparison with flight results has been made.

NACA RM L9K11

MEASUREMENTS OF AERODYNAMIC CHARACTERISTICS OF A 35° SWEPTBACK NACA 65-009 AIRFOIL MODEL WITH 1/4-CHORD BEVELLED-TRAILING-EDGE FLAP AND TRIM TAB BY THE NACA WING-FLOW METHOD. Harold I. Johnson and B. Porter Brown. January 6, 1950. 68p. diagrs., photo. (NACA RM L9K11) (Declassified from Confidential, 8/23/54)

Contains lift, pitching-moment, and hinge-moment data from wing-flow tests of a low-aspect-ratio sweptback airfoil model having a full-span 1/4-chord bevelled-trailing-edge flap. Mach number range was 0.55 to 1.15. Conclusion is that bevelled trailing edge is undesirable type of aerodynamic balance for large speed range because of nonuniform balancing characteristics at subsonic speeds and loss of balancing effectiveness at low supersonic speeds.

NACA RM L9K22

RESULTS OBTAINED DURING FLIGHTS 1 TO 6 OF THE NORTHROP X-4 AIRPLANE (A.F. NO. 46-677). James T. Matthews, Jr. January 12, 1950. 19p. diagrs., photos., tab. (NACA RM L9K22) (Declassified from Confidential, 8/23/54)

Results are presented for flights 1 to 6 of a Northrop X-4 number 2 semitailless research airplane (A.F. No. 46-677) equipped with NACA instruments. Data presented include time histories of a complete pull-up and several short runs in level and accelerated flight, and the effect of dive-brake extension on longitudinal and lateral trim extension.

NACA RM L9K28

AN INVESTIGATION OF THE SPIN, RECOVERY, AND TUMBLING CHARACTERISTICS OF A 1/20-SCALE MODEL OF THE NORTHROP X-4 AIRPLANE. Lawrence J. Gale, Ira P. Jones, Jr. and Jack H. Wilson. January 4, 1950. 27p. diagrs., photos., 4 tabs. (NACA RM L9K28) (Declassified from Confidential, 8/23/54)

An investigation of the spin, recovery, and tumbling characteristics of a 1/20-scale model of the Northrop X-4 airplane has been conducted in the Langley 20-foot free-spinning tunnel. The effects of control settings and movements upon the erect and inverted spin and recovery characteristics of the model were determined for the model for loading conditions simulating various degrees of exhaustion of fuel in the airplane. An investigation was also made to determine the spin-recovery parachute requirements.

NACA RM L9L05

INVESTIGATION OF THE NACA 4-(4)(06)-057-45A AND NACA 4-(4)(06)-057-45B TWO-BLADE SWEPT PROPELLERS AT FORWARD MACH NUMBERS TO 0.925. James B. Delano and Daniel E. Harrison. February 6, 1950. 44p. diagrs., photos. (NACA RM L9L05) (Declassified from Confidential, 8/23/54)

The paper presents propeller characteristics for the NACA 4-(4)(06)-057-45A and NACA 4-(4)(06)-057-45B two-blade swept propellers for forward Mach numbers up to 0.925 for blade angles of 25°, 55°, 60°, 65°, and 70°. Moderate delays in onset of adverse compressibility effects were obtained through use of large amounts of sweep. The measured delay was approximately 25 percent of the value predicted by the use of simple infinite-span sweep theory.

NACA RM L9L08a

MOTION OF A TRANSONIC AIRPLANE NOSE SECTION WHEN JETTISONED AS DETERMINED FROM WIND-TUNNEL INVESTIGATIONS ON A 1/25-SCALE MODEL. Stanley H. Scher and Lawrence J. Gale. May 26, 1950. 64p. diagrs., photos., tab. (NACA RM L9L08a) (Declassified from Confidential, 8/23/54)

An investigation has been conducted with a 1/25-scale model in the Langley 300 mph 7- by 10-foot tunnel, the Langley free-flight tunnel, and the Langley 20-foot free-spinning tunnel to determine the path and motion of a transonic airplane nose section when jettisoned. The investigation included determination of the probable accelerations that would act on a pilot in the jettisoned nose section.

NACA RM L9L12

PRESSURE DISTRIBUTIONS ON THE BLADE SECTIONS OF THE NACA 10-(3)(066)-033 PROPELLER UNDER OPERATING CONDITIONS. Julian D. Maynard and Maurice P. Murphy. January 24, 1950. 166p. diagrs., photos., 12 tabs. (NACA RM L9L12) (Declassified from Confidential, 8/23/54)

Contains preliminary data obtained by measuring the pressure distributions on eleven blade sections of the NACA 10-(3)(066)-033 propeller having section design lift coefficients of 0.3 and varying in thickness from about 4 percent at the tip to 16 percent at the spinner surface. The pressure distributions

together with the corresponding section normal-force coefficients, chordwise-pressure-force coefficients, and pitching-moment coefficients are presented in the form of tables for a range of angle of attack from about -2° to 11° and for a Mach number range from about 0.3 to 1.2.

NACA RM L9L12a

LATERAL-CONTROL INVESTIGATION OF FLAP-TYPE CONTROLS ON A WING WITH QUARTER-CHORD LINE SWEPT BACK 35°, ASPECT RATIO 4, TAPER RATIO 0.6, AND NACA 65A006 AIRFOIL SECTION. TRANSONIC-BUMP METHOD. Robert F. Thompson. January 25, 1950. 22p. diagrs., tab. (NACA RM L9L12a) (Declassified from Confidential, 8/23/54)

This paper presents the results of an investigation to determine the control-effectiveness characteristics of 30-percent-chord flap-type control surfaces of various spans on a semispan wing-fuselage model by the transonic-bump method. The model employed a wing with the quarter-chord line swept back 35°, an aspect ratio of 4, a taper ratio of 0.6, and an NACA 65A006 airfoil section parallel to the free stream. Rolling moments, pitching moments, and lift were obtained through a Mach number range of 0.6 to 1.20.

NACA RM L9L15

THE TIME LAG BETWEEN FLAP DEFLECTION AND FORCE DEVELOPMENT AT A MACH NUMBER OF 4. Walter F. Lindsey and Edward F. Ulmann. February 13, 1950. 11p. diagr., photos. (NACA RM L9L15) (Declassified from Confidential, 8/23/54)

Presents the results of an investigation at a Mach number of 4 and a Reynolds number of 5×10^6 of the time lag between flap deflection and force development on a rectangular wing having a 9-percent-thick symmetrical circular-arc profile and a 30-percent-chord full-span flap. The lag was found to be less than one-half of a millisecond or less than a 3-1/2 chord movement of the model.

NACA RM L9L16

PRESSURE MEASUREMENTS AT SUPERSONIC SPEEDS ON A SECTION OF A RECTANGULAR WING HAVING AN NACA 65-009 PROFILE. Robert W. Rainey. March 10, 1950. 31p. diagrs., photos., tab. (NACA RM L9L16) (Declassified from Confidential, 8/23/54)

Experimental and predicted pressure distributions are presented for a section of a rectangular wing having an NACA 65-009 profile at $M = 1.62$, 1.93, and 2.40 at Reynolds numbers of 1.07×10^6, 0.97×10^6, and 0.81×10^6, respectively. Integrated normal-force, pitching-moment, and chordwise coefficients, as well as shadowgraphs and a discussion of the character of flow about the model, are reported. Comparison between the aerodynamic characteristics of the NACA 65-009 airfoil and a symmetrical circular-arc airfoil of the same thickness ratio is made.

NACA RM L9L19

FLIGHT INVESTIGATION OF THE EFFECT OF THICKENING THE AILERON TRAILING EDGE ON CONTROL EFFECTIVENESS FOR SWEPTBACK TAPERED WINGS HAVING SHARP- AND ROUND-NOSE SECTIONS. H. Kurt Strass and Edison M. Fields. May 2, 1950. 20p. diagrs., photo., tab. (NACA RM L9L19) (Declassified from Confidential, 8/23/54)

The effect of thickening the trailing edge of an aileron on control effectiveness and drag at transonic and supersonic speeds as determined in flight are presented for a wing having an NACA 0010-64 airfoil section, a taper ratio of 0.455, an aspect ratio of 3.6, sweepback of the quarter-chord of 38.1°, and a trailing edge angle of 17°. The results are compared with a previous investigation of a similar wing having a circular-arc section. The blunt trailing edge eliminated the control reversal obtained with the true-contour ailerons and greatly improved the control effectiveness although at some sacrifice in drag.

NACA RM L9L21a

HYDRODYNAMIC FORCE CHARACTERISTICS OF A STREAMLINE FUSELAGE MODIFIED BY EITHER BREAKER STRIPS OR ROWS OF AIR JETS SIMULATING CHINES. Bernard Weinflash, Charles L. Shuford, Jr. and Kenneth W. Christopher. February 21, 1950. 45p. diagrs., photos. (NACA RM L9L21a) (Declassified from Confidential, 8/23/54)

Force tests were made to determine the effect of trim on the resistance, hydrodynamic lift, and hydrodynamic moment of a streamline fuselage modified by either strips or rows of air jets simulating chines. Tests were also made of the model modified by the strips for three load-on-the-water conditions and for the model with the longitudinal curvature of the after half of the fuselage bottom eliminated.

NACA RM L9L23

PRESSURE DISTRIBUTIONS ON THE BLADE SECTIONS OF THE NACA 10-(3)(049)-033 PROPELLER UNDER OPERATING CONDITIONS. W. H. Gray and Robert M. Hunt. February 14, 1950. 120p. diagrs., 11 tabs. (NACA RM L9L23) (Declassified from Confidential, 8/23/54)

Presents unanalyzed data in tabular form obtained from pressure-distribution measurements on one of a family of five related propellers incorporating 16-series blade sections. Nine radial stations were investigated with a variation of thickness ratio from 2.6 percent to 8.9 percent and covering a section Mach number range from 0.375 to 1.197.

NACA RM L9L23a

AN INVESTIGATION OF SEVERAL NACA 1-SERIES NOSE INLETS WITH AND WITHOUT PROTRUDING CENTRAL BODIES AT HIGH-SUBSONIC MACH NUMBERS AND AT A MACH NUMBER OF 1.2. Robert E. Pendley and Harold L. Robinson. February 21, 1950. 53p. diagrs., photos. (NACA RM L9L23a) (Declassified from Confidential, 8/23/54)

Measurements of pressure distribution, drag, and internal-flow pressure loss are presented for three NACA 1-series nose inlets, two of which were fitted with protruded central bodies. Test Mach number and inlet-velocity ratio ranged from 0.4 to 1.2 and from 0 to 1.34, respectively. Nose-inlet pressure drag at a Mach number of 1.2, and central-body effects on subcritical drag, the supercritical drag rise, and inlet total-pressure loss are discussed.

NACA RM L9L28a

AERODYNAMIC INVESTIGATION AT MACH NUMBER 1.92 OF A RECTANGULAR WING AND TAIL AND BODY CONFIGURATION AND ITS COMPONENTS. Macon C. Ellis, Jr. and Carl E. Grigsby. March 1, 1950. 96p. diagrs., photos., 4 tabs. (NACA RM L9L28a) (Declassified from Confidential, 8/23/54)

An investigation at Mach number 1.92 in the Langley 9-inch supersonic tunnel of a variable body-wing-tail configuration has been made in order to determine and to isolate the aerodynamic effects on each other of the components of the configuration. The body had a fineness ratio of 12.5 with a cylindrical midsection so that the aspect-ratio-4 rectangular wing could be located at three longitudinal positions along the body. The variable-incidence-angle rectangular tail was of the same aspect ratio as the wing, but one-fourth the wing area, and could be located at three vertical positions relative to the plane of the wing. The tests included lift, drag, and pitching-moment measurements of all possible elements and combinations of this model.

NACA RM L50A03

LATERAL-CONTROL INVESTIGATION OF FLAP-TYPE CONTROLS ON A WING WITH UNSWEPT QUARTER-CHORD LINE, ASPECT RATIO 4, TAPER RATIO 0.6, AND NACA 65A006 AIRFOIL SECTION. TRANSONIC-BUMP METHOD. Alexander D. Hammond. March 10, 1950. 20p. diagrs. (NACA RM L50A03) (Declassified from Confidential, 8/23/54)

This paper presents the results of a lateral-control investigation of a 30-percent-chord flap-type control having various spans and spanwise locations on a wing with unswept quarter-chord line, aspect ratio 4, taper ratio 0.6, and an NACA 65A006 airfoil section. Rolling moments, pitching moments, and lift of the semispan wing-fuselage were obtained through a Mach number range of 0.7 to 1.15.

NACA RM L50A03a

AN 8-FOOT AXISYMMETRICAL FIXED NOZZLE FOR SUBSONIC MACH NUMBERS UP TO 0.99 AND FOR A SUPERSONIC MACH NUMBER OF 1.2. Virgil S. Ritchie, Ray H. Wright and Marshall P. Tulin. February 23, 1950. 52p. diagrs., photos., 2 tabs. (NACA RM L50A03a) (Declassified from Confidential, 8/23/54)

The design and operating characteristics of an 8-foot-diameter circular nozzle for Mach number 1.2 and for high-subsonic Mach numbers are discussed. The nozzle was carefully designed and adjusted for boundary-layer displacement. The flow in the subsonic and supersonic test sections was satisfactorily uniform for model testing. Consideration was given to disturbances in the flow, irregularities at the wall, humidity effects, and power requirements.

NACA RM L50A12

AERODYNAMIC CHARACTERISTICS OF A WING WITH QUARTER-CHORD LINE SWEPT BACK 60°, ASPECT RATIO 2, TAPER RATIO 0.6, AND NACA 65A006 AIRFOIL SECTION. TRANSONIC-BUMP METHOD. Boyd C. Myers, II and Thomas J. King, Jr. February 24, 1950. 31p. diagrs., photos., tab. (NACA RM L50A12) (Declassified from Confidential, 8/23/54)

This paper presents the results of an investigation by the transonic-bump method of a wing-fuselage combination employing a wing with quarter-chord line swept back 60°, aspect ratio 2, taper ratio 0.6, and NACA 65A006 airfoil. Lift, drag, pitching-moment and root-bending-moment characteristics were obtained for the wing-alone and wing-fuselage configurations over a Mach number range from 0.70 to 1.18. In addition, effective downwash angles and dynamic-pressure characteristics in the region of the tail plane were obtained and are presented for a range of tail heights at one tail length. In order to expedite publishing of these data, only a brief analysis has been made.

NACA RM L50A13

PRELIMINARY INVESTIGATION OF A SUBMERGED AIR SCOOP UTILIZING BOUNDARY-LAYER SUCTION TO OBTAIN INCREASED PRESSURE RECOVERY. Mark R. Nicholas and P. Kenneth Pierpont. March 17, 1950. 77p. diagrs., photos., tab. (NACA RM L50A13) (Declassified from Confidential, 8/23/54)

Presents results of low-speed tests of a submerged inlet consisting essentially of a conventional scoop located in a dimple in the fuselage surface. Boundary-layer-control systems investigated are shown to provide important increases in performance. It appears that the flow instability frequently encountered in the case of twin internally coupled inlets will be avoided for design high-speed inlet-velocity ratios as low as 0.5.

NACA RM L50A17

LATERAL-CONTROL INVESTIGATION OF FLAP-TYPE CONTROLS ON A WING WITH QUARTER-CHORD LINE SWEPT BACK 60°, ASPECT RATIO 4, TAPER RATIO 0.6, AND NACA 65A006 AIRFOIL SECTION. TRANSONIC-BUMP METHOD. Raymond D. Vogler. March 2, 1950. 21p. diagrs. (NACA RM L50A17) (Declassified from Confidential, 8/23/54)

This paper presents the results of a lateral-control investigation of a 30-percent-chord flap-type control of various spanwise magnitudes and locations on a wing of 60° of sweepback of the quarter-chord line, an aspect ratio of 4, a taper ratio of 0.6, and an NACA 65A006 airfoil section. Rolling and pitching moments and lift of the semispan wing-fuselage were obtained through a Mach number range of 0.7 to 1.15.

NACA RM L50A18

AERODYNAMIC CHARACTERISTICS OF A WING WITH UNSWEPT QUARTER-CHORD LINE, ASPECT RATIO 2, TAPER RATIO 0.78, AND NACA 65A004 AIRFOIL SECTION. TRANSONIC-BUMP METHOD. Edward C. Polhamus and George S. Campbell. March 8, 1950. 17p. diagrs., photos., tab. (NACA RM L50A18) (Declassified from Confidential, 8/23/54)

This paper presents the results of an investigation by the transonic-bump method of a wing having an unswept quarter-chord line, aspect ratio 2, taper ratio 0.78, and NACA 65A004 airfoil. Lift, drag, pitching-moment, and root-bending-moment characteristics were obtained over a Mach number range of from 0.60 to 1.17. Experimental values of lift-curve slope, lateral center of pressure, and drag due to lift are compared with available theory.

NACA RM L50A23

A DISCUSSION OF THE DESIGN OF HIGHLY SWEPT PROPELLER BLADES. Richard T. Whitcomb. May 4, 1950. 31p. diagrs., photos. (NACA RM L50A23) (Declassified from Confidential, 8/23/54)

A description of the two swept propellers investigated in the Langley 8-foot high-speed tunnel is presented, together with the discussions of the numerous assumptions and analyses on which the designs of these propellers are based.

NACA RM L50A26

PRESSURE DISTRIBUTIONS ON THE BLADE SECTIONS OF THE NACA 10-(3)(090)-03 PROPELLER UNDER OPERATING CONDITIONS. Peter J. Johnson. March 22, 1950. 90p. diagrs., 10 tabs. (NACA RM L50A26) (Declassified from Confidential, 8/23/54)

Presents unanalyzed data in tabular form obtained from pressure-distribution measurements on one of a family of five related propellers incorporating NACA 16-series blade sections. Pressure distributions were measured at nine radial stations for which blade-section thickness ratio varied from 0.300 to 0.053 and section Mach number varied from 0.28 to 1.18.

NACA RM L50A30

EXPLORATORY INVESTIGATION OF LEADING-EDGE CHORD-EXTENSIONS TO IMPROVE THE LONGITUDINAL STABILITY CHARACTERISTICS OF TWO 52° SWEPTBACK WINGS. G. Chester Furlong. March 10, 1950. 32p. diagrs., photo. (NACA RM L50A30) (Declassified from Confidential, 8/23/54)

Results are presented of exploratory tests obtained with leading-edge wing chord-extensions on two 52° sweptback wings for the purpose of obtaining satisfactory longitudinal stability through the lift range. Both wings exhibit a vortex flow similar to that which has been observed on triangular wings. One wing of aspect ratio 2.8 has circular-arc airfoil sections, and the other wing of aspect ratio 2.9 has NACA 64_1-112 airfoil sections. The tests were conducted at Reynolds numbers in the vicinity of 6.0×10^6.

NACA RM L50A31

WING-FLOW MEASUREMENTS OF LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A CANARD AIRPLANE CONFIGURATION WITH A 45° SWEPTBACK WING AND A TRIANGULAR ALL-MOVABLE CONTROL SURFACE. Harold L. Crane and James J. Adams. August 25, 1950. 53p. diagrs., photo. (NACA RM L50A31) (Declassified from Confidential, 8/23/54)

Presented are lift, pitching-moment, rolling-moment, and drag measurements for a semispan canard configuration for a Mach number range of 0.55 to 1.14 at Reynolds numbers between 225,000 to 575,000. The configuration consisted of a 45° sweptback untapered wing and a triangular control surface mounted on a body of fineness ratio 13.5. The aerodynamic center shift with increasing Mach number was small and the effectiveness of the control surface increased gradually with Mach number with the result that the longitudinal trim and control characteristics in the transonic speed range at low lift coefficients were desirable. Also included are calculated trim curves for various loading conditions and calculated aeroelastic effects.

NACA RM L50B02a

INVESTIGATION OF A SIMPLE DEVICE FOR PREVENTING SEPARATION DUE TO SHOCK AND BOUNDARY-LAYER INTERACTION. Coleman duP. Donaldson. November 29, 1950. 34p. diagrs., photos. (NACA RM L50B02a) (Declassified from Confidential, 8/23/54)

Results are presented of a preliminary investigation of vortex generators introduced into the region of boundary layer to increase the turbulent mixing, in an attempt to prevent separation due to boundary-layer and shock interaction. Prevention of such separation and some of its adverse effects up to Mach numbers ahead of the shock of the order of 1.4 appears possible by means of this simple device. Preliminary flight tests show that this method is effective in controlling shock-induced separation on the wing of an airplane at high speed.

NACA RM L50B03a

AERODYNAMIC CHARACTERISTICS OF A WING WITH QUARTER-CHORD LINE SWEPT BACK 45°, ASPECT RATIO 6, TAPER RATIO 0.6, AND NACA 65A009 AIRFOIL SECTION. TRANSONIC-BUMP METHOD. Kenneth P. Spreemann, William D. Morrison, Jr. and Thomas B. Pasteur, Jr. April 6, 1950. 33p. diagrs., photos., tab. (NACA RM L50B03a) (Declassified from Confidential, 8/23/54)

This paper presents the results of an investigation by the transonic-bump method of a wing alone and a wing-fuselage combination employing a wing with quarter-chord line swept back 45°, aspect ratio 6, taper ratio 0.6, and NACA 65A009 airfoil section. Lift, drag, pitching moment, and root bending moment were obtained for the wing-alone and wing-fuselage configurations over a Mach range of 0.60 to 1.18 and through an angle-of-attack range of -4° to 10°. Effective downwash angles and dynamic-pressure characteristics in the region of the tail plane were also obtained and are presented for a range of tail heights at one tail length.

NACA RM L50B10

THE DAMPING IN ROLL OF ROCKET-POWERED TEST VEHICLES HAVING RECTANGULAR WINGS WITH NACA 65-006 AND SYMMETRICAL DOUBLE-WEDGE AIRFOIL SECTIONS OF ASPECT RATIO 4.5. Albert E. Dietz and James L. Edmondson. March 29, 1950. 12p. diagrs. (NACA RM L50B10) (Declassified from Confidential, 8/23/54)

Experimental determination of damping in roll through a Mach range of 0.85 to 1.45 was conducted for two free-flight models having rectangular wing plan forms and an aspect ratio of 4.5. One model had wings with NACA 65-006 airfoil sections and the other model had wings with 6-percent-thick modified double-wedge airfoil sections.

NACA RM L50B21

PRESSURE DISTRIBUTIONS ON THE BLADE SECTIONS OF THE NACA 10-(5)(066)-03 PROPELLER UNDER OPERATING CONDITIONS. Albert J. Evans and Wallace Luchuk. April 18, 1950. 99p. diagrs., 10 tabs. (NACA RM L50B21) (Declassified from Confidential. 8/23/54)

Presents unanalyzed data in tabular form from pressure distribution measurements on one of a family of five related propellers incorporating NACA 16-series sections. Nine radial stations were investigated which had design lift coefficients of 0.50 and varied in thickness from 16 percent to 4 percent of the chord. The Mach number varied from 0.4 to 1.15.

NACA RM L50C03

PRESSURE DISTRIBUTIONS ON THE BLADE SECTIONS OF THE NACA 10-(0)(066)-03 PROPELLER UNDER OPERATING CONDITIONS. Seymour Steinberg and Robert W. Milling. May 18, 1950. 89p. diagrs., 11 tabs. (NACA RM L50C03) (Declassified from Confidential, 8/23/54)

Presents unanalyzed data in tabular form obtained from pressure-distribution measurements on one of five related propellers incorporating NACA 16-series blade sections. Pressure distributions were measured at nine radial stations for which blade-section thickness ratio varied from 0.04 to 0.10 and section Mach number varied from 0.35 to 1.14.

NACA RM L50C16

AERODYNAMIC CHARACTERISTICS OF A WING WITH UNSWEPT QUARTER-CHORD LINE, ASPECT RATIO 4, TAPER RATIO 0.6, AND NACA 65A004 AIRFOIL SECTION. TRANSONIC-BUMP METHOD. Boyd C. Myers, II and James W. Wiggins. May 8, 1950. 31p. diagrs., photos., tab. (NACA RM L50C16) (Declassified from Confidential, 8/23/54)

This paper presents the results of an investigation by the transonic-bump method of a wing and wing-fuselage combination employing a wing with unswept quarter-chord line, aspect ratio 4, taper ratio 0.6, and NACA 65A004 airfoil section parallel to free stream. Lift, drag, pitching-moment, and root-bending-moment characteristics were obtained for the two configurations over a Mach number range from about 0.60 to 1.15. In addition, effective downwash angles and dynamic-pressure characteristics in the region of the tail plane were obtained and presented for a range of tail heights at one tail length.

NACA RM L50C21

AERODYNAMIC CHARACTERISTICS WITH FIXED AND FREE TRANSITION OF A MODIFIED DELTA WING IN COMBINATION WITH A FUSELAGE AT HIGH SUBSONIC SPEEDS. Edward C. Polhamus and Thomas J. King, Jr. May 2, 1950. 19p. diagrs., photos. (NACA RM L50C21) (Declassified from Confidential, 8/23/54)

An investigation has been made in the Langley high-speed 7- by 10-foot tunnel to determine the aerodynamic characteristics at high subsonic speeds of a modified delta wing with an aspect ratio of 3, a taper ratio of 0.313, a sweepback of 27.7°, and an NACA 64_1A012 airfoil section in combination with a fuselage. Lift, drag, and pitching-moment characteristics with free- and fixed-transition are presented through a Mach number range of 0.40 to 0.90.

NACA RM L50C22

AERODYNAMIC AND LATERAL-CONTROL CHARACTERISTICS OF A 1/28-SCALE MODEL OF THE BELL X-1 AIRPLANE WING-FUSELAGE COMBINATION. TRANSONIC-BUMP METHOD. Vernard E. Lockwood. May 5, 1950. 28p. diagrs., tab. (NACA RM L50C22) (Declassified from Confidential, 8/23/54)

This paper presents the lateral-control characteristics and the pitching-moment characteristics of a 1/28-scale model of the X-1 wing-fuselage configuration. The tests were made in the transonic speed range from a Mach number of 0.60 to 1.15 in the Langley high-speed 7- by 10-foot tunnel utilizing the transonic bump. Comparisons have been made between the wind-tunnel results and the flight-test results of the rolling effectiveness, pitching-moment

characteristics, and lateral centers of pressure. The estimations of rolling effectiveness were made using the damping in roll and aileron effectiveness experimentally determined.

NACA RM L50C28

MAXIMUM-LIFT INVESTIGATION OF A 1/40-SCALE X-1 AIRPLANE WING AT MACH NUMBERS FROM 0.60 TO 1.15. Thomas R. Turner. April 21, 1950. 18p. diagrs. (NACA RM L50C28) (Declassified from Confidential, 8/23/54)

This paper contains the lift, drag, and pitching-moment characteristics up to a maximum lift of a 1/40-scale model of the X-1 airplane wing (8-percent-thick wing), also some comparisons with flight results. The Mach number varied from 0.60 to 1.15 with the Reynolds number varying from 415,000 to 533,000.

NACA RM L50D05

AERODYNAMIC CHARACTERISTICS AT A MACH NUMBER OF 1.25 OF A 6-PERCENT-THICK TRIANGULAR WING AND 6- AND 9-PERCENT-THICK TRIANGULAR WINGS IN COMBINATION WITH A FUSELAGE. WING ASPECT RATIO 2.31, BICONVEX AIRFOIL SECTIONS. Albert W. Hall and Garland J. Morris. May 5, 1950. 22p. diagrs., photo., 2 tabs. (NACA RM L50D05) (Declassified from Confidential, 8/23/54)

Tests were made by the NACA wing-flow method on two wing-fuselage models with delta wings of aspect ratio 2.31, 6- and 9-percent-thick biconvex sections, and on the 6-percent-thick wing alone. Lift, drag, pitching-moment, and angle-of-attack measurements are presented for these configurations and some comparisons are made with subsonic and supersonic data from other sources. The test Mach number was 1.25 and the Reynolds number was about 8.8×10^5.

NACA RM L50D19

LOW-SPEED INVESTIGATION OF DEFLECTABLE WING-TIP ELEVATORS ON A LOW-ASPECT-RATIO UNTAPERED 45° SWEPTBACK SEMISPAN WING WITH AND WITHOUT AN END PLATE. Jack Fischel and William M. O'Hare. June 1, 1950. 21p. diagrs., photo. (NACA RM L50D19) (Declassified from Confidential, 8/23/54)

Results and discussion are presented of a low-speed investigation of triangular- and parallelogrammic-plan-form deflectable wing-tip elevators on an untapered 45° sweptback semispan wing with and without a rectangular end plate (simulating a vertical fin) mounted on the wing inboard of the elevators. Lift, drag, and pitching-moment data were obtained through a large angle-of-attack range and a large elevator-deflection range for each elevator plan form on the plain wing and the wing with end plate. Estimated pitching-moment data were compared with experimental data for the two elevator plan forms.

NACA RM L50D20

FLIGHT INVESTIGATION OF THE AILERON CHARACTERISTICS OF THE DOUGLAS D-558-I AIRPLANE (BUAERO NO. 37972) AT MACH NUMBERS BETWEEN 0.6 AND 0.89. Jim Rogers Thompson, William S. Roden and John M. Eggleston. May 26, 1950. 23p. diagrs., photos., tab. (NACA RM L50D20) (Declassified from Confidential, 8/23/54)

Measurements of the aileron effectiveness of the Douglas D-558-I airplane (BuAero No. 37972) indicate that there is no change in aileron effectiveness with Mach number between Mach numbers of 0.6 and 0.89.

NACA RM L50D21

INVESTIGATION OF THE NACA 3-(3)(05)-05 EIGHT-BLADE DUAL-ROTATING PROPELLER AT FORWARD MACH NUMBERS TO 0.925. Robert J. Platt, Jr. and Robert A. Shumaker. June 19, 1950. 42p. diagrs., photo. (NACA RM L50D21) (Declassified from Confidential, 8/23/54)

Force-test results are presented for the NACA 3-(3)(05)-05 eight-blade dual propeller, which was designed for a blade angle of approximately 75°. The tests covered a blade-angle range from 55° to 80° at Mach numbers to 0.925. Some data on the effect of small changes in the rear-propeller blade angle are included. Good efficiencies were obtained at high subsonic Mach numbers by operation at high blade angles.

NACA RM L50D24

A TECHNIQUE UTILIZING ROCKET-PROPELLED TEST VEHICLES FOR THE MEASUREMENT OF THE DAMPING IN ROLL OF STING-MOUNTED MODELS AND SOME INITIAL RESULTS FOR DELTA AND UNSWEPT TAPERED WINGS. William M. Bland, Jr. and Carl A. Sandahl. June 13, 1950. 31p. diagrs., photos., tab. (NACA RM L50D24) (Declassified from Confidential, 8/23/54)

A technique with which the damping in roll of sting-mounted models can be measured over the subsonic, transonic, and supersonic speed range with rocket-propelled test vehicles is described. Initial results for delta and unswept tapered wings are presented and compared with theory.

NACA RM L50D28

EFFECT OF COMPRESSIBILITY AND CAMBER AS DETERMINED FROM AN INVESTIGATION OF THE NACA 4-(3)(08)-03 AND 4-(5)(08)-03 TWO-BLADE PROPELLERS UP TO FORWARD MACH NUMBERS OF 0.925. Melvin M. Carmel, Francis G. Morgan, Jr. and Domenic A. Coppolino. June 29, 1950. 92p. diagrs., photo. (NACA RM L50D28) (Declassified from Confidential, 8/23/54)

Section-thrust-coefficient data are presented for forward Mach numbers up to 0.925 for the NACA 4-(3)(08)-03 propeller for blade angles of 55° to 65° and for the NACA 4-(5)(08)-03 propeller for blade angles of 40° to 65°. A comparison of these results with force-test results is made.

NACA RM L50E09

LATERAL-CONTROL INVESTIGATION OF FLAP-TYPE AND SPOILER-TYPE CONTROLS ON A WING WITH QUARTER-CHORD-LINE SWEEPBACK OF 60°, ASPECT RATIO 2, TAPER RATIO 0.6, AND NACA 65A006 AIRFOIL SECTION. TRANSONIC-BUMP METHOD. Alexander D. Hammond. July 18, 1950. 26p. diagrs. (NACA RM L50E09) (Declassified from Confidential, 8/23/54)

This paper presents the results of a lateral-control investigation of a 30-percent-chord flap-type control and a plain spoiler-type control of 5-percent-chord projection, each having various span and spanwise locations on a wing with a quarter-chord line swept back 60°, aspect ratio 2, taper ratio 0.6, and an NACA 65A006 airfoil section parallel to free stream. Rolling and pitching moments and lift of the semispan wing-fuselage were obtained through a Mach number range of 0.17 to 1.15 with flap-type controls, and lift, drag, pitching moment, rolling moment, and yawing moment of the semispan wing-fuselage were obtained through a Mach number range of 0.6 to 1.15 with the spoiler-type controls.

NACA RM L50E19a

FLIGHT INVESTIGATION AT MACH NUMBERS FROM 0.6 to 1.7 TO DETERMINE DRAG AND BASE PRESSURES ON A BLUNT-TRAILING-EDGE AIRFOIL AND DRAG OF DIAMOND AND CIRCULAR-ARC AIRFOILS AT ZERO LIFT. John D. Morrow and Ellis Katz. August 11, 1950. 25p. diagrs., photos. (NACA RM L50E19a) (Declassified from Confidential, 8/23/54)

Results of an exploratory free-flight investigation at zero lift of several rocket-powered drag-research models having rectangular 6-percent-thick wings are presented for a Mach number range of 0.6 to 1.7. Wings having diamond, circular-arc, and blunt-trailing-edge airfoil sections were tested. Pressures over the base of the blunt-trailing-edge airfoil were measured. The drags of all the models were measured and are compared with theory in this paper.

NACA RM L50E26

DAMPING IN ROLL OF RECTANGULAR WINGS OF SEVERAL ASPECT RATIOS AND NACA 65A-SERIES AIRFOIL SECTIONS OF SEVERAL THICKNESS RATIOS AT TRANSONIC AND SUPERSONIC SPEEDS AS DETERMINED WITH ROCKET-POWERED MODELS. James L. Edmondson. August 24, 1950. 16p. diagrs. (NACA RM L50E26) (Declassified from Confidential, 8/23/54)

The damping in roll has been determined for a series of rectangular wings of various aspect ratios and thickness ratios through use of rocket-powered models and the canted-nozzle technique. An empirical thickness correction factor has been derived to be used with existing linear supersonic damping-in-roll theory to allow closer prediction of experimental damping for limited cases.

NACA RM L50F01

RESULTS OF FLIGHT TESTS TO DETERMINE THE ZERO-LIFT DRAG CHARACTERISTICS OF A 60° DELTA WING WITH NACA 65-006 AIRFOIL SECTION AND VARIOUS DOUBLE-WEDGE SECTIONS AT MACH NUMBERS FROM 0.7 TO 1.6. Clement J. Welsh. August 11, 1950. 15p. diagrs., photo. (NACA RM L50F01) (Declassified from Confidential, 8/23/54)

Results of an exploratory free-flight investigation at zero lift of several rocket-powered drag research models equipped with 60° sweptback delta wings are presented for a Mach number range from about 0.70 to 1.60. The airfoil sections tested included the NACA 65-006 and a series of double-wedge sections with various positions of maximum thickness.

NACA RM L50F19

LOW-SPEED TESTS OF A MODEL SIMULATING THE PHENOMENON OF CONTROL-SURFACE BUZZ. William H. Phillips and James J. Adams. August 16, 1950. 16p. diagrs., photo. (NACA RM L50F19) (Declassified from Confidential, 8/23/54)

Low-speed tests have been made of an airfoil model with a freely hinged flap connected to spoilers which passed through slots in the airfoil ahead of the hinge line. Under certain conditions, continuous oscillations of the flap, similar to buzz, were obtained. This result indicates that flow separation may be an important factor in producing buzz at transonic speeds.

NACA RM L50F19a

SPIN AND RECOVERY CHARACTERISTICS OF A MODEL OF A FIGHTER TYPE OF AIRPLANE WITHOUT A HORIZONTAL TAIL AND HAVING EITHER A SINGLE VERTICAL TAIL OR TWIN VERTICAL TAILS. Lawrence J. Gale and Norman E. Pumphrey. July 25, 1950. 23p. diagrs., photos., 2 tabs. (NACA RM L50F19a) (Declassified from Confidential, 8/23/54)

The investigation indicated similar spin and recovery characteristics for either tail configuration tested at a given mass distribution. For a mass distribution chiefly along the wings, the vertical tail surfaces were not adequate for recovery from the spin. When the mass was distributed chiefly along the fuselage, however, either vertical-tail configuration, when in a rearward position, was effective in satisfactorily terminating the spin.

NACA RM L50F26
National Advisory Committee for Aeronautics. MEASUREMENTS OF THE EFFECT OF TRAILING-EDGE THICKNESS ON THE ZERO-LIFT DRAG OF THIN LOW-ASPECT-RATIO WINGS. John D. Morrow. August 14, 1950. 12p. diagrs., photo. (NACA RM L50F26) (Declassified from Confidential, 8/23/54)

Results of an exploratory free-flight investigation at zero lift of several rocket-powered drag-research models having 4-percent-thick wings of 0.423 taper ratio are presented for a Mach number range of 0.7 to 1.6. Four wings having trailing edges of different thickness were tested. The drag of all the models was measured and is compared with calculated values in this paper.

NACA RM L50F26a

SOME CALCULATIONS OF THE LATERAL RESPONSE OF TWO AIRPLANES TO ATMOSPHERIC TURBULENCE WITH RELATION TO THE LATERAL SNAKING PROBLEM. John D. Bird. August 25, 1950. 24p. diagrs., 2 tabs. (NACA RM L50F26a) (Declassified from Confidential, 8/23/54)

Calculations are made of the lateral response to representative time histories of atmospheric turbulence for two airplanes having widely different dynamic properties; explanations for their difference in behavior are given. The results are discussed in relation to lateral snaking.

NACA RM L50F30

A THEORETICAL INVESTIGATION OF THE INFLUENCE OF AUXILIARY DAMPING IN PITCH ON THE DYNAMIC CHARACTERISTICS OF A PROPORTIONALLY CONTROLLED SUPERSONIC CANARD MISSILE CONFIGURATION. Walter C. Nelson and Anthony L. Passera. August 25, 1950. 46p. diagrs., photo., 3 tabs. (NACA RM L50F30) (Declassified from Confidential, 8/23/54)

A theoretical investigation is presented of the dynamic characteristics of a supersonic canard missile configuration with auxiliary damping in pitch obtained from rate gyro-servo control. Variations in Mach number, altitude, and static margin are considered. Satisfactory system performance is obtained throughout a Mach number and altitude range when additional damping is included in the missile.

NACA RM L50F30a

FLIGHT TESTS AT SUPERSONIC SPEEDS TO DETERMINE THE EFFECT OF TAPER ON THE ZERO-LIFT DRAG OF SWEPTBACK LOW-ASPECT-RATIO WINGS. Murray Pittel. September 5, 1950. 23p. diagrs., photos. (NACA RM L50F30a) (Declassified from Confidential, 8/23/54)

Comparison of experimental flight-test results with theoretical calculations to determine the effect of wing taper and aspect ratio on the zero-lift drag of wings with thin double-wedge sections at supersonic speeds is presented.

NACA RM L50G03

INVESTIGATION OF FLAP-TYPE AILERONS ON AN UNTAPERED WING HAVING AN ASPECT RATIO OF 3.7, 45° SWEEPBACK, AND AN NACA 65A009 AIRFOIL SECTION. TRANSONIC-BUMP METHOD. Richard G. MacLeod. August 23, 1950. 18p. diagrs. (NACA RM L50G03) (Declassified from Confidential, 8/23/54)

This paper presents the results of an investigation to determine the lateral control characteristics of 20-percent-chord flap-type control surfaces of various spans on a semispan wing-fuselage model by the transonic-bump method. The model employed a wing with a sweepback of 45°, an aspect ratio 3.7, a taper ratio of 1.0, and an NACA 65A009 airfoil section parallel to the free stream. Rolling moments were obtained through a small range of angle of attack and control-surface deflections. Lift data on the complete model are also included. The experimental results were in good agreement with those predicted from low-speed theory and other experimental data at a Mach number of 0.6, and the relative spanwise effectiveness of the aileron remained fairly constant throughout the Mach number range tested.

NACA RM L50G11

LOW-SPEED STATIC STABILITY CHARACTERISTICS OF A CANARD MODEL WITH A 45° SWEPTBACK WING AND A 60° TRIANGULAR HORIZONTAL CONTROL SURFACE. John W. Draper. September 6, 1950. 43p. diagrs., photo., 2 tabs. (NACA RM L50G11) (Declassified from Confidential, 8/23/54)

This paper contains results of an investigation made to determine the low-speed static stability characteristics of a canard model having a 45° sweptback untapered wing and a 60° triangular-plan-form horizontal control surface.

NACA RM L50G13a

INVESTIGATION AT TRANSONIC SPEEDS OF A 35-PERCENT-CHORD AILERON ON A TAPERED WEDGE-TYPE WING OF ASPECT RATIO 2.5 WITH AND WITHOUT A FUSELAGE. Thomas R. Turner and Joseph E. Fikes. September 8, 1950. 25p. diagrs. (NACA RM L50G13a) (Declassified from Confidential, 8/23/54)

This paper presents the results of an investigation to determine the effects of fuselage diameter on some of the aerodynamic characteristics of an unswept wing having a modified double-wedge section, an aspect ratio of 2.5, and a taper ratio of 0.625. Rolling moment coefficients for a 35-percent-chord aileron of various spans along with some lift, drag, and pitching moment coefficient data are presented for the wing with a fuselage of two different diameters and without a fuselage through a Mach number range from 0.60 to 1.18. Estimated and experimental values of aileron effectiveness are presented at a Mach number of 0.60.

NACA RM L50G14

AERODYNAMIC CHARACTERISTICS AT A MACH NUMBER OF 1.38 OF FOUR WINGS OF ASPECT RATIO 4 HAVING QUARTER-CHORD SWEEP ANGLES OF 0°, 35°, 45°, AND 60°. William B. Kemp, Jr., Kenneth W. Goodson and Robert A. Booth. October 10, 1950. 41p. diagrs., photos., tab. (NACA RM L50G14) (Declassified from Confidential, 8/23/54)

This paper presents a description of the Langley 6-inch supersonic tunnel together with the results of an investigation made at a Mach number of 1.38 of a series of wings having an aspect ratio 4, taper ratio 0.6, and an NACA 65A006 airfoil section. Lift, drag, pitching-moment, and bending-moment data were obtained for wing alone and wing-body configurations. Comparisons are made between experimental and theoretical lift-curve slopes and stability characteristics.

NACA RM L50G14a

THE EXTERNAL-SHOCK DRAG OF SUPERSONIC INLETS HAVING SUBSONIC ENTRANCE FLOW. Louis M. Nucci. December 20, 1950. 28p. diagrs., photos. (NACA RM L50G14a) (Declassified from Confidential, 8/23/54)

The external-shock drag at a Mach number of 2.70 has been determined by two methods for a circular inlet having low external compression at various mass-flow conditions and for a circular inlet having high external compression. The results indicate a large increase in external shock drag for both inlets at subdesign mass flows, with the drag of the external compression type being considerably higher for comparable mass-flow reduction than that of the inlet having low external compression. A simple approximate method of calculating the external-shock drag is described which is more easily applied than the procedure using characteristics if the entering mass flow and the shock configuration are both known.

NACA RM L50G18

THE CALCULATION OF THE PATH OF A JETTISONABLE NOSE SECTION. Roscoe H. Goodwin. September 7, 1950. 35p. diagrs. (NACA RM L50G18) (Declassified from Confidential, 8/23/54)

A method is presented for calculating the path of a jettisonable nose section at any speed by means of successive approximations (solved graphically) using static aerodynamic characteristics. Comparisons with experimentally determined paths are presented, and the method is applied to the problem of finding the path of a nose section that is jettisoned by use of rockets.

NACA RM L50G24

FLIGHT MEASUREMENTS OF DRAG AND BASE PRESSURE OF A FIN-STABILIZED PARABOLIC BODY OF REVOLUTION (NACA RM-10) AT DIFFERENT REYNOLDS NUMBERS AND AT MACH NUMBERS FROM 0.9 TO 3.3. H. Herbert Jackson, Charles B. Rumsey and Leo T. Chauvin. September 1, 1950. 21p. diagrs., photos. (NACA RM L50G24) (Declassified from Confidential, 8/23/54)

Free-flight tests at supersonic speeds have been made to determine the Reynolds number effects on total drag and base drag of a fin-stabilized parabolic-arc body of revolution having a body fineness ratio of 12.2 and designated the NACA RM-10 configuration. The Reynolds number range of 14×10^6 to 210×10^6 was obtained by testing full-scale and half-scale models through the Mach number range from 0.9 to 3.3.

NACA RM L50H03

PROPELLER SECTION AERODYNAMIC CHARACTERISTICS AS DETERMINED BY MEASURING THE SECTION SURFACE PRESSURES ON AN NACA 10-(3)(08)-03 PROPELLER UNDER OPERATING CONDITIONS. Albert J. Evans. November 8, 1950. 162p. diagrs., 10 tabs. (NACA RM L50H03) (Declassified from Confidential, 8/23/54)

This investigation presents propeller section aerodynamic characteristics obtained by measurement of the section surface pressure distribution at nine radial stations on an operating propeller blade. The results are compared with results from tests with two-dimensional airfoils and cover a range of Mach numbers from 0.20 to 1.15 for angles of attack from -1° to 12° for NACA 16-series airfoils.

NACA RM L50H07

LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS AT HIGH-SUBSONIC SPEEDS OF TWO MODELS OF A TRANSONIC RESEARCH AIRPLANE WITH WINGS AND HORIZONTAL TAILS OF ASPECT RATIOS 4.2 AND 2. Arvo A. Luoma and John B. Wright. September 29, 1950. 134p. diagrs., photos., 3 tabs. (NACA RM L50H07) (Declassified from Confidential, 8/23/54)

This paper contains longitudinal stability and control characteristics of two 1/16-scale models of a transonic research airplane tested with no nose-inlet flow. Aspect ratio was the main variable. Various horizontal-tail incidences and elevator deflections were tested. The tests were made up to a Mach number of approximately 0.95 in the Langley 8-foot high-speed tunnel.

NACA RM L50H09

MEASUREMENTS OF AERODYNAMIC CHARACTERISTICS OF A 35° SWEPTBACK NACA 65-009 AIRFOIL MODEL WITH 1/4-CHORD FLAP HAVING A 31-PERCENT-FLAP-CHORD OVERHANG BALANCE BY THE NACA WING-FLOW METHOD. Harold I. Johnson and Harold R. Goodman. September 25, 1950. 38p. diagrs., photo. (NACA RM L50H09) (Declassified from Confidential, 8/23/54)

Lift, pitching-moment, and hinge-moment data obtained from wing-flow tests of a low-aspect-ratio sweptback-airfoil model having a full-span 1/4-chord overhang-balanced flap are presented. Mach number range was 0.55 to 1.15. Comparisons are made with previously unpublished data from tests of a plain-flap model. Conclusion is that 31-percent-flap-chord overhang balance tested was relatively ineffective for reducing hinge moments below a Mach number of 1.00 and totally ineffective between Mach numbers of 1.00 and 1.15.

NACA RM L50H11

EFFECTS OF SWEEP ON THE MAXIMUM-LIFT CHARACTERISTICS OF FOUR ASPECT-RATIO-4 WINGS AT TRANSONIC SPEEDS. Thomas R. Turner. October 3, 1950. 25p. diagrs. (NACA RM L50H11) (Declassified from Confidential, 8/23/54)

An investigation at transonic speeds has been made to determine the effect of wing sweep on the maximum lift characteristics of a series of wings having an aspect ratio of 4, a taper ratio of 0.6, and the quarter-chord line swept back 0°, 35°, 45°, and 60°. The Mach number varied from 0.61 to 1.20 with a Reynolds number variation from 380,000 to 460,000. Lift data are presented from approximately zero lift to beyond maximum lift. Drag and pitching-moment data are also presented.

NACA RM L50H15

LOW-SPEED INVESTIGATION OF A SEMISUBMERGED AIR SCOOP WITH AND WITHOUT BOUNDARY-LAYER SUCTION. P. Kenneth Pierpont and Robert R. Howell. February 23, 1951. 46p. diagrs., photos., 2 tabs. (NACA RM L50H15) (Declassified from Confidential, 8/23/54)

This investigation presents results at low-speed tests of a half-submerged inlet consisting of a conventional scoop located in a depression in the fuselage surface. Boundary-layer-control systems investigated are shown to provide increases in impact-pressure ratio up to 8 percent at $V_i/V_O = 0.6$. The impact-pressure recovery of a partly submerged inlet appears to exceed that of a submerged inlet in the inlet-velocity-ratio range suitable for high-speed operation.

NACA RM L50H22

TRANSONIC DRAG CHARACTERISTICS OF A WING-BODY COMBINATION USING A THIN TAPERED WING OF 45° SWEEPBACK. Max C. Kurbjun and Stanley Faber. September 28, 1950. 14p. diagrs., photo., tab. (NACA RM L50H22) (Declassified from Confidential, 8/23/54)

Contains drag measurements by the free-fall method for a wing-body combination and its components employing a wing of 0.2 taper ratio, NACA 65003 airfoil section (perpendicular to midchord line), 45° sweepback (midchord line), and a fineness-ratio-12 body.

NACA RM L50H23

PRELIMINARY EMPIRICAL DESIGN REQUIREMENTS FOR THE PREVENTION OF TUMBLING OF AIRPLANES HAVING NO HORIZONTAL TAILS. Robert L. Bryant. October 11, 1950. 23p. diagrs., 2 tabs. (NACA RM L50H23) (Declassified from Confidential, 8/23/54)

An investigation has been made of the design characteristics and loadings that are conducive to the tumbling of airplanes that have no horizontal tails. Preliminary empirical design requirements based on model tests of 18 different configurations are presented. A brief explanation of the phenomenon of tumbling is appended.

NACA RM L50H24

AN INVESTIGATION OF THREE TRANSONIC FUSELAGE AIR INLETS AT MACH NUMBERS FROM 0.4 TO 0.94 AND AT A MACH NUMBER OF 1.19. Robert E. Pendley, Harold L. Robinson and Claude V. Williams. November 7, 1950. 51p. diagrs., photos., 3 tabs. (NACA RM L50H24) (Declassified from Confidential, 8/23/54)

Measurements of internal-flow pressure recovery, external-surface pressures, and external drag are presented for three fuselage-side inlets designed for use at transonic speeds. The test Mach number and inlet-velocity ratio ranged from 0.4 to 1.19 and from 0 to 1.9, respectively. The investigation showed that the maximum value of the impact-pressure recovery was high at all Mach numbers. The use of a higher critical Mach number external shape increased the supercritical drag-rise Mach number, decreased the supercritical drag, and reduced the drag at the supersonic Mach number.

NACA RM L50H28a

EFFECT OF AN END PLATE ON THE AERODYNAMIC CHARACTERISTICS OF A 20.55° SWEPTBACK WING WITH AN ASPECT RATIO OF 2.67 AND A TAPER RATIO OF 0.5. TRANSONIC-BUMP METHOD. James M. Watson. December 21, 1950. 15p. diagrs., photo. (NACA RM L50H28a) (Declassified from Confidential, 8/23/54)

This paper contains the results of an investigation of two wings having an aspect ratio of 2.67, a sweepback of 20.55°, and a taper ratio of 0.5, one wing with and one wing without an end plate. A Mach number range of 0.60 to 1.18 was attained by use of the transonic-bump technique.

NACA RM L50H30a

DAMPING IN YAW AND STATIC DIRECTIONAL STABILITY OF A CANARD AIRPLANE MODEL AND OF SEVERAL MODELS HAVING FUSELAGES OF RELATIVELY FLAT CROSS SECTION. Joseph L. Johnson. October 16, 1950. 20p. diagrs., tab. (NACA RM L50H30a) (Declassified from Confidential, 8/23/54)

Contains results of damping-in-yaw and static-directional-stability tests for flat-fuselage models having major axis horizontal and vertical, for a flat-fuselage model with major axis horizontal in combination with a 45° sweptback wing, and for a canard model having a triangular horizontal control surface and a 45° sweptback wing. The effect of a vertical tail located at the rear of the fuselage was determined for each model investigated.

NACA RM L50I01

LOW-SPEED WIND-TUNNEL INVESTIGATION OF A TRIANGULAR SWEPTBACK AIR INLET IN THE ROOT OF A 45° SWEPTBACK WING. Arvid L. Keith, Jr. and Jack Schiff. November 6, 1950. 71p. diagrs., photos., 5 tabs. (NACA RM L50I01) (Declassified from Confidential, 8/23/54)

Results of a low-speed study of a 45° sweptback wing-root air-inlet configuration believed suitable for transonic speed airplanes are presented. The inlet configuration lift and drag characteristics are compared with those of a basic model. Boundary-layer growth along the fuselage nose, inlet total-pressure recoveries, and static-pressure distributions over the inlet and wing surfaces are presented for wide ranges of inlet-velocity ratio and angle of attack.

NACA RM L50I05

EFFECTS ON THE LATERAL OSCILLATION OF FIXING THE RUDDER AND REFLEXING THE FLAPS ON THE BELL X-1 AIRPLANE. Hubert M. Drake. December 11, 1950. 14p. diagrs., photo. (NACA RM L50I05) (Declassified from Confidential, 8/23/54)

In flight tests of the Bell X-1 airplane at a Mach number of 0.85 it has been found that fixing the rudder reduced the amplitude of the snaking oscillation, but did not eliminate it. It was also found that reflexing the wing flaps to change the inclination of the principal axis of inertia increased the dynamic lateral stability, but had only a small effect on the snaking oscillation.

NACA RM L50I08a

FLIGHT INVESTIGATION AT MACH NUMBERS FROM 0.8 TO 1.5 TO DETERMINE THE EFFECTS OF NOSE BLUNTNESS ON THE TOTAL DRAG OF TWO FIN-STABILIZED BODIES OF REVOLUTION. Roger G. Hart. October 16, 1950. 12p. diagrs., photos., 2 tabs. (NACA RM L50I08a) (Declassified from Confidential, 8/23/54)

Values of total-drag coefficient were measured for two fin-stabilized, blunt-nose bodies of revolution in free flight at Mach numbers from 0.8 to 1.5. The blunt-nose bodies were designed by rounding off the sharp noses of bodies, having nose fineness ratios of about 3-1/2, to radii equal to about 1/4 the maximum radii. No increase in the drag of either body was found.

NACA RM L50I28a

FLIGHT MEASUREMENTS OF BASE PRESSURE ON BODIES OF REVOLUTION WITH AND WITHOUT SIMULATED ROCKET CHAMBERS. Robert F. Peck. November 16, 1950. 21p. diagrs., photos. (NACA RM L50I28a) (Declassified from Confidential, 8/23/54)

Base pressures were measured on fin-stabilized bodies of revolution with and without rocket chambers and with and without a converging afterbody. At Mach numbers between 0.7 and 1.2, the results show that the presence of a "cold" rocket chamber increased the pressure (less suction) over the center portion of the bases. The effects of rocket chambers on pressures near the edge of the bases were not as consistent throughout the Mach number range nor as appreciable at most speeds as were the effects on pressures measured on the center line.

NACA RM L50J02

A PRELIMINARY FLIGHT INVESTIGATION OF THE EFFECTS OF VORTEX GENERATORS ON SEPARATION DUE TO SHOCK. Lindsay J. Lina and Wilmer H. Reed, III. November 30, 1950. 30p. diagrs., photos., tab. (NACA RM L50J02) (Declassified from Confidential, 8/23/54)

A preliminary flight investigation showed that several configurations of vortex generators mounted on the upper surface of a modified wing of an F-51D airplane reduced separation caused by shock.

NACA RM L50J05

A WIND-TUNNEL INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS OF A FULL-SCALE SWEPTBACK PROPELLER AND TWO RELATED STRAIGHT PROPELLERS. Albert J. Evans and George Liner. January 4, 1951. 102p. diagrs., photos., tab. (NACA RM L50J05) (Declassified from Confidential, 8/31/54)

Propeller aerodynamic characteristics are presented and a brief description of the NACA 10-(1.7)(062) -057-27 two-blade swept propeller and two related straight propellers is included. An increase of about 6 percent in the value of helical tip Mach number at which compressibility losses become manifest was realized by the use of sweep. Analysis of the results warns against pseudo gains attained by the use of sweep in propellers at the expense of overall performance.

NACA RM L50J06

INVESTIGATION OF A 42.7° SWEPTBACK WING MODEL TO DETERMINE THE EFFECTS OF TRAILING-EDGE THICKNESS ON THE AILERON HINGE-MOMENT AND FLUTTER CHARACTERISTICS AT TRANSONIC SPEEDS. Robert F. Thompson. December 26, 1950. 42p. diagrs., photos., 2 tabs. (NACA RM L50J06) (Declassified from Confidential, 8/31/54)

A wind-tunnel investigation of a semispan wing-fuselage model having 42.7° of sweepback of the wing leading edge was made through a speed range to a Mach number of 0.60 to 1.175. The 0.20-chord outboard aileron was tested with three trailing-edge to hinge-line thickness ratios ($t = 0$, $t = 0.5$, and $t = 1.0$) to determine the effects on hinge moments and one-degree-of-freedom aileron flutter. Presented are hinge-moment data, hinge-moment parameters, and aileron free-floating characteristics. A comparison of the flutter frequency is made with two previously published empirical analyses.

NACA RM L50J10

TABULATED PRESSURE COEFFICIENTS AND AERODYNAMIC CHARACTERISTICS MEASURED IN FLIGHT ON THE WING OF THE DOUGLAS D-558-I AIRPLANE FOR A 1 g STALL, A SPEED RUN TO A MACH NUMBER OF 0.90, AND A WIND-UP TURN AT A MACH NUMBER OF 0.86. Earl R. Keener and Mary Pierce. December 15, 1950. 40p. diagrs., photos., 5 tabs. (NACA RM L50J10) (Declassified from Confidential, 8/31/54)

Presents tabulated pressure coefficients and aerodynamic characteristics measured in flight on the right wing of the Douglas D-558-I airplane for a 1 g stall, a speed run to a Mach number of 0.90, and a wind-up turn at a Mach number of 0.86.

NACA RM L50J12

DRAG INVESTIGATION OF SOME FIN CONFIGURATIONS FOR BOOSTER ROCKETS AT MACH NUMBERS BETWEEN 0.5 AND 1.4. John C. McFall, Jr. November 21, 1950. 17p. diagrs., photos., tab. (NACA RM L50J12) (Declassified from Confidential, 8/31/54)

This paper presents the results of an investigation using rocket-propelled free-flight models to furnish drag data for booster drag estimates and to determine the drag of various booster fin configurations. Model booster fins of a type extensively used by the NACA were flown through a Mach number range of 0.5 to 1.4. Two booster plan forms were investigated: one with aspect ratio 2.04, taper ratio 0.37, and having various tie-rod bracing and the other, a cantilever design, with aspect ratio 3.20 and taper ratio 0.32.

NACA RM L50J17

SKIN-TEMPERATURE TELEMETER FOR DETERMINING BOUNDARY-LAYER HEAT-TRANSFER COEFFICIENTS. Clifford L. Fricke and Francis B. Smith. March 15, 1951. 22p. diagrs. (NACA RM L50J17) (Declassified from Confidential, 8/31/54)

A method of experimentally determining boundary-layer heat-transfer coefficients by telemetering the skin temperatures of supersonic rockets is given. A platinum resistance wire temperature sensing element developed to indicate accurately the rapidly changing skin temperature is described and the overall accuracy of the instrumentation is discussed.

NACA RM L50J18

INVESTIGATION AT SUPERSONIC SPEEDS OF SOME OF THE FACTORS AFFECTING THE FLOW OVER A RECTANGULAR WING WITH SYMMETRICAL CIRCULAR-ARC SECTION AND 30-PERCENT-CHORD TRAILING-EDGE FLAP. K. R. Czarnecki and James N. Mueller. January 2, 1951. 111p. diagrs., photos. (NACA RM L50J18) (Declassified from Confidential, 8/31/54)

The results of an investigation at supersonic speeds (M = 1.62, 1.93, and 2.40) of some of the factors affecting the flow over a rectangular wing with a symmetrical circular-arc section and a 30-percent-chord trailing-edge flap are presented. The factors included are Mach number, wing thickness, effect of fixing transition, flap-gap leakage, model asymmetry, and surface condition.

NACA RM L50J19

EFFECTS OF SWEEP ON THE DAMPING-IN-ROLL CHARACTERISTICS OF THREE SWEPTBACK WINGS HAVING AN ASPECT RATIO OF 4 AT TRANSONIC SPEEDS. Vernard E. Lockwood. December 14, 1950. 23p. diagrs. (NACA RM L50J19) (Declassified from Confidential, 8/31/54)

The damping-in-roll characteristics of three wings of aspect ratio 4 and taper ratio 0.6 with sweep angles of 0°, 35°, and 45° at the quarter-chord line and an NACA 65A006 airfoil section have been determined through the Mach number range from 0.6 to 1.15 and an angle-of-attack range from 0° to approximately 7° in the Langley 7- by 10-foot-tunnel transonic bump by the twisted-wing method. Comparisons are included with the results obtained at subsonic Mach numbers by the free-roll method on a series of similar wings.

NACA RM L50J20

LOW-SPEED INVESTIGATION OF THE EFFECT OF SEVERAL FLAP AND SPOILER AILERONS ON THE LATERAL CHARACTERISTICS OF A 47.5° SWEPTBACK-WING - FUSELAGE COMBINATION AT A REYNOLDS NUMBER OF 4.4×10^6. Jerome Pasamanick and Thomas B. Sellers. December 8, 1950. 57p. diagrs., photo. (NACA RM L50J20) (Declassified from Confidential, 8/31/54)

Presents results of an investigation in the Langley full-scale tunnel of various plain spoiler and flap-type ailerons on a wing-fuselage combination. The wing leading-edge sweep was 47.5°, the aspect ratio was 3.4, the taper ratio was 0.51, and the airfoil sections were NACA 64_1A112. The data include the effects of aileron span, location, and trailing-edge thickness and of spoiler span, location, and projection on the longitudinal and lateral characteristics at zero yaw for a range of angle of attack at a Reynolds number of 4.4×10^6.

NACA RM L50J30

FLIGHT INVESTIGATION OF THE EFFECT OF SIDESLIP ON THE PRESSURE AT THE STATIC ORIFICES OF THE BOEING B-29 AIRPLANE. Robert G. Chilton and B. Porter Brown. April 11, 1951. 12p. diagrs. (NACA RM L50J30) (Declassified from Confidential, 8/31/54)

The effect of sideslip on the measurement of static pressure obtained from orifices located on each side of the fuselage near the nose of an airplane is shown by measurements taken in steady and oscillatory sideslips. The result is discussed with respect to its effect on the indications of change and rate of change of altitude of an airplane on a bombing run.

NACA RM L50K01a

EFFECTS ON THE SNAKING OSCILLATION OF THE BELL X-1 AIRPLANE OF A TRAILING-EDGE BULB ON THE RUDDER. Hubert M. Drake and Harry P. Clagett. January 16, 1951. 14p. diagrs., photo. (NACA RM L50K01a) (Declassified from Confidential, 8/31/54)

It was found that a rudder trailing-edge bulb did not appreciably affect the snaking oscillation over the Mach number range from 0.75 to 1.0.

NACA RM L50K09

ESTIMATED DECELERATION OF AIRPLANE NOSE SECTION JETTISONED AT VARIOUS ALTITUDES AND AIRSPEEDS. Stanley H. Scher. January 8, 1951. 39p. diagrs. (NACA RM L50K09) (Declassified from Confidential, 8/31/54)

An analytical investigation has been made of the deceleration of typical proposed airplane jettisonable nose sections after being jettisoned at Mach numbers ranging from 0.85 to 3.0 and at altitudes ranging from sea level to 120,000 feet.

NACA RM L50K10

THE EFFECT OF MASS DISTRIBUTION ON THE LOW-SPEED DYNAMIC LATERAL STABILITY AND CONTROL CHARACTERISTICS OF A MODEL WITH A 60° TRIANGULAR WING. Joseph L. Johnson. March 9, 1951. 23p. diagrs., 2 tabs. (NACA RM L50K10) (Declassified from Confidential, 8/31/54)

Results of an investigation to determine the effect of mass distribution on the dynamic lateral stability and control characteristics of a model with a 60° triangular wing are presented. The moments of inertia in roll and yaw were increased to correspond to those of a triangular-wing fighter airplane with wing tanks. Flight tests and calculations were made for five different loading conditions.

NACA RM L50K20

THE USE OF SUCTION TO PREVENT SHOCK-INDUCED SEPARATION IN A NOZZLE. James R. Sterrett, Robert W. Dunning and Maurice J. Brevoort. January 30, 1951. 64p. diagrs., photos., 2 tabs. (NACA RM L50K20) (Declassified from Confidential, 8/31/54)

An investigation was made of the use of suction to prevent shock-induced flow separation in a nozzle formed by a 7.5-percent-thick bump on the wall of a channel. Various transverse and longitudinal suction-slot arrangements and suction through porous surfaces were tested. All these devices were effective in preventing separation, and certain suction-slot arrangements reduced the total power loss, including the power lost in the suction process.

NACA RM L50K27

AN EXPERIMENTAL STUDY AT MODERATE AND HIGH SUBSONIC SPEEDS OF THE FLOW OVER WINGS WITH 30° AND 45° OF SWEEPBACK IN CONJUNCTION WITH A FUSELAGE. Richard T. Whitcomb. June 15, 1951. 56p. diagrs., photos. (NACA RM L50K27) (Declassified from Confidential, 8/31/54)

A relatively extensive study is presented of the pressure distributions, wake surveys, and tuft patterns obtained at Mach numbers to 0.96 for tapered wings with 30° and 45° of sweepback in conjunction with a fuselage.

NACA RM L50K28

AN EXPERIMENTAL STUDY OF MODERATE AND HIGH SUBSONIC SPEEDS OF THE FLOW OVER WINGS WITH 30° AND 45° OF SWEEPFORWARD IN CONJUNCTION WITH A FUSELAGE. Richard T. Whitcomb. June 15, 1951. 47p. diagrs., photo. (NACA RM L50K28) (Declassified from Confidential, 8/31/54)

A relatively extensive study is presented of the pressure distributions and wake measurements obtained at Mach numbers to 0.96 for tapered wings with 30° and 45° of sweepforward, in conjunction with a fuselage.

NACA RM L50L01

AERODYNAMIC CHARACTERISTICS AT TRANSONIC SPEEDS OF A 60° DELTA WING EQUIPPED WITH A TRIANGULAR PLAN-FORM CONTROL HAVING A SKEWED HINGE AXIS AND AN OVERHANG BALANCE. TRANSONIC-BUMP METHOD. Harleth G. Wiley. February 6, 1951. 31p. diagrs. (NACA RM L50L01) (Declassified from Confidential, 8/31/54)

This paper presents the aerodynamic characteristics of a 60° delta wing of aspect ratio 2.31, taper ratio 0, and an NACA 65-006 airfoil section, which was equipped with an aerodynamically balanced triangular control mounted on a skewed hinge axis. Lift, drag, pitching moment, rolling moment, and hinge moment were obtained at various angles of control deflection and angles of attack through a Mach number range of 0.6 to 1.18.

NACA RM L50L04

EFFECTS OF SEVERAL ARRANGEMENTS OF RECTANGULAR VORTEX GENERATORS ON THE STATIC-PRESSURE RISE THROUGH A SHORT 2:1 DIFFUSER. E. Floyd Valentine and Raymond B. Carroll. February 20, 1951. 35p. diagrs., photos. (NACA RM L50L04) (Declassified from Confidential, 8/31/54)

Several arrangements of simple rectangular noncambered vortex generators were investigated in a 2:1 area-ratio diffuser of length equal to the inlet diameter and having an initial boundary-layer thickness of 5 percent of the inlet diameter. Some arrangements actually reduced the diffuser static-pressure rise. The effect of one of the better vortex-generator arrangements was to increase the diffuser effectiveness by 30 percent making it equal to that of a diffuser of twice the length.

NACA RM L50L04a

PRESSURE DISTRIBUTIONS OVER A RETRACTED LEADING-EDGE SLAT ON A 40° SWEPTBACK WING AT MACH NUMBERS UP TO 0.9. Jones F. Cahill and Gale C. Oberndorfer. January 26, 1951. 36p. diagrs. (NACA RM L50L04a) (Declassified from Confidential, 8/31/54)

Pressure distributions over a retracted leading-edge slat on a 40° sweptback wing are presented for a series of angles of attack up to maximum lift at Mach numbers of 0.1, 0.4, 0.6, 0.7, 0.8, 0.85, and 0.9. These data were obtained in the Langley low-turbulence pressure tunnel at a constant Reynolds number of approximately 3×10^6. The Reynolds number was maintained approximately constant through the Mach number range by varying the stagnation pressure.

NACA RM L50L07

AN EXPERIMENTAL STUDY OF MODERATE AND HIGH SUBSONIC SPEEDS OF THE FLOW OVER AN UNSWEPT WING IN CONJUNCTION WITH A FUSELAGE. Richard T. Whitcomb. June 18, 1951. 35p. diagrs., photos. (NACA RM L50L07) (Declassified from Confidential, 8/31/54)

A relatively extensive study is presented of the pressure distributions, wake measurements, and tuft patterns obtained for an unswept, high-aspect-ratio, tapered wing, in conjunction with a fuselage, at Mach numbers up to 0.925.

NACA RM L50L12a

TABULATED PRESSURE COEFFICIENTS AND AERODYNAMIC CHARACTERISTICS MEASURED IN FLIGHT ON THE WING OF THE DOUGLAS D-558-I AIRPLANE THROUGHOUT THE NORMAL-FORCE-COEFFICIENT RANGE AT MACH NUMBERS OF 0.67, 0.74, 0.78, AND 0.82. Earl R. Keener, James R. Peele and Julia B. Woodbridge. January 29, 1951. 37p. diagrs., photos., 6 tabs. (NACA RM L50L12a) (Declassified from Confidential, 8/31/54)

Tabulated pressure coefficients and aerodynamic characteristics measured in flight on the right wing of the Douglas D-558-I airplane throughout the normal-force-coefficient range at Mach numbers of 0.67, 0.74, 0.78, and 0.82 are presented.

NACA RM L50L18

FLIGHT DETERMINATION OF THE DRAG AND PRESSURE RECOVERY OF AN NACA 1-40-250 NOSE INLET AT MACH NUMBERS FROM 0.9 TO 1.8. R. I. Sears and C. F. Merlet. February 28, 1951. 32p. diagrs., photos., 2 tabs. (NACA RM L50L18) (Declassified from Confidential, 8/31/54)

External-drag and pressure-recovery data are presented for the NACA 1-40-250 nose inlet. The tests were made using rocket-propelled models in free flight at Mach numbers from 0.9 to 1.8. The Reynolds number based on body diameter varied from 4 to 10×10^6.

NACA RM L50L28

ERROR IN AIRSPEED MEASUREMENT DUE TO STATIC-PRESSURE FIELD AHEAD OF THE WING TIP OF A SWEPT-WING AIRPLANE MODEL AT TRANSONIC SPEEDS. Edward C. B. Danforth and Thomas C. O'Bryan. March 1, 1951. 16p. diagrs., photo. (NACA RM L50L28) (Declassified from Confidential, 8/31/54)

Contains measurements of static pressure taken at a distance of 1 tip chord ahead of the wing tip of a model of a swept-wing fighter airplane for the condition of near zero lift. The measurements made by means of the NACA wing-flow method cover a range of Mach numbers from 0.7 to 1.08. The influence of the complete airplane configuration on the static pressure is shown, together with the influences of the wing and fuselage taken separately. Comparisons with the linear theory are made where possible.

NACA RM L51A16

A COMPARISON OF TWO TECHNIQUES UTILIZING ROCKET-PROPELLED VEHICLES FOR THE DETERMINATION OF THE DAMPING-IN-ROLL DERIVATIVE. David G. Stone and Carl A. Sandahl. May 3, 1951. 17p. diagrs., photos. (NACA RM L51A16) (Declassified from Confidential, 8/31/54)

Rocket-powered flight investigations have been conducted for the purposes of comparing damping-in-roll derivatives as obtained from the torque-nozzle technique and the sting-mount technique. The agreement in damping-in-roll values obtained by the two techniques was good and showed the transonic rolling behavior of wings to be more affected by wing-dropping characteristics than by damping in roll.

NACA RM L51A17

APPLICATION OF THEODORSEN'S PROPELLER THEORY TO THE CALCULATION OF THE PERFORMANCE OF DUAL-ROTATING PROPELLERS. Jean Gilman, Jr. March 15, 1951. 31p. diagrs. (NACA RM L51A17) (Declassified from Confidential, 8/31/54)

Theodorsen's propeller theory is used to calculate the performance of dual-rotating propellers having nonideal load distributions. The ratio of the spinner radius to the propeller radius is shown to have a significant effect in evaluating the mass coefficient used in making calculations for either performance or design work. Sample performance calculations are made and the results are compared with experimental results for flight Mach numbers varying from 0.53 to 0.90.

NACA RM L51A18

CORRELATION OF SUPERSONIC CONVECTIVE HEAT-TRANSFER COEFFICIENTS FROM MEASUREMENTS OF THE SKIN TEMPERATURE OF A PARABOLIC BODY OF REVOLUTION (NACA RM-10). Leo T. Chauvin and Carlos A. deMoraes. March 7, 1951. 39p. diagrs., photo. 2 tabs. (NACA RM L51A18) (Declassified from Confidential, 8/31/54)

Free-flight tests at supersonic speeds have been made to determine the local convective heat-transfer coefficients, evaluated from measured skin temperatures along the body of a rocket-propelled fin-stabilized parabolic body of revolution. The Mach number range covered was 1.02 to 2.48 and the Reynolds number range was 3.18×10^6 to 163.85×10^6. The experimental values are compared with the results obtained from the V-2 research missile and also with several equations for heat transfer in a turbulent boundary layer.

NACA RM L51A19

THE TORSIONAL DEFLECTIONS OF SEVERAL PROPELLERS UNDER OPERATING CONDITIONS. W. H. Gray and A. E. Allis. June 1951. 56p. diagrs., photos., tab. (NACA RM L51A19) (Declassified from Confidential, 8/31/54)

Presents measured and computed torsional deflections of the family of constant-chord solid aluminum-alloy propeller blades used in a concurrent investigation of blade-section pressure distributions. The deflections were not negligible and varied with blade design and operating condition. It was concluded that blade torsional deflection may be computed with sufficient accuracy and should be considered in the design of thin propeller blades.

NACA RM L51A23

FLIGHT DETERMINATION OF THE EFFECTS OF WING VORTEX GENERATORS ON THE AERODYNAMIC CHARACTERISTICS OF THE DOUGLAS D-558-I AIRPLANE. De E. Beeler, Donald R. Bellman and John H. Griffith. August 14, 1951. 23p. diagrs., photos., tab. (NACA RM L51A23) (Declassified from Confidential, 8/31/54)

Tests were made to determine the effects of wing vortex generators on the handling and buffeting characteristics of the Douglas D-558-I airplane. Measurements of the chordwise pressure distribution over one section of the wing, the total-head losses in a portion of the wing wake, the total airplane drag, and the buffeting and handling characteristics were made with the basic configuration and with vortex generators of an arbitrary size, shape, and location installed on the wing.

NACA RM L51B12

AVERAGE SKIN-FRICTION COEFFICIENTS FROM BOUNDARY-LAYER MEASUREMENTS IN FLIGHT ON A PARABOLIC BODY OF REVOLUTION (NACA RM-10) AT SUPERSONIC SPEEDS AND AT LARGE REYNOLDS NUMBERS. Charles B. Rumsey and J. Dan Loposer. March 7, 1951. 33p. diagrs., photo. (NACA RM L51B12) (Declassified from Confidential, 8/31/54)

Boundary-layer measurements were made at two stations on a rocket-powered, fin-stabilized, parabolic body of revolution of fineness ratio 12.2. Skin-friction coefficients were determined over a Mach number range from 1.5 to 3.4 and over the Reynolds number range, based on body length to the measurement station, from 42×10^6 to 160×10^6. Theoretical turbulent skin-friction coefficients for a flat plate, with heat transfer, are also shown.

NACA RM L51B13

THE EFFECT OF END PLATES, END STRUTS, AND DEPTH OF SUBMERGENCE ON THE CHARACTERISTICS OF A HYDROFOIL. Kenneth L. Wadlin, Rudolph E. Fontana and Charles L. Shuford, Jr. April 12, 1951. 84p. diagrs., photos. (NACA RM L51B13) (Declassified from Confidential, 8/31/54)

An investigation was made in Langley tank No. 2, at subcavitation speeds, of the effect of end plates and end-mounted struts. Only small improvements might be expected in the maximum lift-drag ratios by the addition of end plates. End struts reduced the lift-drag ratio attainable with a single strut. The effect of end plates and end struts on effective aspect ratio was in good agreement with theory. An approximate theoretical solution of the effect of depth on the lift of a hydrofoil was developed.

NACA RM L51B28

NOTE ON FLUTTER OF A 60° DELTA WING ENCOUNTERED AT LOW-SUPERSONIC SPEEDS DURING THE FLIGHT OF A ROCKET-PROPELLED MODEL. William T. Lauten, Jr. and Grady L. Mitcham. May 14, 1951. 21p. diagrs., photos., 5 tabs. (NACA RM L51B28) (Declassified from Confidential, 8/31/54)

Results of the flight test of a rocket-powered model of a delta-wing (60° sweepback) body configuration indicated a wing flutter at a Mach number of 1.11 and a subsequent structural failure of a Mach number of 0.99. Sections of the flight time history and the ground-test results of a duplicate wing for natural frequencies of vibration, the structural influence coefficients, and the mass, moment of inertia, and center of gravity of streamwise strips of the wing are presented.

NACA RM L51C07

EFFECT OF A DEFLECTABLE WING-TIP CONTROL ON THE LOW-SPEED LATERAL AND LONGITUDINAL CHARACTERISTICS OF A LARGE-SCALE WING WITH THE LEADING EDGE SWEPT BACK 47.5°. Roy H. Lange and Marvin P. Fink. April 26, 1951. 41p. diagrs., photo., 2 tabs. (NACA RM L51C07) (Declassified from Confidential, 8/31/54)

Results are presented of an investigation in the Langley full-scale tunnel of the effect of a 20-percent-semispan deflectable wing-tip control on the low-speed lateral and longitudinal characteristics of a wing with the leading edge swept back 47.5° and circular-arc-airfoil sections. The basic wing configurations, the wing with drooped-nose flaps deflected 40°, and the wing with drooped-nose and semispan plain flaps deflected 40° were investigated throughout. All the data are presented for a Reynolds number of 4.3×10^6 and a Mach number of 0.07.

NACA RM L51C26

AERODYNAMIC CHARACTERISTICS OF TAPERED WINGS HAVING ASPECT RATIOS OF 4, 6, AND 8, QUARTER-CHORD LINES SWEPT BACK 45°, AND NACA 631A012 AIRFOIL SECTIONS. TRANSONIC-BUMP METHOD. Edward C. Polhamus and Thomas J. King, Jr. June 13, 1951. 23p. diagrs., photos., 2 tabs. (NACA RM L51C26) (Declassified from Confidential, 8/31/54)

This paper presents the results of an investigation by the transonic-bump method of wings of aspect ratios 8, 6, and 4 with the quarter-chord lines swept back 45°, and having NACA 631A012 airfoil sections, parallel to the plane of symmetry. Lift, drag, pitching-moment, and root bending-moment characteristics are presented for the Mach number range from 0.70 to 1.15.

NACA RM L51D18

FLIGHT INVESTIGATION OF THE LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF THE DOUGLAS D-558-I AIRPLANE (BUAERO NO 37972) AT MACH NUMBERS UP TO 0.89. Melvin Sadoff, William S. Roden and John M. Eggleston. June 1951. 26p. diagrs., photos., tab. (NACA RM L51D18) (Declassified from Confidential, 8/31/54)

Results and analysis pertaining to the longitudinal stability and control characteristics of the Douglas D-558-I airplane (BuAero No. 37972) are presented. The results indicated that large and rapid changes in elevator deflection and force were required for balance above a Mach number of 0.84. Analysis indicated that a major part of these changes was due to a loss in elevator effectiveness. A large increase in the apparent stick-fixed stability parameter $d\delta_e/dC_N$ was also noted due to a loss in elevator effectiveness combined with an increase in airplane stability.

NACA RM L51D19

EFFECTS OF SPANWISE THICKNESS VARIATION ON THE AERODYNAMIC CHARACTERISTICS OF 35° AND 45° SWEPTBACK WINGS OF ASPECT RATIO 6. TRANSONIC-BUMP METHOD. William D. Morrison, Jr. and Paul G. Fournier. July 1951. 38p. diagrs., photo. (NACA RM L51D19) (Declassified from Confidential, 8/31/54)

The effects of taper-in-thickness on the aerodynamic characteristics of wings having 35° and 45° of sweepback, aspect ratio 6, and taper ratio 0.6 have been determined by the transonic-bump technique over a Mach number range from 0.6 to 1.14. The results of this investigation are compared with those obtained from wings of the same plan form but of various constant section thickness ratios. Theoretical subsonic and low supersonic calculations of lift-curve slope, aerodynamic center, and lateral center-of-pressure location were determined.

NACA RM L51D23

THEORETICAL INVESTIGATION OF AN AUTOMATIC CONTROL SYSTEM WITH PRIMARY SENSITIVITY TO NORMAL ACCELERATIONS AS USED TO CONTROL A SUPERSONIC CANARD MISSILE CONFIGURATION. Ernest C. Seaberg and Earl F. Smith. July 1951. 48p. diagrs., photo., 3 tabs. (NACA RM L51D23) (Declassified from Confidential, 8/31/54)

An analysis has been made to determine the possibilities of using an autopilot primarily sensitive to linear accelerations for longitudinal control of a specific supersonic canard airframe. Essentially, the control system combines the use of a linear accelerometer and an integrating servomotor to obtain desired normal accelerations of the missile. The analysis is based largely on comparisons of normal acceleration transient responses obtained for various conditions of Mach number, altitude, static margin, and rate-of-pitch feedback. Because the acceleration control system has no directional space reference of its own, it is believed that its primary usefulness is in conjunction with a homing seeker or with a guidance system which will provide a directional space reference.

NACA RM L51D24

PRESSURE-DISTRIBUTION MEASUREMENTS OVER A 45° SWEPTBACK WING AT TRANSONIC SPEEDS BY THE NACA WING-FLOW METHOD. Edward C. B. Danforth and Thomas C. O'Bryan. June 1951. 42p. diagrs., photos. (NACA RM L51D24) (Declassified from Confidential, 8/31/54)

Pressure distributions have been obtained over the chord of an untapered, 45° sweptback wing model of 3.5 aspect ratio with 2-inch-chord NACA 65-210 airfoil sections normal to the leading edge at four stations along the span. The measurements, made by the NACA wing-flow method, covered Mach numbers from 0.7 to 1.1 and angles of attack from -1° to 4° at a nominal Reynolds number of 0.6×10^6 based on the chord. Comparisons are made with force tests and theory where possible.

NACA RM L51D24a

WING-FLOW INVESTIGATION OF THE CHARACTERISTICS OF SEVEN UNSWEPT, UNTAPERED AIRFOILS OF ASPECT RATIO 8.0. Harold L. Crane and James J. Adams. June 13, 1951. 54p. diagrs., photo. (NACA RM L51D24a) (Declassified from Confidential, 8/31/54)

Measurements were made of normal force, chord force, and pitching moment at angles of attack from -6° to 14° and Mach numbers of 0.65 to 1.08, for seven airfoil sections. The sections included were NACA 65-010, 65-210, 836D110, 847B110, a 10-percent-thick airfoil with 3-to-1 elliptical nose faired into a straight-sided afterbody, an airfoil having the same thickness distribution and a reflex-camber line obtained by subtracting an NACA 240 from an NACA 420 mean line, and an airfoil having the thickness distribution of the NACA 65-010 and the reflex-camber line.

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CURRENT NACA REPORTS

NACA RM E54G07

INVESTIGATION OF NOISE FIELD AND VELOCITY PROFILES OF AN AFTERBURNING ENGINE. Warren J. North, Edmund E. Callaghan and Chester D. Lanzo. September 1954. 23p. diagrs., photos. (NACA RM E54G07)

Sound pressure levels and jet velocity profiles are presented for an engine-afterburner combination over a range of afterburner fuel-air ratios. At high fuel-air ratios, a severe low-frequency resonance producing high noise levels was encountered. A current fighter aircraft with a different afterburner configuration yielded considerably lower sound pressure levels and resonance-free operation, indicating the importance of acoustic considerations in afterburning designs.

NACA RM E54G22a

RECOVERY CORRECTIONS FOR BUTT-WELDED, STRAIGHT-WIRE THERMOCOUPLES IN HIGH-VELOCITY, HIGH-TEMPERATURE GAS STREAMS. Frederick S. Simmons. September 1954. 19p. diagrs. (NACA RM E54G22a)

Experimental measurements show that a reasonable correlation among recovery corrections at various pressures and temperatures for butt-welded straight-wire thermocouples is given by an empirical equation in which the correction is seen to be proportional to the fifth root of the pressure and inversely proportional to the fourth root of the temperature. Resultant probable errors in temperature measurements are presented and discussed.

NACA TN 3151

EXACT SOLUTIONS OF LAMINAR-BOUNDARY-LAYER EQUATIONS WITH CONSTANT PROPERTY VALUES FOR POROUS WALL WITH VARIABLE TEMPERATURE. Patrick L. Donoughe and John N. B. Livingood. September 1954. 42p. diagrs., 2 tabs. (NACA TN 3151)

Solutions were computed for a Prandtl number of 0.7 and a range of cooling-air flows, and pressure and wall temperature gradients. For each case, boundary layer thicknesses and heat-transfer and friction coefficients were also computed and tabulated. Steeper temperature profiles for a given coolant flow were obtained by increased wall temperature gradients. Wall temperature gradients for zero boundary-layer tamperature gradients at the wall were increased by increased pressure gradient and decreased by increased coolant flow.

NACA TN 3200

STRESS ANALYSIS OF CIRCULAR SEMIMONOCOQUE CYLINDERS WITH CUTOUTS BY A PERTURBATION LOAD TECHNIQUE. Harvey G. McComb, Jr. September 1954. 37p. diagrs., 3 tabs. (NACA TN 3200)

A method is presented for analyzing the stresses about a cutout in a circular cylinder of semimonocoque construction. The method involves the use of so-called perturbation solutions which are superposed on the stress distribution that would exist in the structure with no cutout in such a way as to give the effects of a cutout. The method can be used for any loading case for which the structure without the cutout can be analyzed and is sufficiently versatile to account for stringer and shear reinforcement about the cutout.

NACA TN 3213

TRANSONIC FLOW PAST CONE CYLINDERS. George E. Solomon, California Institute of Technology. September 1954. 56p. diagrs., photos. (NACA TN 3213)

Experimental results are presented for transonic flow past cone-cylinder, axially symmetric bodies. The drag coefficient and surface Mach number are studied as the free-stream Mach number is varied and, wherever possible, the experimental results are compared with theoretical predictions. Interferometric results for several typical flow configurations are shown and an example of shock-free supersonic-to-subsonic compression is experimentally demonstrated. The theoretical problem of transonic flow past finite cones is discussed briefly and an approximate solution of the axially symmetric transonic equations, valid for a semi-infinite cone, is presented.

NACA TN 3227

APPLICATION OF TWO-DIMENSIONAL VORTEX THEORY TO THE PREDICTION OF FLOW FIELDS BEHIND WINGS OF WING-BODY COMBINATIONS AT SUBSONIC AND SUPERSONIC SPEEDS. Arthur Wm. Rogers. September 1954. (ii), 91p. diagrs., photo., 3 tabs. (NACA TN 3227)

A theoretical method is evaluated for predicting flow fields behind wings of wing-body combinations at supersonic speeds and slender configurations at subsonic speeds. The method was applied to the calculation of downwash at tail locations behind wings of triangular-wing and cylindrical-body combinations at M = 2.0, to illustrate effects of aspect ratio, angle of attack and incidence, ratio of body radius to wing semispan, and angle of bank on the vortex wake.

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NACA TN 3243

THEORETICAL ANALYSIS OF AN AIRPLANE ACCELERATION RESTRICTOR CONTROLLED BY NORMAL ACCELERATION, PITCHING ACCELERATION, AND PITCHING VELOCITY. Christopher C. Kraft, Jr. September 1954. 42p. diagrs., 3 tabs. (NACA TN 3243)

An acceleration restrictor which limits the elevator motion has been analyzed. The system has been assumed to be sensitive to two different control signals. One signal is proportional to normal and pitching acceleration and the other is a function of normal and pitching acceleration and pitching velocity. Several values of time lag in the device used to stop the elevator motion have been studied for two center-of-gravity positions and for forward speeds up to 1,000 feet per second.

NACA TN 3246

AN EXPERIMENTAL INVESTIGATION OF WHEEL SPIN-UP DRAG LOADS. Benjamin Milwitzky, Dean C. Lindquist and Dexter M. Potter. September 1954. 18p. diagrs. (NACA TN 3246. Formerly RM L53E06b)

This paper presents some recently obtained information on landing-gear applied drag loads and on the nature of the wheel spin-up phenomenon in landing, based on a program of tests under controlled conditions in the Langley impact basin. In particular, a study has been made of the nature and variation of the coefficient of friction between the tire and the runway during the spin-up process. Also, comparisons have been made of the various results obtained in forward-speed impacts, forward-speed impacts with reverse wheel rotation, spin-up drop tests, and forward-speed impacts with wheel prerotation.

NACA TN 3262

STARTING AND OPERATING LIMITS OF TWO SUPERSONIC WIND TUNNELS UTILIZING AUXILIARY AIR INJECTION DOWNSTREAM OF THE TEST SECTION. Henry R. Hunczak and Morris D. Rousso. September 1954. 28p. diagrs., photo. (NACA TN 3262)

Data are presented for tunnels operating at Mach numbers 3.85, 3.05, and 2.87 over a range of injector-to-tunnel mass-flow ratios of 0.5 to 1.35. At Mach number 3.85, the starting pressure ratio of 9.8 without injectors but with a fixed second throat was reduced to 4.68 with injectors operating at an injector-to-tunnel mass-flow ratio of 1.27. The running pressure ratio was lowered from 8.3 to 4.5. Corresponding reductions at Mach number 3.05 were from 4.5 to 2.71 for starting and from 4.5 to 2.37 for running at a mass-flow ratio of 0.9.

NACA TN 3285

SECTION CHARACTERISTICS OF AN NACA 0006 AIRFOIL WITH AREA SUCTION NEAR THE LEADING EDGE. James A. Weiberg and Robert E. Dannenberg. September 1954. 47p. diagrs., photos., 3 tabs. (NACA TN 3285)

Results are presented of an investigation of a two-dimensional NACA 0006 airfoil with area suction near the leading edge. The maximum lift of the wing without suction was increased 43 percent for a section flow coefficient of 0.0010 at a free-stream velocity of 162 feet per second.

NACA TN 3287

HEAT TRANSFER FROM A HEMISPHERE-CYLINDER EQUIPPED WITH FLOW-SEPARATION SPIKES. Jackson R. Stalder and Helmer V. Nielsen. September 1954. 29p. diagrs., photos. (NACA TN 3287)

Average heat-transfer, temperature-recovery, and pressure-distribution measurements were obtained over the hemispherical nose of a body of revolution both with and without flow-separation spikes. The tests, conducted in a range of Reynolds numbers from 1.55 to 9.85 x 10^5 and from Mach number 0.12 to 5.04, indicated that in supersonic flow the addition of spikes approximately doubles the rate of heat transfer, regardless of spike length.

NACA TN 3300

INVESTIGATION OF LIFT, DRAG, AND PITCHING MOMENT OF A 60° DELTA-WING—BODY COMBINATION (AGARD CALIBRATION MODEL B) IN THE LANGLEY 9-INCH SUPERSONIC TUNNEL. August F. Bromm, Jr. September 1954. 18p. diagrs., photos. (NACA TN 3300)

Results are presented from tests of the AGARD Calibration Model B in the Langley 9-inch supersonic tunnel. Measurements were made of the lift, drag, and pitching moment at Mach numbers of 1.62, 1.94, and 2.41 and at a Reynolds number, based on body length, of approximately 3.0 x 10^6. The zero-lift drag data compared favorably with available data and were in the proper sequence for the effects of Reynolds number.

BRITISH REPORTS

N-32662*

Nat. Gas Turbine Establishment (Gt. Brit.)
THE REFLECTION AND TRANSMISSION OF PRESSURE DISTURBANCES AT AREA CHANGES IN INFINITE DUCTS. M. V. Nesbitt. February 1954. 103p. diagrs., tab. (NGTE Memo. M. 198)

In most problems involving the propagation of pressure disturbances, reflection, and transmission of the disturbance at area changes must be considered. In this paper data are presented describing the reflection and transmission of pressure disturbances at abrupt area changes inside infinite ducts and at the ends of semi-infinite ducts. The presentation is such that only an initial flow condition, the ratio of the downstream area to the upstream area, the pulse size and its direction of travel need be defined to obtain the magnitude of the reflected and transmitted pulses. Although the results are expressed in terms of the sonic velocities in the various flow regions, they may be readily converted to terms of pressure or velocity. The data refers only to Mach numbers less than 1.

N-32686*

Royal Aircraft Establishment (Gt. Brit.)
A HOT-WIRE ANEMOMETER FOR THE MEASUREMENT OF SMALL AIRFLOWS. P. A. Stickles and T. R. H. Sizer. March 1954. 16p. diagrs., photos. (RAE Tech. Note EL. 50)

The principle underlying the operation of the hot-wire anemometer and its field of application in the measurement of small air flow are described. Full electrical and constructional details of the instrument are given together with details of a cone-valve for controlling the back-pressure and a low-pressure chamber for simulating high altitude conditions. The sources of error are discussed and an indication is given of the limits of accuracy to be expected.

N-32694*

Royal Aircraft Establishment (Gt. Brit.)
APPROXIMATE THEORETICAL CALCULATIONS OF THE EFFECT OF CYLINDRICAL TAILPIPES ON THE THRUST OF A ROCKET MOTOR. D. M. Clemmow. March 1954. 57p. diagrs., 16 tabs. (RAE RPD 18)

Assuming one-dimensional flow (free from oblique shocks) calculations have been made of the effect of nonconducting cylindrical tailpipes on the thrust delivered by rocket motors. Both supersonic and subsonic pipes of a range of lengths and diameters have been examined for a number of different chamber pressures, and for each case optimum area expansion ratios for motors with pipes have been determined. With supersonic pipes the thrust loss increases to a maximum value (of nearly 20 percent for the worst case investigated) which occurs when the pipe is long enough for the flow to become sonic at its downstream end. With subsonic pipes the existence of irreversible flow upstream of the nozzle throat necessitates separate examination of different cases.

N-32695*

Royal Aircraft Establishment (Gt. Brit.)
STATIC AND DYNAMIC RESPONSE OF A DESIGN OF DIFFERENTIAL PRESSURE YAWMETER AT SUPERSONIC SPEEDS. L. J. Beecham and S. J. Collins. February 1954. 56p. diagrs., photos. (RAE GW 19)

Static calibration curves are provided for incidences up to 30° at speeds from M = 1.3 to 1.9, and the instrument is shown to resolve accurately when rolled out of the free stream incidence plane. Relations are developed from which a close approximation to the Mach number, incidence and roll angle may be obtained, without recourse to calibration curves, in terms of the differential pressures across each pair of holes and the pitot pressure measured at an axial hole; the free stream static pressure requires to be determined independently. Dynamic behavior of the instrument and associated pressure pick-ups is examined, and a design developed for which the acoustic natural frequency is high compared with that likely to be encountered in flight.

N-32697*

Nat. Gas Turbine Establishment (Gt. Brit.)
THE DESIGN AND TESTING OF A FULL SCALE VORTEX COMBUSTION CHAMBER FOR RESIDUAL OIL BURNING. A. P. Johnstone. March 1954. 65p. diagrs., photos., 5 tabs. (NGTE Memo. M. 203)

This memorandum describes the design, development, and performance of a large vortex chamber burning 6,000 seconds residual fuel oil. The chamber was designed to pass 38 lb/sec of air at 4 atmospheres and 100 percent overload tests were attempted. The chamber was fully cooled by dilution air for a total loss of 2.0 lb/sq in. at 4 atmospheres. The system had three tangential entries and operated on one, two, or three entries with uniform symmetrical exhaust temperature profiles. Combustion efficiencies were high, 97 to 99 percent, falling off more rapidly below about 50 percent of the design mixture strength.

N-32701*

Ministry of Supply (Gt. Brit.)
AN ANALYSIS OF N. A. C. A. HELICOPTER REPORTS. R. N. Liptrot. May 1954. 61p. diagrs., 5 tabs. (MOS S & TM 7/54)

Theory is compared with flight and model tests, in order to obtain empiric correcting factors which will enable reliable performance estimates to be made for new helicopter designs. A survey of general theory is followed by an analysis of certain American reports. Correcting factors for effective blade drag for tip speed ratio, compressibility and stalling of the retreating blade are derived. A method of calculating the retreating blade tip angle of attack for twisted blades is presented. The work was carried out by the author under Ministry of Supply sponsorship.

N-32723*

Royal Aircraft Establishment (Gt. Brit.)
THE TENSILE PROPERTIES OF D. T. D. 546 AND D. T. D. 687 AFTER HEATING AT ELEVATED TEMPERATURES. May 1954. 5p. diagrs. (RAE Tech. Note Met. 197)

The tensile properties of D. T. D. 546 and D. T. D. 687 after heating at various temperatures up to about 300° C for periods ranging from 5 seconds to 1000 hours have been reviewed and plotted in convenient curves. At temperatures of about 125° C and above, the aluminum-zinc-magnesium alloy D. T. D. 687 loses strength to a very much greater extent than the D. T. D. 546, thus losing the higher strength advantage it possesses at room temperature.

N-32725*

Royal Aircraft Establishment (Gt. Brit.)
TENSILE AND COMPRESSIVE TESTS ON TITANIUM STRIP AT ELEVATED TEMPERATURES. D. C. Hayward. March 1954. 34p. diagrs., photos., 12 tabs. (RAE Tech. Note Met. 194)

The compressive testing of hot rolled commercial purity titanium strip was carried out in a fixture using steel balls to prevent lateral buckling of the test piece. Tests in tension and compression at temperatures ranging from room temperature to 400° C were made to provide data for tangent moduli graphs. Longitudinal and transverse tensile strength values were almost equal but under compression there was marked anisotropy. Strength was well maintained at the higher temperatures. Differences in stiffness were greatest at room temperature but were appreciably reduced at 400° C.

N-32726*

Royal Aircraft Establishment (Gt. Brit.)
DESIGN AND DEVELOPMENT OF THE R. A. E. DUMMY OF THE STANDARD AIRMAN. G. Lovell. May 1954. 27p. diagrs., photos., 4 tabs. (RAE Tech. Note Mech. Eng. 176)

A dummy of the standard airman has been developed at the R. A. E. for use in dynamic and static tests. It has been designed to the dimensions of the average airman and the limbs and the complete man have approximately the correct weights and centers of gravity. Its all up weight is normally 166 pounds but it can be varied from this figure if desired. The dummy has a basic metal structure, covered with foam rubber and articulated at the joints. While it is normally fitted with a simple canvas suit, it can be dressed in standard aircrew clothing, equipment, and headgear. There are cavities for instruments in the head and in the upper and lower trunks. A box containing three mechanical accelerometers mutually at right angles can be fitted in each of these cavities.

N-32727*

Royal Aircraft Establishment (Gt. Brit.)
THE STABILITY OF THE RUNGE-KUTTA METHOD OF SOLUTION OF LINEAR DIFFERENTIAL EQUATIONS. R. H. Merson. June 1954. 12p. diagrs. (RAE Tech. Note GW 320)

The solution of a linear differential equation with constant coefficients as given by the Runge-Kutta method is obtained and the stability is studied. It is shown that the Runge-Kutta solution will be stable when the true solution is stable if the interval of integration is less than about 2.8 times the time constant of every subsidence and less than about 2.8 times the reciprocal of the undamped frequency of every oscillatory mode.

N-32729*

Royal Aircraft Establishment (Gt. Brit.)
CALCULATION OF CHORD AND SPANWISE LOADINGS ON THREE THIN WINGS. L. Klanfer. April 1954. 13p. diagrs., 4 tabs. (RAE Tech. Note Aero 2306)

The pressure distribution over three thin wings has been calculated and compared with results obtained by Redshaw using his "three-dimensional potential analyzer". The agreement is good.

N-32730*

Royal Aircraft Establishment (Gt. Brit.)
FLEXIBLE EDGE ATTACHMENTS FOR WINDSCREENS. F. M. Clowes and L. W. Lord. May 1954. 13p. diagrs., 3 tabs. (RAE Tech. Note Chem. 1228)

A flexible edge attachment consisting of glass cloth and polyvinylbutyral has been developed for aircraft windscreens. While the attachment enables the windscreen to be bolted securely to the frame, it will accommodate a difference of thermal expansion between the frame and the windscreen. The joint strength decreases with rise in temperature so that the method is best suited to normal and low temperature conditions.

MISCELLANEOUS

N-3074D

INDEX OF NACA TECHNICAL PUBLICATIONS, JUNE, 1953 - MAY, 1954. 1954. viii, 212p. (NACA)

There is a classified listing of subject categories; a chronological listing of NACA publications under each subject category; an alphabetical index to the subject categories; and an author index.

NACA Rept. 1135

Errata No. 1 on "EQUATIONS, TABLES, AND CHARTS FOR COMPRESSIBLE FLOW." Ames Research Staff. 1953.

NACA TN 3109

Errata No. 1 on "AN INVESTIGATION OF LAMELLAR STRUCTURES AND MINOR PHASES IN ELEVEN COBALT-BASE ALLOYS BEFORE AND AFTER HEAT TREATMENT." J. W. Weeton and R. A. Signorelli. March 1954.

NACA TN 3118

Errata No. 2 on "DESIGN DATA FOR MULTIPOST-STIFFENED WINGS IN BENDING." Roger A. Anderson, Aldie E. Johnson, Jr. and Thomas W. Wilder, III. January 1954.

UNPUBLISHED PAPERS

N-18639*

ON THE SUITABILITY OF ELECTROLYTICALLY POLISHED SPECIMENS FOR THE METALLOGRAPHIC INVESTIGATION OF ALUMINUM AND ITS ALLOYS. (Über die Eignung elektrolytische polierter Proben für die metallographische Untersuchung von Aluminum und seinen Legierungen). H. Rohrig and W. Schneider. August 1954. 10p. diagr., photos. (Trans. from Aluminum, v. 23, no. 6, June, 1941, p. 281-284)

Known methods for electrolytic polishing of aluminum parts are reviewed and discussed. It is concluded that the applicability of electrolytic polishing methods to the preparation of metallographic specimens in the field of aluminum is comparatively limited.

DECLASSIFIED NACA REPORTS

THE FOLLOWING REPORTS HAVE BEEN DECLASSIFIED FROM CONFIDENTIAL, 9/10/54

RM A51H20
RM L51I11

NACA RM A50H03

PRELIMINARY FLIGHT INVESTIGATION OF THE WING-DROPPING TENDENCY AND LATERAL-CONTROL CHARACTERISTICS OF A 35° SWEPT-WING AIRPLANE AT TRANSONIC MACH NUMBERS. George A. Rathert, Jr., L. Stewart Rolls, Lee Winograd and George E. Cooper. September 11, 1950. 14p. diagrs., photo., tab. (NACA RM A50H03) (Declassified from Confidential, 9/10/54)

Results are presented from a preliminary flight investigation on an F-86A airplane of the lateral-control characteristics and the wing-dropping tendency encountered at high Mach numbers. The wing-dropping tendency was found to result from a combination of three factors: a small initial directional asymmetry, an abrupt increase in positive dihedral effect, and a reduction in the lateral-control effectiveness.

NACA RM A50J09a

PRELIMINARY FLIGHT INVESTIGATION OF THE DYNAMIC LONGITUDINAL-STABILITY CHARACTERISTICS OF A 35° SWEPT-WING AIRPLANE. William C. Triplett and Rudolph D. Van Dyke, Jr. December 11, 1950. 26p. diagrs., photo., tab. (NACA RM A50J09a) (Declassified from Confidential, 9/10/54)

Flight tests were conducted on a 35° swept-wing airplane to determine the dynamic longitudinal-stability characteristics. Period and damping of oscillatory responses were measured over a Mach number range of 0.60 to 1.04. Also presented as functions of Mach number are the static stability parameter C_{m_α}, the factor $C_{m_q} + C_{m_{\dot{\alpha}}}$, and the number of cycles required for the oscillation to damp to 1/10 amplitude. Sharp variations in damping were noted between Mach numbers of 0.88 and 0.96 in addition to a decrease above Mach number 0.96.

NACA RM A51B28

FLIGHT MEASUREMENTS OF THE WING-DROPPING TENDENCY OF A STRAIGHT-WING JET AIRPLANE AT HIGH SUBSONIC MACH NUMBERS. Seth B. Anderson, Edward A. Ernst and Rudolph D. Van Dyke, Jr. April 24, 1951. 16p. diagrs., photo., tab. (NACA RM A51B28) (Declassified from Confidential, 9/10/54)

Flight tests conducted on a straight-wing fighter-type jet airplane showed that the wing-dropping tendency encountered at high subsonic Mach numbers was due primarily to a progressive reduction in aileron effectiveness and an increase in effective dihedral which made the lateral trim particularly sensitive to small changes in sideslip angle.

NACA RM A51C28

A COMPARISON OF THE MEASURED AND PREDICTED LATERAL OSCILLATORY CHARACTERISTICS OF A 35° SWEPT-WING FIGHTER AIRPLANE. Walter E. McNeill and George E. Cooper. July 1951. 21p. diagrs., 3 tabs. (NACA RM A51C28) (Delcassified from Confidential, 9/10/54)

Flight measurements of the lateral oscillatory characteristics of a 35° swept-wing fighter airplane were obtained at altitudes of 10,000 and 35,000 feet for an over-all Mach number range from 0.41 to 1.04. Period, time to damp to half amplitude, and ratio of angle-of-bank amplitude to angle-of-sideslip amplitude, $|\varphi|/|\beta|$, are presented as functions of Mach number for each test altitude, and are compared with values computed from wind-tunnel data and estimated stability derivatives. In general, agreement between the measured and predicted lateral oscillatory characteristics of the test airplane was satisfactory.

NACA RM A51E03

SUBSONIC MACH AND REYNOLDS NUMBER EFFECTS ON THE SURFACE PRESSURES, GAP FLOW, PRESSURE RECOVERY, AND DRAG OF A NONROTATING NACA 1-SERIES E-TYPE COWLING AT AN ANGLE OF ATTACK OF 0°. Robert M. Reynolds and Robert I. Sammonds. July 1951. 73p. diagrs., photo., 3 tabs. (NACA RM A51E03) (Declassified from Confidential, 9/10/54)

Measurements of pressure distributions on the external, inner lip, spinner, and propeller-blade-shank fairing surfaces are presented for an NACA 1-51-117 (E-type) cowling with an NACA 1-41.43-042.86 spinner suitable for a turbine-propeller installation. Ram-recovery ratios, external drag, and gap leak flow are also included. The tests were conducted with the model at an angle of attack of 0° and with the cowling not rotating. The flow characteristics are presented for a range of Mach numbers from 0.23 to 0.88 at a Reynolds number of 1.8 million and for a range of Reynolds numbers from 1.8 to 8.1 million at 0.23 Mach number. Inlet-velocity ratio was varied between 0.06 and 0.78.

NACA RM A51E14

MEASUREMENTS IN FLIGHT OF THE LONGITUDINAL CHARACTERISTICS OF TWO JET AIRCRAFT, ONE WITH A DIVING TENDENCY AND THE OTHER WITH A CLIMBING TENDENCY AT HIGH MACH NUMBERS. Seth B. Anderson. October 1951. 18p. diagrs., photos., 2 tabs. (NACA RM A51E14) (Declassified from Confidential, 9/10/54)

Flight tests conducted on two jet airplanes of generally similar configuration, one identified with a diving tendency and the other with a climbing tendency at high Mach numbers, showed that the difference in longitudinal control appears to be governed by the balance between two opposing moments; a diving tendency caused chiefly by an increase in angle of attack of the horizontal tail surfaces, and a climbing tendency due to the pitching moment of the wing.

NACA RM A51E24

AN EXPERIMENTAL INVESTIGATION AT SUBSONIC SPEEDS OF A SCOOP-TYPE AIR-INDUCTION SYSTEM FOR A SUPERSONIC AIRPLANE. Curt A. Holzhauser. July 1951. 45p. diagrs., photos. (NACA RM A51E24) (Declassified from Confidential, 9/10/54)

Measurements of ram-recovery ratio, static pressure, and boundary layer are presented at a Mach number of 0.17 for a large range of mass-flow ratios, angles of attack, and angles of sideslip for a scoop-type intake located on top of the fuselage. At 0° angles of attack and sideslip the ram-recovery ratio measured at the minimum-area station was 0.98 at a mass-flow ratio of 1.0. Above a mass-flow ratio of 1.2, the ram-recovery ratio decreased rapidly. The variation of ram-recovery ratio with angle of attack was small compared with the variation of ram-recovery ratio with angle of sideslip.

NACA RM A51F12a

INVESTIGATION OF A TRIANGULAR WING IN CONJUNCTION WITH A FUSELAGE AND HORIZONTAL TAIL TO DETERMINE DOWNWASH AND LONGITUDINAL STABILITY CHARACTERISTICS - TRANSONIC BUMP METHOD. Edwin C. Allen. August 1951. 22p. diagrs., photos. (NACA RM A51F12a) (Declassified from Confidential, 9/10/54)

This report presents effective downwash at the tail position and the static longitudinal-stability characteristics of a semispan model having a thin triangular wing of aspect ratio 2, a slender fuselage, and a thin, unswept horizontal tail. The range of Mach numbers was from 0.40 to 1.10 with a corresponding Reynolds number range of 1.0 to 1.9 million. The effects of vertical position of the horizontal tail at one longitudinal station behind the wing were investigated.

NACA RM A51G27

LONGITUDINAL FREQUENCY-RESPONSE CHARACTERISTICS OF A 35° SWEPT-WING AIRPLANE AS DETERMINED FROM FLIGHT MEASUREMENTS, INCLUDING A METHOD FOR THE EVALUATION OF TRANSFER FUNCTIONS. William C. Triplett and G. Allan Smith. September 1951. 45p. diagrs., photo. (NACA RM A51G27) (Declassified from Confidential, 9/10/54)

Data obtained from dynamic flight measurements are used to compute the longitudinal frequency-response characteristics of a 35° swept-wing airplane through the Mach number range of 0.59 to 1.05. Also presented is a general graphical method for the determination of numerical coefficients of the transfer functions from frequency-response data. The variations in these coefficients with changes in Mach number and altitude are shown.

NACA RM A51H09

STABILITY AND CONTROL MEASUREMENTS OBTAINED DURING USAF-NACA COOPERATIVE FLIGHT-TEST PROGRAM ON THE X-4 AIRPLANE (USAF NO. 46-677). Melvin Sadoff, Herman O. Ankenbruck and William O'Hare. October 1951. 38p. diagrs., photos., tab. (NACA RM A51H09) (Declassified from Confidential, 9/10/54)

Results obtained during the Air Force testing of the Northrop X-4 airplane are presented. Information is included on the stalling characteristics, the static and dynamic longitudinal- and lateral-directional stability characteristics and the lateral-control characteristics.

NACA RM A51H20a

COMPARISON OF DRAG, PRESSURE RECOVERY, AND SURFACE PRESSURE OF A SCOOP-TYPE INLET AND AN NACA SUBMERGED INLET AT TRANSONIC SPEEDS. Joseph L. Frank and Robert A. Taylor. December 1951. 63p. diagrs., photos. (NACA RM A51H20a) (Declassified from Confidential, 9/10/54)

Comparative data were obtained for a scoop-type inlet and an NACA submerged inlet at transonic speeds. The submerged inlet effected the higher ram recovery at mass-flow ratios below about 0.50. At maximum mass-flow ratio (0.92) and 0° angle of attack, the ram recovery of the two inlets was about equal. In general, the scoop-type inlet caused the greater external drag.

NACA RM A51I12

A FLIGHT EVALUATION OF THE LONGITUDINAL STABILITY CHARACTERISTICS ASSOCIATED WITH THE PITCH-UP OF A SWEPT-WING AIRPLANE IN MANEUVERING FLIGHT AT TRANSONIC SPEEDS. Seth B. Anderson and Richard S. Bray. November 1951. 33p. diagrs., photo., tab. (NACA RM A51I12) (Declassified from Confidential, 9/10/54)

Flight measurements on a swept-wing jet aircraft showed that the pitch-up encountered in a wind-up turn at transonic Mach numbers was due principally to an unstable break in the wing pitching moment associated with flow separation near the wing tip. The pitch-up encountered in slowing down in a dive-recovery maneuver was due chiefly to a reduction in wing-fuselage stability. An increase in down load for the horizontal tail was indicated with increase in Mach number for normal force-coefficient values in excess of approximately 0.2.

NACA RM A51J11

THE EFFECTS AT TRANSONIC SPEEDS OF THICKENING THE TRAILING EDGE OF A WING WITH A 4-PERCENT-THICK CIRCULAR-ARC AIRFOIL. Joseph W. Cleary and George L. Stevens. December 1951. 43p. diagrs., photo. (NACA RM A51J11) (Declassified from Confidential, 9/10/54)

Effects of systematic variation of trailing-edge thickness of a symmetrical circular-arc airfoil on lift, drag, pitching moment, base pressure, and wake pressure fluctuations were investigated for the transonic Mach number range by the wind-tunnel bump technique. Results show that for trailing-edge thickness of 0.3 of the airfoil thickness beneficial gains in lift-drag ratios can be expected at subsonic Mach numbers with no measurable increase in minimum drag. Higher lift-curve slopes were observed in the transonic Mach number range for blunt-trailing-edge airfoils as compared with circular-arc airfoils.

NACA RM A51J18

THE EFFECTIVENESS OF WING VORTEX GENERATORS IN IMPROVING THE MANEUVERING CHARACTERISTICS OF A SWEPT-WING AIRPLANE AT TRANSONIC SPEEDS. Norman M. McFadden, George A. Rathert, Jr. and Richard S. Bray. February 1952. 45p. photos., diagrs., tab. (NACA RM A51J18) (Declassified from Confidential, 9/10/54)

The effects of wing vortex generators, multiple boundary-layer fences, and extension of the outer two segments of the wing leading-edge slats on the aerodynamic characteristics of a 35° swept-wing fighter were measured in flight tests at transonic speeds and high altitudes. Significant improvements were obtained in the pitch-up and wing-dropping-tendency characteristics with certain arrangements of vortex generators.

NACA RM A51J19a

THE EFFECT OF ENTRANCE MACH NUMBER AND LIP SHAPE ON THE SUBSONIC CHARACTERISTICS OF A SCOOP-TYPE AIR-INDUCTION SYSTEM FOR A SUPERSONIC AIRPLANE. Curt A. Holzhauser. January 1952. 39p. diagrs., photos., tab. (NACA RM A51J19a) (Declassified from Confidential, 9/10/54)

This report presents the ram-recovery ratios and static-pressure distributions of a scoop-type intake with a rounded lip and with a sharp lip. The entrance Mach numbers ranged from 0 to choking for free-stream Mach numbers of 0.08 to 0.33. The wake drag coefficients of these two types of installations are compared. The ram-recovery ratio of the intake with a rounded lip was greater than with a sharp lip at the higher mass-flow ratios. When the air flow was separated in the duct, the ram-recovery ratio decreased with increasing entrance Mach numbers.

NACA RM E50H16a

INVESTIGATION OF IGNITION CHARACTERISTICS OF AN-F-32 AND TWO AN-F-58a FUELS IN SINGLE CAN-TYPE TURBOJET COMBUSTOR. Warren D. Rayle and Howard W. Douglass. October 13, 1950. 25p. photos., diagrs., 2 tabs. (NACA RM E50H16a) (Declassified from Confidential, 9/10/54)

Ignition characteristics of AN-F-32 and two AN-F-58a fuels were studied in a single can-type turbojet combustor under air-flow conditions representing engine speeds of 1600, 2500, and 4000 rpm, altitudes from sea level to 30,000 feet, ambient temperatures at sea level from 90° to -36° F, and flight Mach numbers of 0 and 0.6. Critical fuel-flow rates for ignition increased with increase in preignition engine speed, with increase in altitude, or with decrease in sea-level ambient temperature. This flow rate appears to increase in a direct relation to decrease in fuel volatility as indicated by the 10-percent-evaporated temperature.

NACA RM E51B02

COMBUSTION PROPERTIES OF ALUMINUM AS RAM-JET FUEL. J. Robert Branstetter, Albert M. Lord and Melvin Gerstein. March 28, 1951. 37p. diagrs., photos. (NACA RM E51B02) (Declassified from Confidential 9/10/54)

An experimental investigation was conducted on the combustion properties of aluminum as a fuel for use in jet-powered aircraft. Two techniques of injection were investigated. In one method aluminum powder was utilized whereas in the other aluminum wire was utilized. Aluminum powder was burned stably and at combustion efficiencies that averaged about 50 percent, although the thrust obtained was less than that obtained by burning propane at equivalent conditions. Aluminum wire was burned with about 75 percent combustion efficiency. Solid deposits in the combustors were found to be a serious obstacle to the use of aluminum as a ram-jet fuel.

NACA RM E51B08

CORRELATION OF ANALOG SOLUTIONS WITH EXPERIMENTAL SEA-LEVEL TRANSIENT DATA FOR CONTROLLED TURBINE-PROPELLER ENGINE, INCLUDING ANALOG RESULTS AT ALTITUDES. James Lazar and Wilfred L. DeRocher, Jr. August 1951. 36p. diagrs. (NACA RM E51B08) (Declassified from Confidential, 9/10/54)

A satisfactory correlation was obtained between experimental sea-level transient data and solutions from the analog representation. The analog representation is accomplished by transfer functions that were formed from a frequency-response analysis of the experimental transient data as obtained from the controlled engine. This analog representation was then used to compute system response at altitude.

NACA RM E51C02

CARBON DEPOSITION OF SEVERAL SPECIAL TURBOJET-ENGINE FUELS. Jerrold D. Wear and James W. Useller. April 10, 1951. 15p. photos., diagr., tab. (NACA RM E51C02) (Declassified from Confidential, 9/10/54)

Investigations were conducted to determine the carbon forming characteristics of MIL-F-5624 and MIL-F-5161 type fuels in a single J33 combustor and of a MIL-F-5161 fuel in a J35 full-scale engine. The carbon deposition of the fuels investigated in the single combustor could be estimated from a previously established empirical correlation with volumetric average boiling temperature and hydrogen-carbon ratio. The results indicated that MIL-F-5161 type fuels formed more carbon in the single combustor and the full-scale turbojet engine than most MIL-F-5624 type fuels, and may result in marginal operation in several turbojet engines.

NACA RM E51C14

EFFECT OF FUEL VOLATILITY ON PERFORMANCE OF TAIL-PIPE BURNER. Zelmar Barson and Arthur F. Sargent, Jr. April 30, 1951. 18p. diagrs., tab. (NACA RM E51C14) (Declassified from Confidential, 9/10/54)

Fuels having Reid vapor pressures of 6.3 and 1.0 pounds per square inch were investigated in a tail-pipe burner on an axial-flow-type turbojet engine at a simulated flight Mach number of 0.6 and altitudes from 20,000 to 45,000 feet. With the burner configuration used in this investigation, having a mixing length of only 8 inches between the fuel manifold and the flame holder, the low-vapor-pressure fuel gave lower combustion efficiency at a given tail-pipe fuel-air ratio. Because the exhaust-nozzle area was fixed, the lower efficiency resulted in lower thrust and higher specific fuel consumption. The maximum altitude at which the burner would operate was practically unaffected by the change in fuel volatility.

NACA RM E51D16

INVESTIGATION OF MECHANISMS OF BLADE FAILURE OF FORGED HASTELLOY B AND CAST STELLITE 21 TURBINE BLADES IN TURBOJET ENGINE. C. Yaker, C. F. Robards and F. B. Garrett. August 1951. 41p. diagrs., photos., 2 tabs. (NACA RM E51D16) (Declassified from Confidential, 9/10/54)

An investigation was conducted to study the mechanisms of blade failure of forced Hastelloy B and cast Stellite 21. The blades were mounted in a 16-25-6 alloy rotor and subjected to 20-minute cycles consisting of 15 minutes at rated speed and approximately 5 minutes at idle. The first failures of the Hastelloy B and Stellite 21 blades were probably the result of excessive vibratory stresses and occurred after 14.25 and 16.75 hours, respectively. After 28.75 hours of operation, all but 3 of the original 25 Hastelloy B blades had either failed or contained stress-rupture-type cracks and four of the original 27 Stellite 21 blades contained stress-rupture-type cracks.

NACA RM E51D26

ANALYSIS OF EXPERIMENTAL SEA-LEVEL TRANSIENT DATA AND ANALOG METHOD OF OBTAINING ALTITUDE RESPONSE FOR TURBINE-PROPELLER ENGINE WITH RELAY-TYPE SPEED CONTROL. George Vasu and George J. Pack. May 17, 1951. 28p. diagrs., photo. (NACA RM E51D26) (Declassified from Confidential, 9/10/54)

Correlation has been established between transient engine and control data obtained experimentally and data obtained by simulating the engine and control with an analog computer. This correlation was established at sea-level conditions for a turbine-propeller engine with a relay-type speed control. The behavior of the controlled engine at altitudes of 20,000 and 35,000 feet was determined with an analog computer using the altitude pressure and temperature generalization factors to calculate the new engine constants for these altitudes. Because the engine response varies considerably at altitude some type of compensation appears desirable and four methods of compensation are discussed.

NACA RM E51F11

ALTITUDE-IGNITION LIMIT OF A TURBOJET ENGINE USING A CONDENSER-DISCHARGE IGNITION SYSTEM. John C. Armstrong. October 1951. 5p. diagrs. (NACA RM E51F11) (Declassified from Confidential, 9/10/54)

The altitude-ignition limits of a condenser-discharge ignition system installed on a turbojet engine were determined at a flight Mach number of 0.6 using 1.1-pound Reid vapor pressure fuel. Ignition was possible up to an altitude of 55,000 feet with 4.8 joules per spark and 6 sparks per second.

NACA RM E51F18

VELOCITY AND TEMPERATURE FIELDS IN CIRCULAR JET EXPANDING FROM CHOKED NOZZLE INTO QUIESCENT AIR. Morris D. Rousso and Fred D. Kochendorfer. July 1951. 34p. diagrs., photos. (NACA RM E51F18. Formerly RM E50E03a) (Declassified from Confidential, 9/10/54)

The Mach number and temperature profiles in jets expanding from convergent and convergent-divergent nozzles are presented for several values of nozzle-exit pressure ratio. The effects of jet temperature, Reynolds number, and humidity on jet spreading are briefly evaluated. The results indicated that the downstream Mach number profiles for a heated jet are slightly narrower than those for an unheated jet, whereas the downstream temperature profiles were unaffected by nozzle temperature change, and that the effects of Reynolds number and humidity were negligible.

NACA RM L51E01

CONTRIBUTIONS OF WING, TAIL, AND FUSELAGE TO THE AERODYNAMIC CHARACTERISTICS OF A SEMISPAN MODEL OF A SUPERSONIC AIRPLANE CONFIGURATION AT TRANSONIC SPEEDS FROM TESTS BY THE NACA WING-FLOW METHOD. Norman S. Silsby and James M. McKay. July 1951. 34p. diagrs., photos., tab. (NACA RM L51E01) (Declassified from Confidential, 9/10/54)

An investigation has been made by the NACA wing-flow method at transonic speeds to determine the contributions of wing, tail, and fuselage to the aerodynamic characteristics of a semispan airplane model having a long slender fuselage and a straight wing and tail of low aspect ratio with faired symmetrical double-wedge airfoil sections 4.6-percent chord in thickness. Lift, drag, and pitching moments were obtained for the complete model, wing-fuselage configuration, fuselage-tail configuration, and fuselage alone. The Mach number range of the tests was from 0.60 to 1.13, and the Reynolds number range was from about 0.3×10^6 to 0.7×10^6.

NACA RM L51E07

SYSTEM ANALYSES AND AUTOPILOT DESIGN FOR AUTOMATIC ROLL STABILIZATION OF A SUPERSONIC PILOTLESS AIRCRAFT. Jacob Zarovsky. July 1951. 55p. diagrs., tab. (NACA RM L51E07) (Declassified from Confidential, 9/10/54)

Automatic roll stabilization system analysis and roll autopilot detail design have been conducted for a supersonic pilotless aircraft with twin jet engines. The autopilots investigated were a gyro-actuated control, a gyro-actuated control with a rate-sensing device (to provide additional damping), and an electronic hydraulic autopilot. It was concluded that an electronic-hydraulic roll autopilot with a passive electrical network and suitable gain adjustment appears to be a practical and realizable means of providing the required system roll stabilization characteristics.

NACA RM L51E09

WING-FLOW STUDY OF PRESSURE-DRAG REDUCTION AT TRANSONIC SPEED BY PROJECTING A JET OF AIR FROM THE NOSE OF A PROLATE SPHEROID OF FINENESS RATIO 6. Mitchell Lopatoff. October 1951. 20p. photos., diagrs., tab. (NACA RM L51E09) (Declassified from Confidential, 9/10/54)

Contains studies by NACA wing-flow method of pressure-drag reduction obtained at transonic speed by projecting a jet of air from the nose of a prolate spheroid. Comparisons of pressure distributions with and without the jet are made. Shadowgraphs of the model obtained in a small supersonic tunnel at a constant Mach number of 1.5 while the thrust of the jet was varied are presented.

NACA RM L51E18

RESULTS OF FLIGHT TESTS TO DETERMINE DRAG OF PARABOLIC AND CONE-CYLINDER BODIES OF VERY LARGE FINENESS RATIOS AT SUPERSONIC SPEEDS. Clement J. Welsh and Carlos A. deMoraes. August 1951. 17p. diagrs., photos. (NACA RM L51E18) (Declassified from Confidential, 9/10/54)

Results of free-flight investigation at supersonic speeds to determine zero-lift drag of bodies of revolution with varying fineness ratios are presented for both parabolic and cone-cylinder bodies.

NACA RM L51E25a

A PRELIMINARY INVESTIGATION OF COMBUSTION WITH ROTATING FLOW IN AN ANNULAR COMBUSTION CHAMBER. Ira R. Schwartz. September 1951. 18p. diagrs., photos. (NACA RM L51E25a) (Declassified from Confidential, 9/10/54)

A preliminary investigation of flame-stability and flame-extinction characteristics of a propane-air mixture in an annular combustion chamber was conducted with both straight and rotational flow. The rotating mixture burned at higher axial-inlet stream velocities and with more stable flames than could be obtained with straight-flow burning. Unsteady burning, accompanied by the pulsations and intense noise usually present in straight-flow burning, was not present in the rotating-flow burning. The external axial-flame length was appreciably less and the flame divergence was greater with rotating flow.

NACA RM L51F01

COMPARISON OF AIRFOIL SECTIONS ON TWO TRIANGULAR-WING-FUSELAGE CONFIGURATIONS AT TRANSONIC SPEEDS FROM TESTS BY THE NACA WING-FLOW METHOD. Albert W. Hall and James M. McKay. August 1951. 23p. diagrs., photo., tab. (NACA RM L51F01) (Declassified from Confidential, 9/10/54)

Tests were made by the NACA wing-flow method at transonic speeds on four triangular-wing-fuselage models. Two models had wings of aspect ratio 2.31 with NACA 65009 and 9-percent-thick biconvex sections and two models had wings of aspect ratio 4.00 with NACA 65006 and 6-percent-thick double-wedge sections. Lift, drag, pitching-moment, and angle-of-attack measurements are presented for a Mach number range of 0.75 to 1.075. The test Reynolds number was approximately 1.5×10^6.

NACA RM L51F01a

STATIC LATERAL STABILITY CHARACTERISTICS OF A 1/10-SCALE MODEL OF THE X-1 AIRPLANE AT HIGH SUBSONIC MACH NUMBERS. Richard E. Kuhn and James W. Wiggins. August 1951. 25p. diagrs., photos. (NACA RM L51F01a) (Declassified from Confidential, 9/10/54)

Results are presented of an investigation made in the Langley high-speed 7- by 10-foot tunnel to determine the high-speed static lateral and directional characteristics of a 1/10-scale model of the X-1 transonic research airplane from a Mach number of 0.40 to 0.88.

NACA RM L51F06a

AERODYNAMIC CHARACTERISTICS AT TRANSONIC SPEEDS OF A TAPERED 45° SWEPTBACK WING OF ASPECT RATIO 3 HAVING A FULL-SPAN FLAP-TYPE CONTROL. TRANSONIC-BUMP METHOD. Vernard E. Lockwood and Joseph E. Fikes. August 1951. 35p. diagrs. (NACA RM L51F06a) (Declassified from Confidential, 9/10/54)

Lift, drag, pitching-moment, rolling moment, and flap hinge-moment coefficients were obtained by the transonic-bump method on a wing having a quarter chord sweepback of 45.58°, aspect ratio of 3, a taper ratio of 0.5 and an NACA 64A010 section employing a 0.254-chord full-span flap. The investigation was made at angles of attack of 0°, 4°, and 8°, flap deflections from -27° to 5°, and Mach numbers from 0.6 to 1.17. The investigation was made with the gap at the nose of the flap both sealed and unsealed. The results from the bumps, an investigation of a large model at higher Reynolds number, and available estimation methods are compared.

NACA RM L51F08

A METHOD FOR THE DESIGN OF SWEPTBACK WINGS WARPED TO PRODUCE SPECIFIED FLIGHT CHARACTERISTICS AT SUPERSONIC SPEEDS. Warren A. Tucker. September 1951. 52p. diagrs., 2 tabs. (NACA RM L51F08) (Declassified from Confidential, 9/10/54)

A method is presented for designing sweptback wings to be self-trimming at a given set of flight conditions. This characteristic is achieved by warping the wing in a particular manner, that is, by giving the wing a certain combination of angle of attack, twist, and camber. The method applied directly to a wide class of sweptback wings. The application to any specific wing is simplified to a routine computational procedure, and a discussion is given of some points to be considered in the application to a practical case. Several illustrative examples are worked out, and the resulting wings are shown to be feasiable to construct.

NACA RM L51F08a

SMALL-SCALE INVESTIGATION AT TRANSONIC SPEEDS OF THE EFFECTS OF THICKENING THE INBOARD SECTION OF A 45° SWEPTBACK WING OF ASPECT RATIO 4, TAPER RATIO 0.3, AND NACA 65A006 AIRFOIL SECTION. Kenneth P. Spreemann and William J. Alford, Jr. August 1951. 21p. diagrs., photo. (NACA RM L51F08a) (Declassified from Confidential, 9/10/54)

An investigation was conducted in the Langley high-speed 7- by 10-foot tunnel over a Mach number range of 0.60 to 1.08 to determine the aerodynamic effects of thickening the inboard 40 percent of a semispan wing with the quarter-chord line swept back 45°, an aspect ratio of 4, a taper ratio of 0.3, and an NACA 64A006 airfoil section. Lift, drag, pitching moment, and bending moment were obtained for the two wings. Also included in the paper are some comparisons of experimental results with theory, corrected to elastic conditions.

NACA RM L51F12

TABULATED PRESSURE COEFFICIENTS AND AERODYNAMIC CHARACTERISTICS MEASURED IN FLIGHT ON THE WING OF THE D-558-I RESEARCH AIRPLANE THROUGH A MACH NUMBER RANGE OF 0.80 TO 0.89 AND THROUGHOUT THE NORMAL-FORCE-COEFFICIENT RANGE AT MACH NUMBERS OF 0.61, 0.70, 0.855, AND 0.88. Earl R. Keener and Rozalia M. Bandish. August 1951. 43p. diagrs., photos., 7 tabs. (NACA RM L51F12) (Declassified from Confidential, 9/10/54)

Presents tabulated pressure coefficients and aerodynamic characteristics obtained in flight from pressure distributions over six chordwise rows of orifices on a wing of the Douglas D-558-I research airplane (BuAero No. 37972). It includes data obtained throughout a Mach number range of 0.80 to 0.89 and throughout the normal-force-coefficient range at M = 0.61, 0.70, 0.855, and 0.88.

NACA RM L51F19

THEORETICAL ANALYSES TO DETERMINE UNBALANCED TRAILING-EDGE CONTROLS HAVING MINIMUM HINGE MOMENTS DUE TO DEFLECTION AT SUPERSONIC SPEEDS. Kennith L. Goin. November 1952. 52p. diagrs., tab. (NACA RM L51F19) (Declassified from Confidential, 9/10/54)

Theoretical analyses have been made to determine the plan forms of unbalanced trailing-edge flap-type controls having minimum hinge moments due to deflection and requiring minimum work to overcome the hinge moments due to deflection at supersonic speeds. Ratios of lift and rolling moment to hinge moment and lift and rolling moment to deflection work at fixed values of lift and rolling effectiveness were used as bases for the analyses. The effects of control plan form, control location, and Mach number have been considered.

NACA RM L51F26

EFFECTS OF PROPELLER-SHANK GEOMETRY AND PROPELLER-SPINNER-JUNCTURE CONFIGURATION ON CHARACTERISTICS OF AN NACA 1-SERIES COWLING-SPINNER COMBINATION WITH AN EIGHT-BLADE DUAL-ROTATION PROPELLER. Arvid L. Keith, Jr., Gene J. Bingham and Arnold J. Rubin. September 1951. 73p. diagrs., photos., 5 tabs. (NACA RM L51F26) (Declassified from Confidential, 9/10/54)

Results of low-speed investigation of aerodynamic characteristic of NACA 1-series cowling-spinner combination equipped with several eight-blade dual-rotation propellers differing in shank-thickness ratio are presented. Studies of sealed and faired propeller spinner junctures, four junctures that permit blade rotation, and two methods for retarding spinner boundary-layer separation are included.

NACA RM L51F28

EFFECTS OF SPANWISE THICKNESS VARIATION ON THE TRANSONIC AERODYNAMIC CHARACTERISTICS OF WINGS HAVING 35° OF SWEEPBACK, ASPECT RATIO 4, AND TAPER RATIO 0.60. William D. Morrison, Jr. and Paul G. Fournier. September 1951. 21p. diagrs., photo. (NACA RM L51F28) (Declassified from Confidential, 9/10/54)

The aerodynamic characteristics of a wing tapered in thickness from 6 percent at the root to 2 percent at the tip having 35° sweepback, aspect ratio 4, and taper ratio 0.60 have been determined by a reflection plane technique over a Mach number range from 0.60 to 1.08 at a Reynolds number of about 650,000. The results of this investigation are compared with those of a wing of identical plan form but of a constant thickness ratio. Theoretical subsonic and low-supersonic calculation of lift-curve slope, aerodynamic center, and lateral center-of-lift location are compared with experimental results.

NACA RM L51F29

BASE PRESSURES MEASURED ON SEVERAL PARABOLIC-ARC BODIES OF REVOLUTION IN FREE FLIGHT AT MACH NUMBERS FROM 0.8 TO 1.4 AND AT LARGE REYNOLDS NUMBERS. Ellis Katz and William E. Stoney, Jr. October 1951. 20p. diagrs., photos. (NACA RM L51F29) (Declassified from Confidential, 9/10/54).

Base pressures were measured on several fin stabilized bodies of parabolic-arc profile in free flight at Mach numbers from 0.8 to 1.4 and at Reynolds numbers from 20 to 130 million. The bodies varied in length from 6 to 25 diameters and had afterbodies which converged to base areas equal to 19.1 percent of the frontal areas. Pressures were also measured on the side of the bodies immediately ahead of the bases.

NACA RM L51G03

AN INVESTIGATION AT TRANSONIC SPEEDS OF THE EFFECTS OF CONTROL CHORD AND SPAN ON THE CONTROL CHARACTERISTICS OF A TAPERED WEDGE-TYPE WING OF ASPECT RATIO 2.5. TRANSONIC-BUMP METHOD. Raymond D. Vogler, Vernard E. Lockwood and Thomas R. Turner. September 1951. 36p. diagrs. (NACA RM L51G03) (Declassified from Confidential, 9/10/54)

This paper presents the results of a control investigation of 25-, 35-, and 45-percent-chord controls of various spanwise magnitudes on an unswept double-wedge-type wing of aspect ratio 2.5 and taper ratio of 0.625. Rolling and pitching moments and lift of the semispan wing-fuselage combination were obtained through a Mach range of 0.6 to 1.18 and at a Reynolds number near 1.2×10^6. The control deflections ranged from 0° to 15°. The investigation was conducted in the Langley high-speed 7- by 10-foot tunnel using the transonic bump.

NACA RM L51G09

PRELIMINARY INVESTIGATION OF THE EFFECTS OF RECTANGULAR VORTEX GENERATORS ON THE PERFORMANCE OF A SHORT 1.9:1 STRAIGHT-WALL ANNULAR DIFFUSER. Charles C. Wood. October 1951. 27p. diagrs., photo., tab. (NACA RM L51G09) (Declassified from Confidential, 9/10/54)

Results are presented of a preliminary investigation of vortex generators introduced into the region of boundary layer near the inlet of a short annular diffuser to increase turbulent mixing in an attempt to prevent separation and resulting adverse effects. Rectangular noncambered airfoils were used as vortex generators and were varied in chord, span, angle of attack, number, and location. Some of the vortex generator arrangements resulted only in small increases to diffuser performance, while other arrangements resulted in substantial increases. The effect of one of the better vortex-generator arrangements was to eliminate separation of the flow entirely and to increase the diffuser effectiveness 17 percent.

NACA RM L51G20

A CORRELATION OF EXPERIMENTAL ZERO-LIFT DRAG OF RECTANGULAR WINGS WITH SYMMETRICAL NACA 65-SERIES AIRFOIL SECTIONS BY MEANS OF THE TRANSONIC SIMILARITY LAW FOR WINGS OF FINITE ASPECT RATIO. Edward C. B. Danforth. September 1951. 20p. diagrs. (NACA RM L51G20) (Declassified from Confidential, 9/10/54)

This paper contains a correlation of zero-lift transonic pressure drag of rectangular wings of finite aspect ratio by means of a transonic similarity law derived in NACA TN 2273. The data correlated were for wings of exposed aspect ratio between 1.12 and 6.25 and thickness ratios between 0.03 and 0.12, all with symmetrical NACA 65-series airfoil sections.

NACA RM L51H02

A THEORETICAL INVESTIGATION OF THE INFLUENCE OF AUTOPILOT NATURAL FREQUENCY UPON THE DYNAMIC PERFORMANCE CHARACTERISTICS OF A SUPERSONIC CANARD MISSILE CONFIGURATION WITH A PITCH-ATTITUDE CONTROL SYSTEM. Anthony L. Passera. October 1951. 32p. diagrs., photos., 2 tabs. (NACA RM L51H02) (Declassified from Confidential, 9/10/54)

A theoretical investigation is made to determine the effects of the natural frequency of a single-degree-of-freedom autopilot upon the dynamic performance characteristics of a supersonic canard missile configuration with rate-damping and pitch-attitude control system. These effects are presented in the form of pitch-angle, control-surface deflection, and normal acceleration transients for several flight conditions in response to a unit step attitude command signal.

NACA RM L51H16a

LOW-SPEED WIND-TUNNEL INVESTIGATION OF A FIXED AND A FREE-FLOATING WING-TIP AILERON ON A WING WITH LEADING EDGE SWEPT BACK 51.3°. R. G. MacLeod. February 1952. 17p. diagrs., photo., tab. (NACA RM L51H16a) (Declassified from Confidential, 9/10/54)

Contains results of a low-speed wind-tunnel investigation of a fixed and a free-floating wing-tip aileron on a wing with leading edge swept back 51.3°. Results indicate that the rolling effectiveness of both ailerons was maintained up to very large angles of attack while the yaw due to aileron deflection was more favorable for the free-floating aileron.

NACA RM L51H22

AERODYNAMIC CHARACTERISTICS AT TRANSONIC SPEEDS OF A 60° DELTA WING EQUIPPED WITH A CONSTANT-CHORD FLAP-TYPE CONTROL WITH AND WITHOUT AN UNSHIELDED HORN BALANCE. TRANSONIC-BUMP METHOD. Harleth G. Wiley and Leon Zontek. September 1952. 25p. diagrs. (NACA RM L51H22) (Declassified from Confidential, 9/10/54)

This paper presents the aerodynamic characteristics of a 60° delta wing of aspect ratio 2.31, taper ratio 0, and an NACA 65-006 airfoil section, which was equipped with a constant-chord control, with and without an unshielded triangular horn balance. Lift, pitching moment, and hinge moment were obtained at various angles of control deflection and angles of attack for both types of controls through a Mach number range of 0.6 to 1.18.

NACA RM L51H23

THE EFFECTS ON THE AERODYNAMIC CHARACTERISTICS OF REVERSING THE WING OF A TRIANGULAR WING-BODY COMBINATION AT TRANSONIC SPEEDS AS DETERMINED BY THE NACA WING-FLOW METHOD. James M. McKay and Albert W. Hall. October 1951. 22p. diagrs., photo., 2 tabs. (NACA RM L51H23) (Declassified from Confidential, 9/10/54)

Tests were made by the NACA wing-flow method on two triangular wing-fuselage models of low aspect ratio with 6-percent-thick biconvex sections. On one model the apex angle of the wing was forward and on the other the apex angle was trailing. Lift, drag, pitching moment, and angle-of-attack measurements are presented for a Mach number range of 0.75 to 1.075. The test Reynolds number was approximately 1.5×10^6.

NACA RM L51H27

INVESTIGATION OF WING-TIP AILERONS ON A 51.3° SWEPTBACK WING AT TRANSONIC SPEEDS BY THE TRANSONIC-BUMP METHOD. William C. Moseley, Jr. and James M. Watson. November 1951. 60p. diagrs. (NACA RM L51H27) (Declassified from Confidential, 9/10/54)

Three wing-tip ailerons were tested through the transonic range on a 51.3° sweptback wing. One was a triangular wing tip deflectable about an axis normal to the leading edge of the wing; the second was a triangular tip added to the basic wing; and the third, utilizing the extended tip area, was obtained by deflecting the area aft of a spanwise axis through the 0.50-tip-chord station of the basic wing. The last two ailerons provided lateral control over the Mach number range at low angles of attack.

NACA RM L51H28

AERODYNAMIC CHARACTERISTICS AT TRANSONIC SPEEDS OF A WING HAVING 45° SWEEP, ASPECT RATIO 8, TAPER RATIO 0.45, AND AIRFOIL SECTIONS VARYING FROM THE NACA 63A010 SECTION AT THE ROOT TO THE NACA 63A006 SECTION AT THE TIP. William D. Morrison, Jr. and Paul G. Fournier. January 1952. 22p. diagrs., photo. (NACA RM L51H28) (Declassified from Confidential, 9/10/54)

The aerodynamic characteristics of a wing tapered in thickness ratio from 10 percent at the root chord to 6 percent at the tip chord, having 45° sweepback, aspect ratio 8, and taper ratio 0.45 have been determined by a reflection-plane technique over a Mach number range from 0.60 to 1.05 at a Reynolds number of about 500,000. The results of this investigation are compared with those obtained for a wing of identical plan form but of a constant 12-percent section thickness. Theoretical subsonic calculations of lift-curve slope, and aerodynamic-center and lateral-center-of-lift locations are compared with the experimental results.

NACA RM L51H29

THE EFFECT OF RAKING THE AILERON TIPS ON THE LATERAL-CONTROL AND HINGE-MOMENT CHARACTERISTICS OF A 20-PERCENT-CHORD PARTIAL-SPAN OUTBOARD AILERON ON A WING WITH LEADING EDGE SWEPT BACK 51.3°. Alexander D. Hammond. November 1951. 41p. diagrs., photo., tab. (NACA RM L51H29) (Declassified from Confidential, 9/10/54)

A wind-tunnel investigation at low speed was made to determine the lateral-control and hinge-moment characteristics of an unsealed plain-radius-nose 20-percent-chord flat-sided partial-span outboard aileron having various plan forms on a wing with the leading edge swept back 51.3°, aspect ratio 3.06, taper ratio 0.49, and NACA 65_1-012 airfoil sections perpendicular to the 55.6-percent-chord line. The results of the investigation indicate that, for ailerons having the same area, plan form has little or no effect on the variation of rolling-moment coefficient with aileron deflection. Changes in the aileron plan form, however, have an appreciable effect on the hinge-moment parameter C_{h_δ}.

NACA RM L51H30

SUMMARY OF RESULTS OBTAINED BY TRANSONIC-BUMP METHOD ON EFFECTS OF PLAN FORM AND THICKNESS OF LIFT AND DRAG CHARACTERISTICS OF WINGS AT TRANSONIC SPEEDS. Edward C. Polhamus. November 1951. 33p. diagrs., tab. (NACA RM L51H30) (Declassified from Confidential, 9/10/54)

This paper presents a summary of the effects of plan form and thickness on the lift and drag characteristics of wings at transonic speeds and comparisons with subsonic, transonic, and supersonic theories. The data considered in this summary were obtained during a transonic research program conducted in the Langley high-speed 7- by 10-foot tunnel by the transonic bump method. The Reynolds numbers of the tests were generally less than 1×10^6.

NACA RM L51I06

EFFECTS OF HORIZONTAL-TAIL POSITION, AREA, AND ASPECT RATIO ON LOW-SPEED STATIC LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A 60° TRIANGULAR-WING MODEL HAVING VARIOUS TRIANGULAR-ALL-MOVABLE HORIZONTAL TAILS. Byron M. Jaquet. December 1951. 61p. diagrs., photo., tab. (NACA RM L51I06) (Declassified from Confidential, 9/10/54)

A low-speed investigation (Mach number of 0.17 and Reynolds number of 2.06×10^6) was made in the Langley stability tunnel to determine the static longitudinal stability and control characteristics of a 60° triangular-wing model having various all-movable triangular horizontal tails. Effects of tail length, height, area, and aspect ratio are presented. All-movable tails are compared with constant-chord flaps and half-delta tip controls.

NACA RM L51I21

SMALL-SCALE INVESTIGATION OF THE EFFECTS OF TWIST AND CAMBER ON THE AERODYNAMIC CHARACTERISTICS OF A 60° 42' SWEPTBACK WING OF ASPECT RATIO 1.94. Kenneth P. Spreemann and William J. Alford, Jr. January 1952. 19p. diagrs., photo., tab. (NACA RM L51I21) (Declassified from Confidential, 9/10/54)

An investigation of two semispan wings having the same plan form was conducted in the Langley high-speed 7- by 10-foot tunnel over a Mach number range of 0.59 to 1.10 to determine the effects of twist and camber on the aerodynamic characteristics of a sweptback wing rotated from its original design position. This paper presents the results of the investigation of the two semispan wings swept back 60° 42'; one wing was untwisted and uncambered, the other incorporated twist and camber. The wings had aspect ratios of 1.94, taper ratios of 0.44, and NACA 64A-series airfoil sections tapered in thickness. Lift, drag, pitching moment, and bending moment were obtained for the two wings.

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1150

CONSIDERATIONS ON THE EFFECT OF WIND-TUNNEL WALLS ON OSCILLATING AIR FORCES FOR TWO-DIMENSIONAL SUBSONIC COMPRESSIBLE FLOW. Harry L. Runyan and Charles E. Watkins. 1953. ii, 7p. diagrs. (NACA Rept. 1150. Formerly TN 2552)

This paper treats the effect of wind-tunnel walls on the oscillating two-dimensional air forces in a compressible medium. The walls are simulated by the usual method of placing images at appropriate distances above and below the wing. An important result shown is that, for certain conditions of wing frequency, tunnel height, and Mach number, the tunnel and wing may form a resonant system so that the forces on the wing are greatly changed from the condition of no tunnel walls.

NACA Rept. 1162

LIFT DEVELOPED ON UNRESTRAINED RECTANGULAR WINGS ENTERING GUSTS AT SUBSONIC AND SUPERSONIC SPEEDS. Harvard Lomax. 1954. ii, 16p. diagrs., 5 tabs. (NACA Rept. 1162. Formerly TN 2925)

Lift forces induced by a vertical gust are estimated on the basis of theoretical calculations. The effects of pitching and wing bending are neglected and only wings of rectangular plan form are considered. However, the effects of Mach number (from 0 to 2) and aspect ratio (2 to ∞) are included, and solutions are given by means of which the response to gusts having arbitrary streamwise gradients can be calculated. Results are presented for sharp-edged and triangular gusts and various wing-air density ratios.

NACA TM 1376

EXPERIMENTS ON TAIL-WHEEL SHIMMY. (Experimentelle Untersuchungen über das Spornradflattern). O. Dietz and R. Harling. October 1954. 81p. diagrs., photos. (NACA TM 1376. Trans. from Zentrale für weissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin, FB 1320)

Model tests on the "running belt" and tests with a full-scale tail wheel were made on a rotating drum as well as on a runway in order to investigate the causes of the undesirable shimmy phenomena frequently occurring on airplane tail wheels, and the means of avoiding them. The small model (scale 1:10) permitted simulation of the mass, moments of inertia, and fuselage stiffnesses of the airplane and determination of their influence on the shimmy, whereas by means of the larger model with pneumatic tires (scale 1:2) more accurate investigations were made on the tail wheel itself. The results of drum and road tests show good agreement with one another and with the model values. Detailed investigations were made regarding the dependence of the shimmy tendency on trail, rolling speed, load, size of tires, ground friction, and inclination of the swivel axis; furthermore, regarding the influence of devices with restoring effect on the tail wheel, and the friction damping required for prevention of shimmy. Finally observations from slow-motion pictures are reported and conclusions drawn concerning the influence of tire deformation.

NACA TN 3245

CALCULATED SUBSONIC SPAN LOADS AND RESULTING STABILITY DERIVATIVES OF UNSWEPT AND 45° SWEPTBACK TAIL SURFACES IN SIDESLIP AND IN STEADY ROLL. M. J. Queijo and Donald R. Riley. October 1954. 110p. diagrs., 2 tabs. (NACA TN 3245)

Subsonic span loads have been calculated for a systematic series of unswept and 45° sweptback tail surfaces by the discrete-horseshoe-vortex method. Results are presented as charts of span loads and the resulting contribution to the side-force and rolling derivatives. Geometric variables covered in the investigation included vertical- and horizontal-tail aspect ratios and vertical position and dihedral of the horizontal tail for various tail assemblies in sideslip and steady roll. Also presented is an extensive table of values of sidewash due to a rectangular vortex.

NACA TN 3247

AN EVALUATION OF AN ACCELEROMETER METHOD FOR OBTAINING LANDING-GEAR DRAG LOADS. Jerome G. Theisen and Philip M. Edge, Jr. October 1954. 22p. diagrs., photos. (NACA TN 3247)

An evaluation is made of applied ground drag loads obtained by means of angular-acceleration measurements on the wheel of a landing gear together with

vertical-acceleration measurements on the upper and lower masses. The data are obtained during forward-speed landing impacts and drop tests in the Langley impact basin. The results obtained by using this method showed good agreement with values obtained simultaneously from specially constructed dynamometers.

NACA TN 3248

AN EXPERIMENTAL AND THEORETICAL INVESTIGATION OF THE ANISOTROPY OF 3S ALUMINUM-ALLOY SHEET IN THE PLASTIC RANGE. Arthur J. McEvily, Jr. and Philip J. Hughes. October 1954. 45p. diagrs., photos., 4 tabs. (NACA TN 3248)

The results of tension and compression tests on 3S aluminum-alloy sheet are presented together with values of Poisson's ratio in the plastic range. Crystallographic anisotropy was found to be responsible for the variation in Poisson's ratio in the width and thickness directions of specimens alined at various directions with respect to the rolling direction in the plane of the sheet. X-ray diffraction studies of annealed specimens were made and pole figures showing the type of preferred orientation were drawn. A theoretical analysis was made to account for the observed anisotropy based on the behavior of single crystals and the texture of the sheet. An independent check of the theory is afforded through comparison with experimental data on cubically alined copper sheet.

NACA TN 3249

THE HYDRODYNAMIC CHARACTERISTICS OF AN ASPECT-RATIO-0.125 MODIFIED RECTANGULAR FLAT PLATE OPERATING NEAR A FREE WATER SURFACE. John A. Ramsen and Victor L. Vaughan, Jr. October 1954. 32p. diagrs. (NACA TN 3249)

Results of an investigation of the hydrodynamic force characteristics of an aspect-ratio-0.125 modified flat plate on a single strut operating near a free water surface are presented. Comparisons between these data and similar data from previous tests on plates having aspect ratios of 1.00 and 0.25 are presented; these comparisons give the effects of aspect ratio on the characteristics. The experimental effects of varying the depth of submersion and angle of attack are shown. The effects of cavitation at the leading edge and of the planing-bubble type of high-angle separation are presented. Comparisons are also presented between the experimental lift for all three aspect ratios at large depths of submersion and several theoretical methods of predicting the lift.

NACA TN 3250

AN EXPERIMENTAL INVESTIGATION OF THE EFFECT OF WHEEL PREROTATION ON LANDING-GEAR DRAG LOADS. Dexter M. Potter. October 1954. 19p. diagrs., photos., tab. (NACA TN 3250)

The effect of prerotation on the wheel spin-up drag loads on a small landing gear during landings has been investigated in the Langley impact basin. The results showed that, at the forward speed of the test (approximately 85 fps), even partial prerotation resulted in a reduction in both the drag load and the vertical load. At very high speeds, however, consideration of the variation of drag load with forward speed as obtained in a previous investigation indicated that large amounts of prerotation must be used in order to assure a reduction in drag load.

NACA TN 3263

LIFT AND MOMENT EQUATIONS FOR OSCILLATING AIRFOILS IN AN INFINITE UNSTAGGERED CASCADE. Alexander Mendelson and Robert W. Carroll. October 1954. 46p. diagrs., 3 tabs. (NACA TN 3263)

Aerodynamic coefficients similar to those of the isolated airfoil are obtained as functions of the cascade geometry and the phasing between successive blades; the phasings considered are zero, 90°, and 180°. These aerodynamic coefficients are plotted for the special case when all the airfoils are vibrating in bending in phase (360° phasing). It is shown that the effect of cascading for this case is to reduce greatly the aerodynamic damping.

NACA TN 3265

VAPORIZATION RATES AND DRAG COEFFICIENTS FOR ISOOCTANE SPRAYS IN TURBULENT AIR STREAMS. Robert D. Ingebo. October 1954. 39p. diagrs., photos., 3 tabs. (NACA TN 3265)

Drop-size distribution and drop-velocity data were obtained for isooctane sprays in turbulent air streams using a droplet camera developed at the NACA Lewis laboratory. Experimental spray vaporization rates, based on the mean diameter, correlated single-droplet vaporization rates. An empirical expression was derived for isooctane droplet drag coefficients.

BRITISH REPORTS

N-32700*

Ministry of Supply (Gt. Brit.)
THE APPLICATION OF "REDUX" ADHESIVE TO AIRCRAFT STRUCTURES. April 1954. 157p. diagrs., photos., 37 tabs. (MOS S & TM 5/54)

This report is concerned with the use of Redux as an adhesive in typical aircraft structures. The strength of the Redux joint was tested by means of static and fatigue tests after considering the variables of pretreatment, pressure, and temperature conditions.

N-32702*

Ministry of Supply (Gt. Brit.)
REPORT ON THE TUNGSTEN ARGON-ARC WELDING OF MAGNESIUM-ZIRCONIUM ALLOYS. AN INVESTIGATION INTO THE USE OF MAGNESIUM ZIRCONIUM ALLOYS IN SHEET AND PLATE FORM. April 1954. 103p. diagrs., photos., 21 tabs. (MOS S & TM 6/54)

This report is an investigation as to the suitability of magnesium-zirconium alloys fabricated by argon arc welding for aircraft structures. The strength of these sheet alloy welds was tested by means of compression and tension loads.

N-32751 *

Aeronautical Research Council (Gt.Brit.)
AN EXPERIMENTAL STUDY OF THREE-DIMENSIONAL HIGH-SPEED AIR CONDITIONS IN A CASCADE OF AXIAL-FLOW COMPRESSOR BLADES. K. W. Todd. 1954. 34p. diagrs., photos. (ARC R & M 2792; ARC 12,711; 12,308)

Detailed investigations have been made by optical and physical methods in a high-speed wind tunnel of the flow characteristics of two compressor cascades. In part 1 a representative high-camber cascade was examined at zero incidence over entry air velocities ranging from low to critical. Traverses were made of discharge angles and wake losses at all heights so that a relation between two- and three-dimensional losses could be obtained. In part 2 the blade and passage design was conditioned by the findings of part 1, with the aim of so modifying the cascade that its efficiency in the critical flow region would be improved.

N-32752*

Aeronautical Research Council (Gt. Brit.)
A NEW LAW OF SIMILARITY FOR PROFILES, VALID IN THE TRANSONIC REGION. K. Oswatitsch. 1954. 12p. diagrs. (ARC R & M 2715; ARC 10,807. Formerly RAE Tech. Note Aero 1902)

A new law of similarity is given, valid for slender profiles in mixed transonic flow with negligible viscosity, according to which the cube of the Prandtl factor of any critical Mach number is proportional to the thickness ratio. It is shown that this rule, and that of von Kármán for flow at sonic speed, are valid for shock waves within the range over which the shock loss is proportional to the cube of the pressure rise. Experimental pressure distributions plotted according to this rule show good agreement, except for the position of the shock wave on the surface.

N-32754 *

Aeronautical Research Council (Gt.Brit.)
TREATMENT OF THE STAGNATION POINT IN ARITHMETICAL METHODS. A. Thom. 1954. 10p. diagrs., 2 tabs. (ARC R & M 2807. Formerly ARC 14,118; FM 1577; Oxford Univ., Engineering Lab. No.53)

In using any of the relaxation techniques near a stagnation point difficulties arise if the variable is log 1/q. This tends to infinity and the difference equation no longer represents adequately the differential equation without special modification. Methods are given whereby larger squares can be used than had been previously practicable. As little variation as possible has been introduced into the procedure so that if an electronic calculator is used, the alterations to the circuits would be reduced to a minimum.

N-32755*

Aeronautical Research Council (Gt.Brit.)
VELOCITY DISTRIBUTION ON THIN TAPERED WINGS WITH FORE-AND-AFT SYMMETRY AND SPANWISE CONSTANT THICKNESS RATIO AT ZERO INCIDENCE. S. Neumark and J. Collingbourne. 1954. 43p. diagrs., 6 tabs. (ARC R & M 2858; ARC 14,474. Formerly RAE Aero 2432)

This report is a continuation of three earlier ones by the present authors and contains a theoretical investigation of subsonic flow past thin tapered unswept wings (of full- or cropped-rhombus plan form), at zero angle of attack. The method used is that of linear perturbation in which the wing is replaced by a system of sources and sinks; the required velocity field is then approximately obtained as that of the velocity components, in the plane of the chord lines, given by this source system. The supervelocity is then determined by direct integration.

N-32756 *

Aeronautical Research Council (Gt.Brit.)
METHODS OF APPROACHING AN ACCURATE THREE-DIMENSIONAL POTENTIAL SOLUTION FOR A WING. H. C. Garner. 1954. 19p. diagrs., 2 tabs. (ARC R & M 2721. Formerly ARC 11,802; Perf.489; FM 1293)

Attention is given to some fundamental aspects of the vortex-sheet theory for determining the distribution of lift on a finite wing. The accuracy and limitations of some existing approximate forms of the theory are discussed. With special reference to the labor of computation an iterative approach to an accurate solution is suggested, and the general mathematical expression for the distribution of lift required to give an exact solution for a Vee wing is considered.

N-32830*

Royal Aircraft Establishment (Gt.Brit.)
TRANSDUCTORS WITH VOLTAGE RE-SET CONTROL. A. G. Milnes. March 1954. 21p. diagrs. (RAE Tech.Note EL.67)

Voltage reset transductors have half-cycle delay times but this response is at the expense of very limited amplification. Factors influencing the performance are discussed and a voltage feedback technique is examined. When preamplification is required thermionic triodes, transistors or conventional transductors may be used; but the control voltage and current conditions of a reset circuit may present matching problems. Applications as computing elements, as synchro-coupling units, as lead networks and for multiplication of two voltages are discussed.

N-32832 *

Royal Aircraft Establishment (Gt.Brit.)
HEAT TRANSFER FROM CIRCULAR FINNED CYLINDERS UNDER NATURAL CONVECTION CONDITIONS. Mary D. Wright and G. A. French. March 1954. 17p. diagrs., 6 tabs. (RAE Tech. Note EL.68)

An experimental investigation has recently been made into the cooling in free air of cylinders fitted with different sizes and thicknesses of circular fins and with varied fin spacings.

N-32836*

Royal Aircraft Establishment (Gt.Brit.)
DESIGN OF TRIDAC (A THREE-DIMENSIONAL SIMULATOR FOR GUIDED MISSILES). PART VI - MONITORING TECHNIQUES. K. C. Garner. May 1954. 18p. diagrs., photos. (RAE Tech.Note GW 318)

Monitoring systems have been developed to detect certain fault conditions in the operation of the majority of the individual components comprising TRIDAC. Voltage variations or failures in the power supplies to the d.c. amplifiers, and abnormal drift voltages which may occur in the d.c. amplifiers are suitably indicated. Monitoring is also provided to detect saturation of the signal output from each of the d.c. amplifiers. The location in the simulator at which any of these faults occur is displayed on a system of warning lights. The basic principles of these, and other associated facilities, considered of importance to fault location and operational procedure, are discussed.

N-32860*

Aeronautical Research Council (Gt. Brit.)
EXPERIMENTS ON THE FLOW INTO A SWEPT LEADING-EDGE INTAKE AT ZERO FORWARD SPEED WITH NOTES ON THE WIDER USES OF A SLOTTED INTAKE. J. Seddon and W. J. G. Trebble. 1954. 18p. diagrs., tab. (ARC R & M 2909; ARC 13,928. Formerly RAE Aero 2409)

The flow into a swept intake at zero forward speed (ground running conditions) is shown to be analogous to the flow round a sharp corner in a duct. Tests have been made on a model of a swept-wing leading-edge intake to measure the losses involved. It is found that the distribution inside the duct can be improved by the use of straight guide vanes, alternatively by means of a special intake slot, or further by a combination of both. Guide vanes increase the mean loss, but the intake slot improves (i.e., reduces) this also. The slot would require to be sealed under flight conditions. It is suggested that this form of slotted intake may have wider applications in the future. Using the results of the experiments and an analogy with the slotted wing, conclusions are drawn regarding the main points of design of the intake slot.

N-32862*

Aeronautical Research Council (Gt. Brit.)
THE ROLLING POWER OF AN ELASTIC SWEPT WING. E. G. Broadbent. 1954. 19p. diagrs., 4 tabs. (ARC R &M 2857; ARC 13,639. Formerly RAE Structures 85)

An iterative method of solution is given for the problem of loss in rolling power due to wing deformation. The method is applicable at subsonic or supersonic speeds, and compressibility effects are allowed for, provided the variation of the aerodynamic derivatives with Mach number is known. The numerical labor involved in the solution is not great and the accuracy is considerably greater than can be achieved by the semirigid method

N-32866*

Nat. Gas Turbine Establishment (Gt.Brit.)
A THEORETICAL EXPRESSION FOR POINT-SOURCE DIFFUSION IN TURBULENT FLOW. A. B. P. Beeton. March 1954. 18p. diagrs. (NGTE R. 152)

A general expression governing the turbulent diffusion of fuel from a point source in a uniform stream is established from theoretical considerations. The distribution at points some distance downstream of the source can then be reduced to a relatively simple equation, which is identical in form with the relation found to hold experimentally for any one section normal to the flow. It indicates a slight modification to the normal empirical law relating distributions at different sections, again confirming the results of experimental work. The general expression enables distributions to be predicted for points as close to the source as may be desired. In comparison with the accurate values obtained by graphical integration of this expression, the approximate equation is found to give better than 1 percent accuracy at all points beyond about 5 mixing lengths downstream of the source.

N-32868*

Royal Aircraft Establishment (Gt. Brit.)
FREQUENCY TRIPLING OF AN ELECTRIC SUPPLY BY SATURABLE TRANSFORMER AND TRANSDUCTOR TECHNIQUES. F. D. Gill. March 1954. 52p. diagrs., photos., 2 tabs. (RAE Tech. Note EL. 62)

Known methods of frequency tripling by means of saturable transformers are examined and found to be too sensitive to input voltage variations for some purposes. A transductor technique has been developed which will tolerate substantial input voltage variations (8 percent). The method is sensitive to the value of load impedance, which must be kept reasonably constant. The frequency tripler is found to be suitable as a power supply to a magnetic amplifier. Both the weight and response time of the magnetic amplifier, redesigned for the triple frequency,

are reduced. In a typical example it is shown that the reduction in amplifier weight compensates for the weight of the frequency tripler and the additional power requirements. The principal advantage of the technique is the improvement in amplifier response time by a factor of three.

N-32869*

Royal Aircraft Establishment (Gt.Brit.)
A CUP-TYPE TRANSMITTING ANEMOMETER WITH IMPROVED RESPONSE TO DECREASING GUSTS. W. J. G. Cox. July 1954. 28p. diagrs., photo. (RAE Tech.Note Instn. 140)

A cup-type anemometer is described, capable of giving remote indication and recording of air speed. The instrument is self-generating, giving a voltage output which is reasonably proportional to air speed. A damping brake is described which automatically comes into operation only while the speed is decaying, thereby minimizing the inherent free wheel tendency of this type of instrument and improving its follow-up characteristic to winds of decreasing velocity. The transient responses of the braked and free rotor to step function air velocity changes are deduced, and calibration and loading curves for a particular model are given.

N-32870*

Royal Aircraft Establishment (Gt.Brit.)
A RANGE OF 50 C/S TRANSDUCTORS. A. G. Milnes and W. N. Corn. April 1954. 23p. diagrs., 3 tabs. (RAE Tech.Note EL.64)

Design details are given for twelve 50 c/s transductors covering a power range up to 200 VA at the limit of linear response. The cores used are of Mumetal or H.C.R. laminations or Hipersil C-cores and the voltage range is 13, 25, 50, 115, 240 and 420 V (rms). Nondimensional transductor characteristics are obtained from the performance curves of these units and applied in a design example.

N-32871*

Royal Aircraft Establishment (Gt.Brit.)
DEVELOPMENT OF A VERY QUICK ACTING ELECTRO HYDRAULIC VALVE. F. W. Read. June 1954. 12p. diagrs., photo. (RAE Tech.Note IAP 1030)

A quick acting hydraulic "on-off" valve was required by Aero Department, R.A.E. as part of experimental equipment to limit the stresses in the tail structure of an aircraft fitted with a powered elevator control and a "g" restrictor. In the first place a "Dowty" type valve was modified and an "on-off" cycle was completed in 45 milliseconds at 700 psi. Flight trials, however, indicated that a shorter operating time was necessary and this note describes a new design in which full hydraulic pressure operates the valves to both "close" and "open" position. A notable improvement in operating times, in rig tests at 450 psi, was shown by the valve "closing" or "opening" in 6 to 7 milliseconds.

N-32876*

Aeroplane and Armament Experimental Establishment (Gt.Brit.) AN ANALYSIS OF THE LONGITUDINAL STABILITY AND CONTROL OF A SINGLE ROTOR HELICOPTER. F. O'Hara. July 16, 1954. 25p. diagrs. (AAEE/Res/280)

The general theory of longitudinal stability and control for a single rotor helicopter is presented in a form similar to that for fixed wing aircraft. It is shown to be possible to establish for the helicopter in forward flight, in the same way as for fixed wing aircraft, stick fixed static and maneuver margins, on which the stability and handling qualities depend to a marked extent. Extension of the theory is required for stick free longitudinal stability and also for rotor wing combinations and tandem rotor helicopters.

N-32877*

Royal Aircraft Establishment (Gt.Brit.)
INTENSITY/TIME CHARACTERISTICS OF THREE EMITTED WAVEBANDS IN A CAPACITOR DISCHARGE THROUGH XENON. R. L. Aspden. May 1954. 10p. diagrs., photos. (RAE Tech.Note Instn.139)

Intensity/time oscillograms, recording the luminous emission obtained when a capacitor is discharged through gas or vapor, conceal any time factor which may be related to specific frequencies or wavebands. The preliminary investigation described herein shows that in the case of a low pressure xenon filled tube, flashed at normal loading, both the time to peak intensity and the pulse duration are functions of frequency. Although the light is a source of continuously varying spectral quality the composite nature of the flash suggests that for a very limited period during discharge the emission may approach blackbody radiation. A method whereby this period may be located and used to obtain the optimum reproduction in color of a high speed transient is outlined. Details are given of the equipment used in the present tests, together with intensity/time curves of three recorded wavebands covering the visible spectrum.

N-32889*

Aeronautical Research Council (Gt.Brit.)
A VARIABLE INDUCTANCE ACCELERATION TRANSDUCER. H. K. P. Neubert. 1954. 19p. diagrs., photos., 2 tabs. (ARC CP 169)

The acceleration transducer described has been designed as a general purpose transducer for the measurement of vibration and the resonance testing of aircraft on the ground and in flight. The two ranges of ±3g and ±9g, with cutoff frequencies at 70 c/sec and 100 c/sec respectively, will cover the most common magnitudes of vibration amplitudes and frequencies in these applications. It is designed for use with a carrier bridge amplifier and galvanometer recorder, providing a frequency range of zero to about 100 c/sec.

N-32890*

Aeronautical Research Council (Gt.Brit.)
THE RAPID, ACCURATE PREDICTION OF PRESSURE ON NON-LIFTING OGIVAL HEADS OF ARBITRARY SHAPE, AT SUPERSONIC SPEEDS. B. W. Bolton-Shaw and H. K. Zienkiewicz, English Electric Co., Luton. 1954. 58p. diagrs., 3 tabs. (ARC CP 154)

Five methods are developed for determining the pressure distribution on an arbitrary, pointed, convex axisymmetric head shape, of which the ordinate and its first three derivatives are everywhere continuous. When the geometric details are specified, the time required to pressure plot a head shape is from 20 minutes to 3 hours. The methods were checked in five trial cases against accurate pressure distribution, obtained by using van Dyke's second order theory, and generally gave very good agreement. The best method to use of the five depends upon head shape and on the speed and accuracy required.

N-32891*

Aeronautical Research Council (Gt.Brit.)
THE TECHNIQUE OF FLUTTER CALCULATIONS. H. Templeton. 1954. 65p. diagrs., 22 tabs. (ARC CP 172)

This report describes the basic principles on which theoretical flutter analyses are made, and illustrates them by some simple applications. The techniques employed are typical of those in current use in this country. Three appendices give the two-dimensional aerodynamic derivatives for a wing-aileron-tab system, computational details of typical forms of solution, and an illustration of the use of resonance test modes in flutter calculations.

N-32893*

Aeronautical Research Council (Gt.Brit.)
NOTE ON AN APPLICATION OF THE TILTING PLATE METHOD OF MACH NUMBER VARIATION FOR WIND TUNNEL TESTS AT LOW SUPERSONIC SPEEDS. J. Seddon and L. Haverty. 1954. 18p. diagrs., photo. (ARC CP 168)

This report describes an application of the method to a study of internal flow problems of side intakes at transonic speeds in a small supersonic tunnel. By arrangements involving the use of three or four tunnel nozzles, a continuous Mach number range from 0.5 to 1.6 is made available, apart from a gap between 0.97 and 1.04. This method is being used in the No. 2, 5-1/2 inch x 5-1/2 inch supersonic tunnel of the R.A.E.

N-32894*

Aeronautical Research Council (Gt.Brit.)
THE MANUFACTURE OF AEROFOIL MODELS BY TANGENT PLANE MILLING. R. S. Marriner. 1954. 20p. diagrs. (ARC CP 166)

The method described in this paper is a milling process followed by a minimum of hand finishing to ensure a smooth blending of the tangential planes. The accuracy achieved in this trial manufacture of a half-delta wing model was generally just within ±0.001 inch. The geometrical ideas and formulas developed are for a particular type of airfoil model, but the general idea of rotating and tilting a blank under a cutter can be applied to other types.

N-32895*

Aeronautical Research Council (Gt.Brit.)
SCHLIEREN METHODS FOR OBSERVING HIGH-SPEED FLOWS. D. W. Holder and R. J. North. 1954. 27p. diagrs., photos. (ARC CP 167)

This paper discusses the present state of knowledge concerning the use of schlieren and direct-shadow methods for the visualization of high-speed flow, the emphasis being on the use of the methods in wind tunnel experiments. The techniques for observing flows which are two-dimensional or which possess axial symmetry have reached an advanced stage of development, and are satisfactory for most investigations of this kind; recent progress is reviewed. Several methods which may be useful for the study of flow round finite wings and wing-body combinations are described briefly.

N-32896*

Aeronautical Research Council (Gt.Brit.)
THE THERMODYNAMICS OF FRICTIONAL RESISTED ADIABATIC FLOW OF GASES THROUGH DUCTS OF CONSTANT AND VARYING CROSS SECTION. W. R. Thomson. 1954. 44p. diagrs. (ARC CP 158)

This report presents an analytical study dealing with the adiabatic flow of gases with frictional losses through ducts of constant and varying cross section. The thermodynamic treatment is along lines published by other workers such as Bailey and Fabri and is essentially one dimensional in character insofar that frictional effects are assumed to be uniformly distributed over the total cross sectional area of flow. With this simplifying assumption, relationships are deduced connecting the pressure, temperature, velocity, and flow area of the gas at any one plane with those at any other plane in a duct.

N-32897*

Aeronautical Research Council (Gt.Brit.)
UNSTEADY CAVITATING FLOW PAST CURVED OBSTACLES. L. C. Woods. 1954. 9p. diagrs. (ARC CP 149)

The plane incompressible flow past two symmetric curved obstacles, between which is a finite constant pressure cavity, is calculated for the case when the cavity length and pressure are functions of time.

N-32898 *

Aeronautical Research Council (Gt. Brit.)
AN INVESTIGATION INTO THE ROLLING POWER AND AILERON REVERSAL CHARACTERISTICS OF SWEPT WINGS. A. V. Coles and R. J. Margetts. 1954. 28p. diagrs., photo., 3 tabs. (ARC CP 159)

This paper reviews briefly existing theories relating to swept wings and presents the results obtained from a program of tests on flexible swept wings. The wings tested were of constant span, aspect ratio and area and had angles of sweep ranging from 15° sweepforward to 60° sweepback. The tests were carried out in a low-speed wind-tunnel, compressibility effects being absent. The test results showed that the reversal speeds of wings of the same stiffness increase with both sweepback and sweepforward, the minimum value occurring with a small amount of sweepback. Predictions of reversal speeds based on semirigid theory showed good agreement with experimental results.

N-32899*

Aeronautical Research Council (Gt.Brit.)
THE PERFORMANCE OF A MULTI-ENGINE HELICOPTER FOLLOWING FAILURE OF ONE ENGINE DURING TAKE-OFF OR LANDING. A. L. Oliver. 1954. 15p. diagrs., tab. (ARC CP 175)

A theoretical analysis has been made considering the type of site proposed for civil operation in built-up areas. The performance of a twin engine helicopter similar to the Bristol 173 appears to be adequate for safe operation, but the handling judgment involved in return landings may make the performance difficult to achieve. A take-off technique allowing climb-away after engine failure at any stage is preferable but this is not possible for the twin engine machine within the space available. It is possible if the twin engines are replaced by four of the same effective total power but only if the turning climb-away is made after engine failure. A helicopter with sufficient performance for a straight climb-away can in general hover with one engine inoperative.

N-32900 *

Aeronautical Research Council (Gt.Brit.)
AERODYNAMIC DERIVATIVES FOR A DELTA WING OSCILLATING IN ELASTIC MODES. D. L. Woodcock. 1954. 33p. diagrs., 13 tabs. (ARC CP 170)

Aerodynamic derivatives are given for a delta wing of aspect ratio 3 and 90° apex angle oscillating with symmetric elastic modes in incompressible inviscid flow. They have been determined by the lattice method of W. P. Jones, using the values of the downwash calculated by D. E. Lehrian when obtaining aerodynamic derivatives for the same delta wing oscillating in rigid wing modes. Results for several modes are given both as local derivatives and also as equivalent constant derivatives. Derivatives for other modes can be obtained either from these or from the values of the reciprocal of the downwash matrix, which also are tabulated.

N-33258*

Aeronautical Research Council (Gt. Brit.)
TOWING-TANK TESTS ON A LARGE SIX-ENGINE FLYING BOAT SEAPLANE, TO SPECIFICATION 10/46 (PRINCESS). PART II - PORPOISING STABILITY, SPRAY AND AIR DRAG TESTS, WITH IMPROVED STEP FAIRING, AFTERBODY DESIGN AND AERODYNAMIC MODIFICATIONS. A. G. Smith, D. F. Wright and T. B. Owen. 1954. 32p. diagrs., photos., 2 tabs. (ARC R & M 2834; ARC 13,964. Formerly RAE Aero 2404)

Tests were made to improve the main-step fairing in order to reduce air drag while retaining satisfactory porpoising stability at high water speeds; to reduce the midplaning porpoising instability found with the hull lines tested in Part I; to test the effect of increased wing and tailplane areas; and to predict more accurately the full-scale performance of the final hull form by representing more closely the anticipated full-scale conditions of lift, slipstream and damping in pitch. The final form evolved is used for the first production aircraft.

MISCELLANEOUS

N-33233

Advisory Group for Aeronautical Research and Development. THE MECHANISM OF CARBON FORMATION. George Porter. (Scheveningen Netherlands Conference - May 3-7, 1954). 16p. diagrs. (AG13/M9)

This paper gives a more detailed account of the theory of carbon formation in combustion processes which has been briefly stated elsewhere. Other theories are critically reviewed and a summary is given of the experimental data relating to carbon formation which has been obtained by the flash photolysis technique. The mechanism proposed, which is believed to apply to the high temperature pyrolysis of hydrocarbons as well as to diffusion flames, premixed flames, and explosions in closed vessels, is as follows: all hydrocarbons, when pyrolysed under the high temperature conditions prevalent in the above systems, undergo a decomposition which results eventually in the formation of acetylene and hydrogen. Acetylene then forms carbon particles by a simultaneous condensation and dehydrogenation.

UNPUBLISHED PAPERS

N-23711*

SOME RESEARCH WORK IN PROGRESS ON TURBOMACHINES. (Quelques Recherches en Cours sur Turbomachines). E. Maillet. May 1954. 26p. diagrs., photos. (Trans. from Association Technique Maritime et Aéronautique, 1953)

Experimental studies carried out on a centrifugal compressor and on components of axial-flow compressors are discussed. Test methods, technique, and measuring equipment are described.

N-23775*

ON EXACT SOLUTIONS OF THE STOKES-NAVIER EQUATIONS OF INCOMPRESSIBLE FLUIDS AT MODIFIED BOUNDARY CONDITIONS. (Über exakte Lösungen der Stokes-Navier-Gleichungen inkompressibler Flussigkeiten bei veränderten Grenzbedingungen). Jakob Ackeret. September 1954. 20p. diagrs. (Trans. from Zeitschrift für angewandte Mathematik und Physik, v. 3, no. 4, 1952, p. 259-271)

There exist solutions of the hydrodynamic equations if the boundary conditions are modified. If it can be arranged that the "solid" boundaries are actually moving with the fluid velocity then really simple solutions are obtained. Several examples are worked out. As turbulence is unlikely to occur under these conditions, the power to move bodies in a viscous fluid at high Reynolds numbers would become extremely low. It seems that even a partial fulfilment of these changed conditions would be of practical interest.

DECLASSIFIED NACA REPORTS

NACA RM L9B10

AN ANALYSIS OF AVAILABLE DATA ON EFFECTS OF WING-FUSELAGE-TAIL AND WING-NACELLE INTERFERENCE ON THE DISTRIBUTION OF THE AIR LOAD AMONG COMPONENTS OF AIRPLANES. Bertram C. Wollner. April 11, 1949. 33p. diagrs., tab. (NACA RM L9B10) (Declassified from Confidential, 8/18/54)

Available information on the effects of wing-fuselage-tail and wing-nacelle interference on the distribution of the air load among components of airplanes is analyzed. The effects of several variables are considered. Of these, vertical wing position is found to affect the change in lift caused by interference between wing and fuselage to the greatest extent.

National Advisory Committee for Aeronautics

Research Abstracts

NO.73 **NOVEMBER 9, 1954**

CURRENT NACA REPORTS

NACA Rept. 1145

A METHOD OF CALIBRATING AIRSPEED INSTALLATIONS ON AIRPLANES AT TRANSONIC AND SUPERSONIC SPEEDS BY THE USE OF ACCELEROMETER AND ATTITUDE-ANGLE MEASUREMENTS. John A. Zalovcik, Lindsay J. Lina and James P. Trant, Jr. 1953. ii, 13p. diagrs., photos., tab. (NACA Rept. 1145. Formerly TN 2099; TN 2570)

A method is described for calibrating airspeed installations on airplanes at transonic and supersonic speeds in which use is made of normal and longitudinal accelerations and attitude angle as measured by instruments carried within the airplane. An airspeed calibration of the pitot-static installation on a jet fighter airplane is presented as an experimental check on the accuracy of the method.

NACA Rept. 1160

THE ZERO-LIFT DRAG OF A SLENDER BODY OF REVOLUTION (NACA RM-10 RESEARCH MODEL) AS DETERMINED FROM TESTS IN SEVERAL WIND TUNNELS AND IN FLIGHT AT SUPERSONIC SPEEDS. Albert J. Evans. 1954. ii, 13p. diagrs., tab. (NACA Rept. 1160. Formerly TN 2944)

Presents zero-lift drag data of an NACA RM-10 slender body of revolution with and without stabilizing fins attached. The results from several wind tunnels and in flight are compared. The results cover a Reynolds number range from about 1×10^6 to 40×10^6 for the wind-tunnel models and 12×10^6 to 140×10^6 for the flight models. The Mach numbers covered include 1.5 to 2.4 in the wind tunnels and 0.85 to 2.5 in flight.

NACA RM 54F22

EFFECTS OF MULTIAXIAL STRETCHING ON CRAZING AND OTHER PROPERTIES OF TRANSPARENT PLASTICS. Irvin Wolock and Desmond A. George, National Bureau of Standards. October 1954. 34p. diagrs., photos., 10 tabs. (NACA RM 54F22)

An investigation was made of the effects of orientation by multiaxial stretching on properties of various plastic glazing materials. The materials studied were Lucite HC-222 (polymethyl methacrylate), Plexiglas 55 (modified polymethyl methacrylate), Gafite, and resin C (polymethyl alpha-chloroacrylate). The following tests were conducted on samples of these materials stretched up to 150 percent: Dimensional stability at elevated temperatures, surface abrasion, standard tensile tests, and stress-solvent crazing tests using ethylene dichloride.

NACA RM E54H04

SLOWING-DOWN DISTRIBUTION TO INDIUM RESONANCE OF NEUTRONS FROM A Ra-α-Be SOURCE IN WATER-IRON MIXTURES. Daniel Fieno. November 1954. 16p. diagrs., photo., 2 tabs. (NACA RM E54H04)

The mean square slowing-down distance to indium resonance $\overline{r^2}$ derived from the slowing-down distribution has been measured for water and for three water-iron mixtures for neutrons from a 0.1-gram Ra-α-Be source. The values of $\overline{r^2}$ for water-iron volume ratios of 1, 2, and 3 and for water were 347, 336, 314, and 291 centimeters squared, respectively. Within the accuracy of the measurements, the relaxation length λ was approximately the same for water and for the three water-iron mixtures, the average value being 10.0 centimeters.

NACA TN 3152

TRANSVERSE OSCILLATIONS IN A CYLINDRICAL COMBUSTION CHAMBER. Franklin K. Moore and Stephen H. Maslen. October 1954. 25p. diagrs. (NACA TN 3152)

Transverse oscillations in combustion chambers are studied. With an axial temperature gradient considered, the modes of weak oscillation are described for low Mach number. Amplification by coupling with vigorous combustion in the flame-holder wake is assumed. The amplification depends on flame-holder and centerbody diameters and on time-lag effects. The nature of finite transverse periodic waves is also analyzed. Results show that such waves have frequencies independent of amplitude and do not steepen with time.

NACA TN 3302

LIQUEFACTION OF AIR IN THE LANGLEY 11-INCH HYPERSONIC TUNNEL. Charles H. McLellan and Thomas W. Williams. October 1954. 36p. diagrs., 4 tabs. (NACA TN 3302)

Pressure and scattered-light measurements were made in the Langley 11-inch hypersonic tunnel to determine the effect of stagnation temperature on the flow in two Mach number 7 nozzles and to determine the nature of the condensation process occurring at low stagnation temperatures. Liquefaction of the air occurred very close to the saturation point without a condensation shock. This result indicates that liquefaction took place on foreign nuclei such as water and carbon-dioxide particles. The results from varying the water vapor and carbon-dioxide content, however, could not be correlated with Max Volmer's condensation theory. The average particle radius was 480 angstroms in the test section of the

single-step Mach number 7 nozzle for stagnation conditions of about 530° R and 29 atmospheres. Under the same conditions about 10^{10} particles per cubic centimeter were present.

NACA TN 3342

EXPERIMENTAL DETERMINATION OF BOUNDARY-LAYER TRANSITION ON A BODY OF REVOLUTION AT M = 3.5. James R. Jedlicka, Max E. Wilkins and Alvin Seiff. October 1954. 56p. diagrs., photos. (NACA TN 3342. Formerly RM A53L18)

Boundary-layer-transition tests were made in free flight through still air on a small-scale fin-stabilized body of revolution of fineness ratio 30 at a Mach number of 3.5 and length Reynolds numbers of 12 and 24 million. Three types of surfaces were tested and the transition Reynolds number was found to depend critically on the surface smoothness. Angle of attack was found to influence transition strongly. This effect was correlated in terms of pressure rise along streamlines and led to a prediction of the effect of varying the body shape on sheltered-side transition. In general, the transition points were time dependent, fluctuating in one case over a range of Reynolds numbers from 4 to 20 million. Steady laminar flow was observed to a length Reynolds number of 11 million. Transition due to roughness and adverse pressure gradient occurred even though the tests were within the region of theoretical infinite laminar stability to small disturbances.

BRITISH REPORTS

N-32750*

Aeronautical Research Council (Gt. Brit.)
THE HIGH-SPEED LABORATORY OF THE AERODYNAMICS DIVISION, N. P. L. D. W. Holder. 1954. 277p. diagrs., photos., 2 tabs. (ARC R & M 2560)

The high-speed tunnel installation of the Aerodynamics Division of the National Physical Laboratory is described. The installation consists of the 12-in. diameter high-speed tunnel, the 20- by 8-in. high-speed tunnel, and a number of smaller tunnels all of which are operated on the induction principle from a common compressed-air storage capacity. The new 18- by 14-in. high-speed tunnel is also described. Some of the experimental techniques which have been used are described, including the schlieren and shadowgraph methods. The last of the report reviews the experimental results obtained in the high-speed tunnels during and immediately before the war. The phenomena which occur on a particular airfoil as Mach is increased are described and the effect of airfoil shape discussed.

N-32753*

Aeronautical Research Council (Gt. Brit.)
THE DRAG INCREASE AT HIGH SUBSONIC SPEEDS. K. Oswatitsch. 1954. 16p. diagrs. (ARC R & M 2716; ARC 11,246. Formerly RAE Tech. Note Aero 1919)

The drag increase beyond the critical Mach number is calculated by modifying the supersonic part of the Karman-Tsien pressure distribution on a profile. This is possible when the supersonic regions are not too large. The formula giving the modified pressure distribution is derived very roughly. It may give only one of the main effects appearing when supersonic speeds occur in the flow, and may be changed and calculated more exactly later. For the calculation of the drag increase, the formula is sufficient. Within the approximation of the theory the lift coefficient is practically unchanged.

N-32757*

Aeronautical Research Council (Gt. Brit.)
A SIMPLE METHOD OF COMPUTING C_D FROM WAKE TRAVERSES AT HIGH-SUBSONIC SPEEDS. J. S. Thompson. 1954. 12p. diagrs., 4 tabs. (ARC R & M 2914; ARC 8462. Formerly RAE Aero 2005)

This note gives a convenient method of obtaining C_D from a pitot-static traverse in an airfoil wake, using Jones' modified equation for compressible flow. Charts are provided from which the integrand C_D' can easily be obtained for any point in the traverse, but it is shown that in nearly all cases an accuracy of 1 percent in C_D can be obtained by applying an integrating factor to the area under the total-head loss curve. Three appendices give (a) a summary of the standard theory and equations, (b) details of the construction of the charts, and (c) an empirical equation giving C_D' in a simple analytical form.

N-32861*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE DYNAMIC CHARACTERISTICS OF SERVO-TAB SYSTEMS OF CONTROL. D. Adamson and D. J. Lyons. 1954. 12p. diagrs., tab. (ARC R & M 2853; ARC 11,666. Formerly RAE Aero 2263)

Curves have been constructed from which estimates can be made of those dynamic characteristics of the servo-tab-type of control which are of chief interest to the designer; namely, the magnitude of the first overshoot of the main flying control beyond its equilibrium position, the lag of the main control surface behind the tab movement, the damping of the main control surface oscillation, and the angular velocity possessed by the main control when it first passes through its equilibrium position.

N-32863*

Aeronautical Research Council (Gt. Brit.)
MODEL TESTS OF AN AIR INTERCHANGE SYSTEM FOR REMOVING ENGINE EXHAUST PRODUCTS FROM A WIND TUNNEL. K. W. Newby, E. G. Barnes and D. W. Bottle. 1954. 32p. diagrs., 3 tabs. (ARC R & M 2639; ARC 11,604. Formerly RAE Aero 2249)

An investigation has been made on the functioning of an air interchange system for removing from a return-circuit wind tunnel a high proportion of the exhaust products from propulsive units under test.

The tests were planned to assist the design of an engine altitude tunnel. The system tested was generally very satisfactory for the specified requirements, and can operate up to interchange ratios of the order of 15 percent without interfering appreciably with the flow in the tunnel working section.

UNPUBLISHED PAPERS

N-15994*

ON BRANCHED POTENTIALS IN SPACE. (Über verzweigte Potentiale in Raum). A. Sommerfeld. September 1954. 36p. diagrs. (Trans. from London Mathematical Soc., Proceedings, v. 28, April 8, 1897, p. 395-429)

Thomson's method of images and its extension by means of branched potentials is discussed. Green's function of a Riemann space with a simple rectilinear branch curve; applications of Green's function of the winding space to problems of ordinary potential theory; and Green's function of a Riemann space with two parallel rectilinear branching curves and its applications are also discussed.

N-21276*

ON THE STRESS ANALYSIS OF SWEPT WINGS. (Over de sterkteberekening van pijlvormige vleugels). J. P. Benthem. September 1954. 182p. diagrs. (Trans. from Nationaal Luchtvaartlaboratorium, Amsterdam. S. 405)

Methods of stress analysis of swept wings are discussed and reviewed. Many of the references are commented upon.

DECLASSIFIED NACA REPORTS

THE FOLLOWING REPORTS HAVE BEEN DECLASSIFIED FROM CONFIDENTIAL, 10/12/54:

✓ = Not in holdings

RM A52F27
RM L51L12a

✓ NACA RM A7A15 (those that are not checked) Decl by Ref on 11-16-54

FLIGHT-TEST MEASUREMENTS OF AILERON CONTROL SURFACE BEHAVIOUR AT SUPERCRITICAL MACH NUMBERS. Harvey H. Brown, George A. Rathert, Jr. and Lawrence A. Clousing. April 23, 1947. 26p. diagrs., photos., 2 tabs. (NACA RM A7A15) (Declassified from Confidential, 10/12/54)

The behavior at supercritical Mach numbers of the ailerons of a jet-propelled fighter has been measured up to 0.866 Mach number. The considerable amount of aileron upfloat occurring at these Mach numbers was found to be due to a large loss in pressure recovery on the upper surface aft of the shock wave which caused very large increases in the aileron hinge moments. Data obtained from pressure distribution measurements are presented to show the very critical effect of Mach number on the magnitude of these hinge moments.

✓ NACA RM A7G03

AN ANALYSIS OF LONGITUDINAL-CONTROL PROBLEMS ENCOUNTERED IN FLIGHT AT TRANSONIC SPEEDS WITH A JET-PROPELLED AIRPLANE. Harvey H. Brown, L. Stewart Rolls and Lawrence A. Clousing. September 25, 1947. 56p. diagrs., photos., 3 tabs. (NACA RM A7G03) (Declassified from Confidential, 10/12/54)

During flight tests of a jet-propelled airplane, a sudden pitch-up motion of the airplane occurred in a recovery from a high-speed dive, although the pilot had not moved the controls so as to produce this motion. Measurements of the stability and control characteristics of the airplane and of the wing pressure distribution during the dive and recovery are presented.

✓ NACA RM A7I16

HIGH-SPEED WIND-TUNNEL TESTS OF A MODEL PURSUIT AIRPLANE AND CORRELATION WITH FLIGHT-TEST RESULTS. Joseph W. Cleary and Lyle J. Gray. January 21, 1948. 56p. diagrs., photos. (NACA RM A7I16) (Declassified from Confidential, 10/12/54)

A wind-tunnel investigation of the aerodynamic characteristics of a 1/3-scale model of a jet propelled airplane was made at high subsonic Mach numbers for comparison with flight test results. Tests were made of wing and fuselage dive-recovery flaps to determine their effectiveness at high speed. In general, the wind-tunnel results show good agreement with the flight-test data. Both wing and fuselage dive-recovery flaps were effective for increasing longitudinal control. However, the wing dive-recovery flaps lost their effectiveness at high Mach numbers.

✓ NACA RM A51E04

EXPERIMENTAL STUDY OF THE EFFECT OF SWEEPBACK ON TRANSONIC AILERON FLUTTER. Lionel L. Levy, Jr. and Earl D. Knechtel. September 1951. 20p. diagrs., photo. (NACA RM A51E04) (Declassified from Confidential, 10/12/54)

The effect of sweepback on the Mach number for which transonic aileron flutter occurs was determined for a wing-aileron combination with an NACA 65-213, a = 0.5, airfoil section. The Mach number range of the investigation extended from 0.70 to 0.95 approximately and the Reynolds number was about 1 million. Angle of attack was varied from -6° to $+6^{\circ}$ for sweep angles of 0° to 50°.

NACA RM A51G10

PRELIMINARY INVESTIGATION OF THE PRESSURE FLUCTUATIONS IN THE WAKES OF TWO-DIMENSIONAL WINGS AT LOW ANGLES OF ATTACK. Robert M. Sorenson, John A. Wyss and James C. Kyle. October 1951. 58p. diagrs., photos. (NACA RM A51G10) (Declassified from Confidential, 10/12/54)

An experimental investigation has been conducted to obtain fundamental two-dimensional data on the extent, magnitude, and other characteristics of the

pressure fluctuations behind airfoils with NACA 23013 and NACA 651-213 sections. Results are presented for the airfoil with the NACA 23013 section through a range of Mach numbers from 0.60 to 0.80 and through a range of angles of attack of -2° to $+5^{\circ}$. The report discusses methods of defining wing- and tail-buffet boundaries in terms of pressure fluctuations in the wake.

NACA RM A51H15

LOAD DISTRIBUTION OVER A FUSELAGE IN COMBINATION WITH A SWEPT WING AT SMALL ANGLES OF ATTACK AND TRANSONIC SPEEDS. Maurice D. White and Bonne C. Look. November 1951. 26p. diagrs., photo., tab. (NACA RM A51H15) (Declassified from Confidential, 10/12/54)

Free-fall tests were made at Mach numbers from 0.85 to 1.06 of a wing-body configuration having a 45° sweptback cambered and twisted wing of aspect ratio 6 on a fuselage of fineness ratio 12.4. The distributions of load over the fuselage as determined from surface pressure measurements are shown in relation to the lifts of the wing for small angles of attack. Comparisons are made with wind-tunnel load distributions and with theoretical load distributions for subsonic and supersonic speeds.

NACA RM A51I25

AN ANALYSIS OF THE EFFECT OF STRUCTURAL FEEDBACK ON THE FLUTTER OF A CONTROL SURFACE HAVING POWER-BOOST SYSTEM. Robert H. Barnes. June 1952. 29p. diagrs., photos. (NACA RM A51I25) (Declassified from Confidential, 10/12/54)

A wind-tunnel program was conducted to determine the cause of flutter which had been experienced on an airplane which employed a full power-boost system. Analysis of the data showed that the power-boost control valve was being actuated due to structural deformation. Accordingly, an analytical study was conducted which showed that structural feedback could have been the cause of flutter.

NACA RM A51K27

BODIES OF REVOLUTION FOR MINIMUM DRAG AT HIGH SUPERSONIC AIRSPEEDS. A. J. Eggers, Jr., David H. Dennis and Meyer M. Resnikoff. February 1952. 44p. diagrs., photos. (NACA RM A51K27) (Declassified from Confidential, 10/12/54)

Newtonian impact theory is used to determine body shapes of minimum drag under various combinations of the conditions of given body length, base diameter, surface area, and volume. In addition an estimate is made of centrifugal forces, and their effect on one minimum-drag shape is considered. An experimental investigation carried out in the Ames 10- by 14-inch supersonic wind tunnel on a family of bodies, including two of the minimum-drag shapes, is found to provide a substantiation of the analysis.

NACA RM A51L03a

SOME EFFECTS OF SIDE-WALL MODIFICATIONS ON THE DRAG AND PRESSURE RECOVERY OF AN NACA SUBMERGED INLET AT TRANSONIC SPEEDS. Robert A. Taylor. February 1952. 25p. diagrs., photos. (NACA RM A51L03a. (Declassified from Confidential, 10/12/54)

Comparative data were obtained for an NACA submerged inlet and two ramp-wall modifications of the NACA submerged inlet. These modified inlets were generally superior to the NACA inlet from the standpoint of pressure recovery at the highest test mass-flow ratios. No significant changes in drag were produced by the modification for Mach numbers below 1.0 and for a mass-flow ratio of 0.88, but small increases in drag, at supersonic Mach numbers and the higher angles of attack, resulted from the modifications.

NACA RM A51L17b

A CORRELATION BY MEANS OF THE TRANSONIC SIMILARITY RULES OF THE EXPERIMENTALLY DETERMINED CHARACTERISTICS OF 22 RECTANGULAR WINGS OF SYMMETRICAL PROFILE. John B. McDevitt. February 1952. 60p. diagrs., 3 tabs. (NACA RM A51L17b) (Declassified from Confidential, 10/12/54)

The similarity rules have been used to correlate the experimental data for a series of 22 rectangular, symmetrical wings having NACA 63A0XX sections, aspect ratios from 1/2 to 6, and thicknesses from 2 to 10 percent. The data were obtained by use of the transonic bump technique over a Mach number range of 0.40 to 1.10, corresponding to a Reynolds number range from 1.25 to 2.05 million.

NACA RM A52A29

FLIGHT TESTING BY RADIO REMOTE CONTROL - FLIGHT EVALUATION OF A BEEP-CONTROL SYSTEM. Howard L. Turner, John S. White and Rudolph D. Van Dyke, Jr. April 1952. 55p. diagrs., photos., tab. (NACA RM A52A29) (Declassified from Confidential, 10/12/54)

A comparison between manual control and remote control showed that a beep-type, ratio-remote-control system was, in general, a satisfactory means of control for conducting standard handling-quality flight tests. The dynamic characteristics of the airplane-autopilot combination and the selection of the proper parameter adjustments are discussed.

NACA RM A52B05

FULL-SCALE WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF WING MODIFICATIONS AND HORIZONTAL-TAIL LOCATION ON THE LOW-SPEED STATIC LONGITUDINAL CHARACTERISTICS OF A 35° SWEPT-WING AIRPLANE. Ralph L. Maki. April 1952. 54p. diagrs., photos., 7 tabs. (NACA RM A52B05) (Declassified from Confidential, 10/12/54)

Low-speed lift, drag, and pitching-moment characteristics of a full-scale 35° swept-wing airplane are presented for Reynolds numbers ranging from 3.2×10^6 to 12.3×10^6, and with the horizontal tail on and off and at a lowered position. Similar data are given for the airplane with modified wing leading edges. Selected tuft photographs are given for several configurations.

NACA RM A52B13

THE EFFECT OF BLUNTNESS ON THE DRAG OF SPHERICAL-TIPPED TRUNCATED CONES OF FINENESS RATIO 3 AT MACH NUMBERS 1.2 TO 7.4. Simon C. Sommer and James A. Stark. April 1952. 18p. photos., diagrs. (NACA RM A52B13) (Declassified from Confidential, 10/12/54)

The drag of spherically blunted conical models of fineness ratio 3 was investigated in the Ames supersonic free-flight wind tunnel at Mach numbers from 1.2 to 7.4 in the Reynolds number range from 1.0×10^6 to 7.5×10^6. The models tested had bluntness ratios of nose diameter to base diameter from 0 to 0.50. The use of small amounts of bluntness for minimizing drag and the drag penalties associated with large bluntnesses are discussed.

NACA RM A52C20

DRAG OF CIRCULAR CYLINDERS FOR A WIDE RANGE OF REYNOLDS NUMBERS AND MACH NUMBERS. Forrest E. Gowen and Edward W. Perkins. June 1952. 26p. diagrs., photos. (NACA RM A52C20) (Declassified from Confidential, 10/12/54)

Pressure distribution measurements on a two dimensional circular cylinder have been made at high subsonic and supersonic speeds. Drag coefficients obtained from these measurements are presented with results from other sources. It was found that a maximum drag coefficient of about 2.1 occurs near sonic velocity. As the Mach number was increased to 2.9 the drag coefficient decreased to about 1.34. No effects of Reynolds number were found at supercritical Mach numbers. Effects of fineness ratio on drag of three-dimensional cylinders at supersonic speeds were investigated and found to be small.

NACA RM A52C24

INVESTIGATION OF LIFT AND CENTER OF PRESSURE OF LOW-ASPECT-RATIO, CRUCIFORM, TRIANGULAR, AND RECTANGULAR WINGS IN COMBINATION WITH A SLENDER FUSELAGE AT HIGH SUPERSONIC SPEEDS. Thomas N. Canning and Billy Pat Denardo. June 1952. 28p. diagrs., photos. (NACA RM A52C24) (Declassified from Confidential, 10/12/54)

Low-aspect-ratio triangular and rectangular wings in combination with a slender body have been tested in the Mach number range between 1.3 and 6.2 and Reynolds numbers based on body length from 2.8 to 16 million in the Ames supersonic free-flight wind tunnel. The experimental lift-curve slope and center of pressure positions are compared with theoretical predictions. Drag of the configurations is also presented. The possible lift-drag ratios for the configurations tested are estimated for Mach number 6.0 flight.

NACA RM A52D01a

EFFECTS OF PROPELLER-SPINNER JUNCTURE ON THE PRESSURE-RECOVERY CHARACTERISTICS OF AN NACA 1-SERIES D-TYPE COWL IN COMBINATION WITH A FOUR-BLADE SINGLE-ROTATION PROPELLER AT MACH NUMBERS UP TO 0.83 AND AT AN ANGLE OF ATTACK OF 0°. Robert I. Sammonds and Ashley J. Molk. June 1952. 45p. diagrs., photos., tab. (NACA RM A52D01a) (Declassified from Confidential, 10/12/54)

Measurement of ram-recovery ratio was made in the duct of a cowling-spinner combination. Tests were conducted at Mach numbers from 0.20 to 0.83 with the propeller operating with an "ideal" propeller-spinner juncture (propeller blade extended to spinner surface) and a platform juncture (fixed airfoil-shaped land that permitted blade angle change), and with the propeller removed. Tests were run at propeller blade angles of 60°, 50°, and 40°, for propeller advance-diameter ratios from 1.3 to 4.5 and inlet-velocity ratios from 0.26 to 1.33. All of the tests were conducted at an angle of attack of 0° and a Reynolds number of 1.77 million, based on the maximum diameter of the cowl.

NACA RM A52D11

THE TRANSONIC CHARACTERISTICS OF 38 CAMBERED RECTANGULAR WINGS OF VARYING ASPECT RATIO AND THICKNESS AS DETERMINED BY THE TRANSONIC-BUMP TECHNIQUE. Warren H. Nelson and Walter J. Krumm. July 1952. 173p. diagrs., photos. (NACA RM A52D11) (Declassified from Confidential, 10/12/54)

An investigation was made in the Ames 16-foot high-speed wind tunnel utilizing the transonic-bump technique to determine the aerodynamic characteristics at transonic Mach numbers of 38 cambered rectangular wings. The wings had aspect ratios of 4, 3, 2, 1.5, and 1, and NACA 63A2XX and 63A4XX sections with thickness-to-chord ratios of 10, 8, 6, 4, and 2 percent. The Mach number range was 0.6 to 1.12 with corresponding Reynolds numbers of 1.7 to 2.2 million. The data are presented without analysis.

NACA RM A52D17

EFFECT OF TRAILING-EDGE THICKNESS ON LIFT AT SUPERSONIC VELOCITIES. Dean R. Chapman and Robert H. Kester. July 1952. 24p. diagrs., photos. (NACA RM A52D17) (Declassified from Confidential, 10/12/54)

Lift forces on various rectangular-plan-form wings were measured in the Mach number range between 1.5 and 3.1 at Reynolds numbers between 0.55 and 2.2 million. The wings differed in trailing-edge thickness, profile shape, maximum thickness ratio, and aspect ratio. Measurements were made on wings with and without a boundary-layer trip and are compared to theoretical calculations. Calculated results using shock-expansion theory are presented for Mach numbers up to 10. In general, thickening the trailing edge resulted in an increase in lift-curve slope. This increase varied between a few percent and about 15 percent, depending primarily on the trailing-edge thickness. Calculations indicate that somewhat greater increases are possible at high supersonic Mach numbers.

NACA RM A52D24

SUPPLEMENTARY NOTE ON MODIFIED-IMPACT-THEORY CALCULATIONS FOR BODIES OF REVOLUTION HAVING MINIMUM DRAG AT HYPERSONIC SPEEDS. Meyer M. Resnikoff. July 1952. 13p. diagr. (NACA RM A52D24) (Declassified from Confidential, 10/12/54)

Newtonian impact theory as modified in NACA RM A51K27, 1952, to include an estimate of centrifugal forces is used to determine bodies for hypersonic flight having minimum pressure foredrag under various combinations of the conditions of given body length, diameter, volume, and surface area.

NACA RM A52E20

AN EXPERIMENTAL INVESTIGATION OF THE BASE PRESSURE CHARACTERISTICS OF NONLIFTING BODIES OF REVOLUTION AT MACH NUMBERS FROM 2.73 TO 4.98. John O. Reller, Jr. and Frank M. Hamaker. September 1952. 47p. diagrs., photos. (NACA RM A52E20) (Declassified from Confidential, 10/12/54)

Base pressure characteristics of related nonlifting bodies of revolution were investigated at free-stream Mach numbers from 2.73 to 4.98 and Reynolds numbers from 0.6×10^6 to 8.8×10^6. The basic body shape was a 10-caliber tangent ogive with a cylindrical afterbody. The variation of base pressure coefficient with free-stream Mach number and Reynolds number was determined for laminar-, transitional-, and turbulent-boundary-layer flow. Some effects of body fineness ratio, nose-profile shape, and afterbody shape (boattail) were also included in the investigation.

NACA RM A52F13

CONTROL EFFECTIVENESS AND HINGE-MOMENT CHARACTERISTICS AT LOW SPEED OF LARGE-CHORD, HORN-BALANCED, FLAP-TYPE CONTROLS ON A TRIANGULAR WING OF ASPECT RATIO 2. Jules B. Dods, Jr. August 1952. 53p. diagrs., photos., 2 tabs. (NACA RM A52F13) (Declassified from Confidential, 10/12/54)

The low-speed lift and hinge-moment characteristics are presented for a triangular wing of aspect ratio 2 having large-chord flap-type controls with a swept-back hinge line and with various sizes and shapes of horn balances. The effects of changes in the following were examined: shielding of the horn balance, percentage of horn balance, trailing-edge thickness, flap nose seal, contour of the horn balance, and Reynolds number. One of the controls which had a nearly optimum balance at low speed was compared with several other types of controls on triangular wings and with an all-movable triangular-wing control.

NACA RM A52F17

INVESTIGATION OF AN NACA SUBMERGED INLET AT MACH NUMBERS FROM 1.17 to 1.99. Warren E. Anderson and Alson C. Frazer. September 1952. 29p. diagrs., photo. (NACA RM A52F17) (Declassified from Confidential, 10/12/54)

An investigation was conducted with a small-scale NACA submerged inlet at supersonic Mach numbers from 1.17 to 1.99. The measured performance of a submerged inlet at low supersonic Mach numbers was compared to the calculated performance of a normal-shock scoop inlet on the basis of net thrust coefficients.

NACA RM A52I17

LATERAL AND DIRECTIONAL DYNAMIC-RESPONSE CHARACTERISTICS OF A 35° SWEPT-WING AIRPLANE AS DETERMINED FROM FLIGHT MEASUREMENTS. William C. Triplett and Stuart C. Brown. December 1952. 62p. diagrs., photo., 3 tabs. (NACA RM A52I17) (Declassified) from Confidential, 10/12/54)

Lateral and directional dynamic-response characteristics, including frequency responses, transfer functions, and stability derivatives of a 35° swept-wing fighter airplane are obtained from flight measurements of transient responses to rudder and to aileron control deflections. Flight records were obtained at two altitudes between Mach numbers of 0.50 and 1.04. Effects of aeroelasticity are discussed, and test results are compared to predictions based on wind-tunnel and theoretical studies.

NACA RM A53G31

A CORRELATION BY MEANS OF TRANSONIC SIMILARITY RULES OF THE EXPERIMENTALLY DETERMINED CHARACTERISTICS OF 18 CAMBERED WINGS OF RECTANGULAR PLAN FORM. John B. McDevitt. September 1953. 57p. diagrs. (NACA RM A53G31) (Declassified from Confidential, 10/12/54)

The effects of one type of camber on the aerodynamic characteristics of rectangular wing at high subsonic and transonic speeds have been studied by applying the transonic similarity rules to the correlation of experimental data for a series of 18 cambered wings having NACA 63A2XX and 63A4XX sections, aspect ratios from 1 to 4, and thicknesses from 4 to 8 percent. The data were obtained by use of a transonic bump over a Mach number range of 0.6 to 1.1.

NACA RM E51F15

INVESTIGATION OF DYNAMIC CHARACTERISTICS OF A TURBINE-PROPELLER ENGINE. Frank L. Oppenheimer and James R. Jacques. September 1951. 22p. diagrs., tab. (NACA RM E51F15) (Declassified from Confidential, 10/12/54)

Time constants that characterize engine speed response of a turbine-propeller engine over the cruising speed range for various values of constant fuel flow and constant blade angle were obtained both from steady-state characteristics and from transient operation. Magnitude of speed response to changes in fuel flow and blade angle was investigated and is presented in the form of gain factors. Results indicate that at any given value of speed in the engine cruising speed range, time constants obtained both from steady-state characteristics and from transient operation agree satisfactorily for any given constant fuel flow, whereas time constants obtained from

transient operation exceed time constants obtained from steady-stage characteristics by approximately 14 percent for any given blade angle.

NACA RM E51F19

PRELIMINARY INVESTIGATION OF THE CONTROL OF A GAS-TURBINE ENGINE FOR A HELICOPTER. Richard P. Krebs. September 1951. 13p. diagrs. (NACA RM E51F19) (Declassified from Confidential, 10/12/54

An analog investigation of the power plant for a gas-turbine powered helicopter indicates that currently proposed turbine-propeller engine controls are satisfactory for helicopter application. Power increases from one-half to full rated at altitudes from sea level to 15,000 feet could be made in less than 4 seconds with either the rotor or propellers absorbing the engine power.

NACA RM E51J25

EXPERIMENTAL INVESTIGATION OF THE VIBRATION CHARACTERISTICS OF FOUR DESIGNS OF TURBINE BLADES AND OF THE EFFECT PRODUCED BY VARYING THE AXIAL SPACING BETWEEN NOZZLE BLADES AND TURBINE BLADES. W. C. Morgan and C. R. Morse. February 1952. 28p. diagrs., photos., tab. (NACA RM E51J25) (Declassified from Confidential, 10/12/54)

An investigation was made to determine the effects of varying the spacing between the nozzle blades and the turbine blades of a turbo-jet engine on turbine-blade vibration for four turbine-blade designs of different degrees of stiffness. In general, there was a tendency toward increase in occurrence of vibration with decrease in spacing. The effect was most evident in the case of the turbine blades that had greater stiffness.

NACA RM E51K21

A METHOD FOR ESTIMATING SPEED RESPONSE OF GAS-TURBINE ENGINES. Harold Gold and Solomon Rosenzweig. January 1952. 26p. diagrs. (NACA RM E51K21) (Declassified from Confidential, 10/12/54)

A brief method is presented for estimating the speed response of turbojet and turbine-propeller engines to a step change in fuel flow. The method approximates the dynamic equilibrium in the gas-turbine engine with a first-order linear differential equation, the time constant of which varies inversely with the equilibrium speed. The deviation of the calculated values from the mean experimental values is only slightly greater than the spread of experimental data.

NACA RM E52B14

RELATIONS BETWEEN FUEL PROPERTIES AND COMBUSTION CARBON DEPOSITION. Edmund R. Jonash, Jerrold D. Wear and Robert R. Hibbard. April 1952. 67p. diagrs., 3 tabs. (NACA RM E52B14) (Declassified from Confidential, 10/12/54)

Methods for predicting carbon-forming propensity of turbojet-engine fuels from results of simple laboratory tests are discussed with a view toward their application to the control of jet fuel quality. The methods involve the use of aromatic content, hydrogen carbon ratio, distillation temperatures, gravity, aniline point, and several empirical laboratory carbon deposition tests. Most accurate prediction of carbon deposition was obtained with (1) the NACA K factor (function of hydrogen-carbon ratio and volumetric average boiling temperature), and (2) the smoking tendency of the fuel, although this latter method requires additional data to establish reproducibility of the method among laboratories.

NACA RM E52D10

INVESTIGATION OF ENGINE PERFORMANCE AND HIGH-TEMPERATURE PROPERTIES OF PRECISION-CAST TURBINE BLADES OF HIGH-CARBON STELLITE 21 AND CONTROLLED-GRAIN-SIZE STELLITE 21. Charles Yaker, Floyd B. Garrett and Paul F. Sikora. June 1952. 38p. diagrs., photos., 6 tabs. (NACA RM E52D10) (Declassified from Confidential, 10/12/54)

The effect of controlled grain size and increased carbon content on engine performance and high temperature properties of precision-cast Stellite 21 turbine blades was investigated. Blades were cast to result in controlled grain sizes, classed fine, medium, and coarse; others were cast of high-carbon Stellite 21. The blades were operated in a turbojet engine. Laboratory stress-rupture tests of specimens cut from blades were conducted at the stress and temperature encountered during rated-speed engine operation. The results of the engine and laboratory tests indicated that (1) fine-grain Stellite 21 blades had lower life and creep resistance than the medium- and coarse-grain blades, and all three grain size blades showed less scatter than the production blades; and (2) higher-carbon Stellite 21 had higher blade life than the production Stellite.

NACA RM E52L17

BEHAVIOR OF FORGED S-816 TURBINE BLADES IN STEADY-STATE OPERATION OF J33-9 TURBOJET ENGINE WITH STRESS-RUPTURE AND METALLOGRAPHIC EVALUATIONS. F. B. Garrett, C. A. Gyorgak and J. W. Weeton. February 1953. 29p. diagrs., photos., 3 tabs. (NACA RM E52L17) (Declassified from Confidential, 10/12/54)

An investigation was conducted to determine the behavior of recently produced, forged S-816 turbine blades in a full-scale turbojet engine, and in particular, the scatter in performance of the alloy. The turbine blades were operated as continuously as possible at a temperature of 1500° F and a centrifugal stress of 21,500 pounds per square inch. The operating lives of the turbine blades varied from 181 to 539 hours, a range of 358 hours. Stress-rupture properties of specimens cut from blade airfoils also varied considerably, as much as 1257 hours at 20,000 pounds per square inch and 1500° F. Since the variability or scatter of stress-rupture data is greater than that of blade performance, the scatter is probably caused by variations in the properties of the forged blades rather than by variations caused by engine operation or installation of the blades. Metallographic examinations were made to deter-

mine possible causes of the scatter and although numerous differences in microstructures of blades were found, no consistent trendencies were observed and the findings did not permit an explanation of the scatter of blade performance. The results of the metallographic examinations and of the physical tests indirectly indicated variables in the fabricating method caused the scatter in properties.

NACA RM E52L30

ADHESIVE AND PROTECTIVE CHARACTERISTICS OF CERAMIC COATING A-417 AND ITS EFFECT ON ENGINE LIFE OF FORGED REFRACTALOY-26 (AMS 5760) AND CAST STELLITE 21 (AMS 5385) TURBINE BLADES. Floyd B. Garrett and Charles A. Gyorgak. February 1953. 21p. photos., diagr., 4 tabs. (NACA RM E52L30) (Declassified from Confidential, 10/12/54)

The adhesive and protective characteristics of National Bureau of Standards Coating A-417 were investigated, as well as the effect of the coating on the life of forged Refractaloy 26 and cast Stellite 21 turbine blades. Coated and uncoated blades were run in a full-scale J33-9 engine and were subjected to simulated service operations consisting of consecutive 20-minute cycles (15 min at rated speed and approximately 5 min at idle). The ceramic coating adhered well to Refractaloy 26 and Stellite 21 turbine blades operated at 1500° F. The coating also prevented corrosion of the Refractaloy 26, a corrosion-sensitive nickel-base alloy, and of the Stellite 21, a relatively corrosion-resistant cobalt-base alloy. Although the coating prevented corrosion of both alloys, it had no apparent effect on blade life.

NACA RM E53A19

COMPARISON OF THEORETICALLY AND EXPERIMENTALLY DETERMINED EFFECTS OF OXIDE COATINGS SUPPLIED BY FUEL ADDITIVES ON UNCOOLED TURBINE-BLADE TEMPERATURE DURING TRANSIENT TURBOJET-ENGINE OPERATION. Louis J. Schafer, Jr., Francis S. Stepka and W. Byron Brown. March 1953. 45p. photos., diagrs., tab. (NACA RM E53A19) (Declassified from Confidential, 10/12/54)

An analysis was made to permit the calculation of the effectiveness of oxide coatings in retarding the transient heat flow into turbine blades when the combustion gas temperature of a turbojet engine is suddenly changed. The analysis is checked with experimental data obtained from a turbojet engine whose blades were coated with two different coating materials (silicon dioxide and boric oxide) by adding silicone oil and tributyl borate to the engine fuel. The very thin coatings (approximately 0.001 in.) that formed on the blades produced a negligible effect on the turbine-blade transient temperature response. From the analysis of this report it was possible to predict the turbine rotor-blade temperature response with a maximum error of 40° F.

NACA RM E53E22

BURNING RATES OF SINGLE FUEL DROPS AND THEIR APPLICATION TO TURBOJET COMBUSTION PROCESS. Charles C. Graves. July 1953. 35p. diagrs., photos., tab. (NACA RM E53E22) (Declassified from Confidential, 10/12/54)

Burning rates were determined for single isooctane drops suspended in various quiescent oxygen-nitrogen atmospheres at room temperature and pressure. The burning rates were compared with those predicted by a previously developed theory based on a heat- and mass-transfer mechanism and with values predicted by a modification to this theory. The drop-burning-rate data were applied to equations for a burning fuel spray in order to calculate the predicted change in burning rate of a fuel spray with variation in oxygen concentration. The results so obtained were compared with the change in combustion efficiency of a single turbojet combustor with inlet oxygen concentration, as determined in a previous investigation. The drop burning rates were proportional to drop diameter and increased approximately 34 percent when oxygen concentration of the surrounding oxygen-nitrogen atmosphere was raised from 17.0 to 34.9 percent by volume. The experimentally determined burning rates agreed well with those predicted by the modified heat- and mass-transfer theory. The predicted change in combustion efficiency with inlet oxygen concentration was appreciably smaller than that observed in the combustor tests.

NACA RM L51E24a

BUFFETING-LOAD MEASUREMENTS ON A JET-POWERED BOMBER AIRPLANE WITH REFLEXED FLAPS. John A. See and William S. Aiken, Jr. August 1951. 28p. diagrs., 3 tabs. (NACA RM L51E24a) (Declassified from Confidential, 10/12/54)

Buffet boundaries, buffeting-load increments for the stabilizers and elevators, and buffeting bending-moment increments for the stabilizers and wings as measured in gradual maneuvers for a jet-powered bomber airplane equipped with reflexed flaps and ailerons and tail tip incidence changes are presented and compared with similar results for the original airplane configuration. The Mach numbers of the tests ranged from 0.35 to 0.81 at pressure altitudes close to 30,000 feet. The predominant buffeting frequencies were close to the natural frequencies of the structural components. The magnitudes and trends of buffeting-load coefficients with Mach number for the reflexed-flap configuration were similar to those for the original configuration.

NACA RM L51G13

AN INVESTIGATION OF PROPELLER VIBRATIONS EXCITED BY WING WAKES. W. H. Gray and William Solomon. January 1952. 31p. diagrs., photo., tab. (NACA RM L51G13) (Declassified from Confidential, 10/12/54)

This paper shows the effect of airspeed and wing drag on the magnitude of vibratory stresses experienced by a propeller operating in a wing wake. It establishes the linearity of the relation between the stresses and the velocity at a fixed value of wing drag coefficient and between stress and drag coefficient at a fixed velocity. It also shows that an augmented stress may be experienced by a propeller operating too close behind the wing trailing edge.

NACA RM L51I12

PRESSURE PULSATIONS ON RIGID AIRFOILS AT TRANSONIC SPEEDS. Milton D. Humphreys. December 1951. 21p. diagrs., photos., tab. (NACA RM L51I12) (Declassified from Confidential, 10/12/54)

The effect of changes in Mach number, thickness ratio, and angle of attack on the amplitude of the instantaneous pressure pulsations acting on airfoils ranging in thicknesses from 4 to 12 percent chord has been obtained at transonic speeds, and the corresponding flows past the airfoils were recorded by high-speed schlieren motion pictures. The results indicate that reduction in airfoil thickness was accompanied by marked reductions in the severity of the aerodynamic pressure pulsations which contribute to airplane buffeting.

NACA RM L51J24

THE UNSYMMETRICAL LOAD AND BENDING MOMENT ON THE HORIZONTAL TAIL OF A JET-POWERED BOMBER MEASURED IN SIDESLIPPPING FLIGHT. T. V. Cooney. January 1952. 19p. diagrs., tab. (NACA RM L51J24) (Declassified from Confidential, 10/12/54)

Results are presented of an analysis of unsymmetrical tail-load and bending-moment measurements made during sideslipping flight tests of a jet-powered bomber airplane having a horizontal tail with 12° of geometric dihedral. The unsymmetrical loads and moments due to dihedral and to induction effects from the vertical tail are deduced from the measurements. A comparison of the results with estimates based on available theory was found to be favorable, suggesting that existing methods might be used to modify present arbitrary design requirements relating to unsymmetrical flight conditions.

NACA RM L51K08

LOW-SPEED STATIC LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF 60° TRIANGULAR-WING AND MODIFIED 60° TRIANGULAR-WING MODELS HAVING HALF-DELTA AND HALF-DIAMOND TIP CONTROLS. Jacob H. Lichtenstein and Byron M. Jaquet. February 1952. 36p. diagrs., photos., tab. (NACA RM L51K08) (Declassified from Confidential, 10/12/54)

The results are presented of an investigation made in the Langley stability tunnel to determine the low-speed static longitudinal stability and control effectiveness characteristics of a basic and a modified 60° triangular-wing model having 10-percent-wing-area half-delta and half-diamond, and 5-percent-wing-area half-diamond tip controls. Comparisons are made between the half-delta and half-diamond controls and between the basic and modified configurations.

NACA RM L51K19

WIND-TUNNEL INVESTIGATION OF A SHIELDED TOTAL-PRESSURE TUBE AT TRANSONIC SPEEDS. William Gracey, Albin O. Pearson and Walter R. Russell. January 1952. 8p. diagrs. (NACA RM L51K19) (Declassified from Confidential, 10/12/54)

The variation of total-pressure error with angle of attack of a shielded total-pressure tube having a curved venturi entry has been determined through an angle-of-attack range of 0° to 60° at Mach numbers ranging from 0.90 to 1.10. The results showed that the tube measured total pressure correctly (to within 1 percent of the impact pressure) for angles of attack up to about 57° at a Mach number of 0.90 and 56° at a Mach number of 1.10.

NACA RM L51K23

THE INTERFERENCE EFFECTS OF A BODY ON THE SPANWISE LOAD DISTRIBUTIONS OF TWO 45° SWEPTBACK WINGS OF ASPECT RATIO 8 FROM LOW-SPEED TESTS AT A REYNOLDS NUMBER OF 4×10^6. Albert P. Martina. February 1952. 48p. diagrs., photo., 2 tabs. (NACA RM L51K23) (Declassified from Confidential, 10/12/54)

Tests of two wing-body combinations have been conducted in the Langley 19-foot pressure tunnel at a Reynolds number of 4×10^6 and a Mach number of 0.19 to determine the effects of the bodies on the wing span load distributions. The wings had 45° sweepback of the quarter-chord line, aspect ratio 8.02, and taper ratio 0.45. One wing was untwisted and incorporated NACA 63_1A012 airfoil sections in the streamwise direction; the second wing was twisted and cambered. The wings were mounted in mid-high-wing positions on identical bodies of revolution of 10:1 fineness ratio having maximum diameters of 10 percent of the spans. The effects on the incremental loading due to the body resulting from wing incidence, upper-surface wing fences, and flap deflection were also determined for the plane wing. The body effects as calculated by using several existing methods are compared with the experimental results.

NACA RM L51K28

LONGITUDINAL FREQUENCY-RESPONSE CHARACTERISTICS OF THE DOUGLAS D-558-I AIRPLANE AS DETERMINED FROM EXPERIMENTAL TRANSIENT-RESPONSE HISTORIES TO A MACH NUMBER OF 0.90. Ellwyn E. Angle and Euclid C. Holleman. February 1952. 28p. diagrs., tab. (NACA RM L51K28) (Declassified from Confidential, 10/12/54)

Transient responses from elevator pulses of the Douglas D-558-I research airplane are analyzed by the Fourier transform to give the longitudinal frequency response of the airplane to a Mach number of 0.90 of altitudes between 30,000 and 37,000 feet.

NACA RM L51K28a

FLUTTER INVESTIGATION OF TWO THIN, LOW-ASPECT-RATIO, SWEPT, SOLID, METAL WINGS IN THE TRANSONIC RANGE BY USE OF A FREE-FALLING BODY. W. T. Lauten, Jr. and Maurice A. Sylvester. February 1952. 12p. diagrs., photo., 2 tabs. (NACA RM L51K28a) (Declassified from Confidential, 10/12/54)

Two thin, interceptor-type (low-aspect ratio), 45° sweptback, untapered wings of solid metal construction have been tested for flutter up to a Mach number of 1.23 by the free-falling-body technique. No flutter was obtained. Flutter calculations yielded results which showed that two-dimensional compressible flow theory is not adequate for predicting flutter for this type of low-aspect-ratio wing in the transonic speed range.

NACA RM L51L04

WIND-TUNNEL INVESTIGATION AT HIGH AND LOW SUBSONIC MACH NUMBERS OF A THIN SWEPTBACK WING HAVING AN AIRFOIL SECTION DESIGNED FOR HIGH MAXIMUM LIFT. Stanley F. Racisz and Nicholas J. Paradiso. February 1952. 46p. diagrs., photo., tab. (NACA RM L51L04) (Declassified from Confidential, 10/12/54)

An investigation has been made of a semispan wing with 45° sweepback, aspect ratio 4, and taper ratio 0.6, equipped with an airfoil section designed to have high maximum lift at low Mach numbers. The lift, drag, and pitching-moment characteristics were determined at Reynolds numbers ranging from 2×10^6 to 9×10^6 for Mach numbers below 0.2 for the wing with and without a split flap. The characteristics of the plain wing were also determined for several values of the Reynolds number at Mach numbers up to about 0.95. The results are compared with results obtained from tests of a wing with the same plan form but with the NACA 65A006 airfoil section.

NACA RM L51L11

AERODYNAMIC CHARACTERISTICS AT TRANSONIC SPEEDS OF A TAPERED 45° SWEPTBACK WING OF ASPECT RATIO 3 HAVING A FULL-SPAN FLAP TYPE OF CONTROL WITH OVERHANG BALANCE. TRANSONIC-BUMP METHOD. Vernard E. Lockwood and John R. Hagerman. January 1952. 24p. diagrs. (NACA RM L51L11) (Declassified from Confidential, 10/12/54)

Lift, pitching-moment, rolling-moment, and flap hinge-moment coefficients were obtained by the transonic bump method on a 45° sweptback wing of aspect ratio 3, and taper ratio of 0.5, and an NACA 64A010 section, employing a 0.254-chord full-span flap. The flap had a 50-percent flap-chord elliptical-nose overhang. The investigation was made at angles of attack of -4°, 0°, 4°, and 8°, flap deflections from -28° to 6°, and Mach numbers from 0.6 to 1.15. The results are compared with the same flap without overhang.

NACA RM L51L14

LOW-SPEED TESTS OF A FREE-TO-YAW MODEL IN TWO WIND TUNNELS OF DIFFERENT TURBULENCE. Jones F. Cahill and John D. Bird. February 1952. 12p. diagrs., photos. (NACA RM L51L14) (Declassified from Confidential, 10/12/54)

Tests have been made at low speeds in the Langley low-turbulence pressure tunnel which has a very low turbulence level and the Langley stability tunnel which has a turbulence level approximately ten times as great in order to determine the extent of any resulting oscillations of a model mounted with freedom in yaw and in order to demonstrate the extent to which directional fluctuations in an air stream can be responsible for such oscillations. Tests covered a range of dynamic pressures from 4 to 175 pounds per square foot with associated ranges of Reynolds numbers and Mach numbers from 1.5×10^6 to 4.6×10^6 and 0.05 to 0.34, respectively.

NACA RM L51L19

PRELIMINARY INVESTIGATION OF THE EFFECTS OF A PADDLE BALANCE ON THE CONTROL CHARACTERISTICS AT TRANSONIC SPEEDS OF A TAPERED 45.58° SWEPTBACK WING OF ASPECT RATIO 3 HAVING A FULL-SPAN FLAP-TYPE CONTROL. William C. Moseley, Jr. February 1952. 24p. diagrs., photo. (NACA RM L51L19) (Declassified from Confidential, 10/12/54)

A preliminary investigation at transonic speeds was made on a wing having a quarter-chord line swept back 45.58°, an aspect ratio of 3, a taper ratio of 0.5, and an NACA 64A010 airfoil section. The Reynolds number of the tests was approximately 1,000,000. The wing had a full-span flap tested with and without a paddle balance. The paddle balance was capable of balancing excessive control hinge moments with only slight effects on the lift and rolling-moment characteristics.

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CURRENT NACA REPORTS

NACA Rept. 1133

MECHANISM OF START AND DEVELOPMENT OF AIRCRAFT CRASH FIRES. I. Irving Pinkel, G. Merritt Preston and Gerald J. Pesman. 1953. iii, 52p. diagrs., photos., 2 tabs. (NACA Rept. 1133. Formerly RM E52F06)

Full-scale aircraft crashes were made to investigate the mechanism of the start and development of aircraft crash fires. The results are discussed herein. This investigation revealed the characteristics of the ignition sources, the manner in which the combustibles spread, the mechanism of the union of the combustibles and ignition sources, and the pertinent factors governing the development of a crash fire as observed in this program.

NACA Rept. 1134

PHOTOGRAPHIC INVESTIGATION OF COMBUSTION IN A TWO-DIMENSIONAL TRANSPARENT ROCKET ENGINE. Donald R. Bellman, Jack C. Humphrey and Theodore Male. 1953. ii, 12p. diagrs., photos., tab. (NACA Rept. 1134. Formerly RM E8F01)

Motion pictures at camera speeds up to 3000 frames per second were taken of the combustion of liquid oxygen and gasoline in a 100-pound thrust rocket engine. The effect of seven methods of propellant injection on the uniformity of combustion was investigated. The flame front was generally found to extend to the injector faces and all the injection systems showed considerable nonuniformity of combustion. Pressure vibration records indicated combustion vibrations that corresponded to resonant-chamber frequencies.

NACA Rept. 1151

THE EFFECTS ON DYNAMIC LATERAL STABILITY AND CONTROL OF LARGE ARTIFICIAL VARIATIONS IN THE ROTARY STABILITY DERIVATIVES. Robert O. Schade and James L. Hassell, Jr. 1953. ii, 24p. diagrs., photo., 2 tabs. (NACA Rept. 1151. Formerly TN 2781)

The results of an experimental and theoretical investigation of the effects of large artificial variations of four rotary stability derivatives on the dynamic lateral stability and control of a 45° sweptback-wing airplane model are presented. The experimental results are presented mainly in the form of flight ratings for stability, control, and general flight behavior. Calculations of period and damping and of the response to rolling and yawing disturbances are also presented.

NACA Rept. 1163

A VISUALIZATION STUDY OF SECONDARY FLOWS IN CASCADES. Howard Z. Herzig, Arthur G. Hansen and George R. Costello. 1954. ii, 51p. diagrs., photos. (NACA Rept. 1163. Formerly TN 2947; RM E52F19)

Flow-visualization techniques are employed to ascertain the streamline patterns of the nonpotential, secondary flows in the boundary layers of cascades, thereby providing a basis for more extended analyses in turbomachines. The three-dimensional deflection of the end-wall boundary layer results in the formation of a vortex well up in each cascade passage. The size and tightness of the vortex generated depend upon the main flow turning in the cascade passage. Once formed, a vortex resists turning in subsequent blade rows. This results in unfavorable angles of attack and possible flow disturbances on the pressure surfaces of subsequent blade rows when the vortices impinge on these surfaces. Two major tip-clearance effects are observed: the formation of a tip-clearance vortex, and the scraping effect of a blade with relative motion past the wall boundary layer. The flow patterns indicate methods for improving the blade-tip loading characteristics of compressors and of low- and high-speed turbines.

NACA Rept. 1164

CONVECTION OF A PATTERN OF VORTICITY THROUGH A SHOCK WAVE. H. S. Ribner. 1954. ii, 17p. diagrs. (NACA Rept. 1164. Formerly TN 2864)

An arbitrary weak spatial distribution of vorticity can be represented in terms of plane sinusoidal shear waves of all orientations and wave lengths (Fourier integral). The analysis treats the passage of a single representative weak shear wave through a plane shock and shows refraction and modification of the shear wave with simultaneous generation of an acoustically intense sound wave. Applications to turbulence and to noise in supersonic wind tunnels are indicated.

NACA Rept. 1171

EFFECT OF HORIZONTAL-TAIL SPAN AND VERTICAL LOCATION ON THE AERODYNAMIC CHARACTERISTICS OF AN UNSWEPT TAIL ASSEMBLY IN SIDESLIP. Donald R. Riley. 1954. ii, 20p. diagrs., photos., tab. (NACA Rept. 1171. Formerly TN 2907)

Wind-tunnel results on the effect of hoirzontal-tail span and vertical location of the horizontal tail relative to the vertical tail on the aerodynamic

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characteristics of an unswept vertical-tail assembly in sideslip are presented. By applying the well-known discrete-horseshoe-vortex method used for wings to the problem of intersecting surfaces, theoretical span loadings were obtained for each of the configurations tested. Calculated values obtained from the span loadings are compared with experimental results.

NACA Rept. 1172

A STUDY OF THE APPLICATION OF POWER-SPECTRAL METHODS OF GENERALIZED HARMONIC ANALYSIS TO GUST LOADS ON AIRPLANES. Harry Press and Bernard Mazelsky. 1954. ii, 17p. diagrs., 2 tabs. (NACA Rept. 1172. Formerly TN 2853)

The applicability of some results from the theory of generalized harmonic analysis to the analysis of gust loads on airplanes in continuous rough air is examined. The input and output relations in terms of power spectrums are used to relate the standard deviation (root mean square) of loads in continuous rough air to the gust response characteristics of the airplane and the spectral characteristics of atmospheric turbulence. For the case of a normally distributed output, which appears from experimental evidence to apply to a homogeneous turbulence condition, the probability distribution of loads is shown to be a simple function of the output power spectrum. In order to illustrate the application of power-spectral analysis to gust loads and to obtain an insight into the relation between loads in continuous rough air and the gust response characteristics of the airplane, two selected series of calculations are presented. The results of these applications are compared with those obtained from calculations for single gusts and their implications are discussed.

NACA TM 1366

HEAT TRANSFER BY FREE CONVECTION FROM HORIZONTAL CYLINDERS IN DIATOMIC GASES. (Wärmeübergang bei breier Strömung am wagrechten Zylinder in zweiatomigen Gasen). R. Hermann. November 1954. 73p. diagrs., photos., 6 tabs. (NACA TM 1366. Trans. from VDI Forschungsheft, No. 379, 1936)

Heat transfer by free convection from horizontal cylinders in diatomic gases is investigated theoretically and experimentally. The heat transfer is given by the theoretical equation $Nu = 0.37(Gr)^{1/4}$ for $10^4 < Gr < 3 \times 10^8$. Experimental determinations of velocity, temperature, and heat transfer are in good agreement with the theory. It is found that the total heat transfer and the boundary-layer development at the upper stagnation point and at the upper edge, respectively, of a horizontal cylinder are equivalent to the respective quantities for a vertical plate which transfers heat on both sides and is 1.31 times the cylinder diameter. A review and discussion of previous investigations of free-convection heat transfer from horizontal cylinders is included.

NACA TM 1373

ON FORCE-DEFLECTION DIAGRAMS OF AIRPLANE SHOCK ABSORBER STRUTS. FIRST, SECOND, AND THIRD PARTIAL REPORTS. (Zur Kenntnis der Kraftwegdiagramme von Flugzeugfederbeinen). K. Schlaefke. November 1954. 48p. diagrs., 4 tabs. (NACA TM 1373. Trans. from Technische Berichte, v. 11, nos. 2, 4, & 5, 1944)

This paper, which is presented in three parts, is an analytical study of the behavior of landing-gear shock struts, with various types of assumptions for the shock-strut characteristics. The effects of tire springing are neglected. The first part compares the behavior of struts with linear and quadratic damping. The second part considers struts with nonlinear spring characteristics and linear or quadratic damping. The third part treats the oleo-pneumatic strut with air-compression springing without damping and with damping proportional to velocity. It is indicated how the damping factor can be determined by experiment.

NACA TM 1378

DETERMINATION OF THE ELASTIC CONSTANTS OF AIRPLANE TIRES. (Ermittlung der elastischen Konstanten von Flugzeugreifen). Boeckh. November 1954. 39p. diagrs. (NACA TM 1378. Trans. from Focke-Wulf Flugzeugbau G.m.b.H, Bremen, V.13.3703)

Measurements were made of the distortion of four German aircraft tires, from about 22 to 28 inches in diameter, at several vertical loadings. For each vertical loading measurements were made of the tire distortion under several lateral, tangential and torsional loadings.

NACA TM 1381

ON THE DETERMINATION OF CERTAIN BASIC TYPES OF SUPERSONIC FLOW FIELDS. (Sulla determinazione di alcuni tipi di campi di corrente ipersonora). Carlo Ferrari. November 1954. 17p. diagrs. (NACA TM 1381. Trans. from Rendiconti della R. Accademie Nazionale dei Lincei, Series 8, v. 7, no. 6, Dec. 1949)

A discussion is given of the application of Fourier series techniques to the problems of linearized supersonic flow. The formulation presented is an extension of the doublet type of "fundamental solution" to higher order types of singularity. The equations developed have application to wing theory but are primarily of importance in wing-body interaction problems. A specific example of a wing-body interference problem is discussed in light of the presented methods.

NACA TN 3217

THE INFLUENCE OF WHEEL SPIN-UP ON LANDING-GEAR IMPACT. W. Flügge and C. W. Coale, Stanford University. October 1954. ii, 107p. diagrs., 8 tabs. (NACA TN 3217. Continuation of TN 2743)

This report deals with the influence of wheel drag on landing-gear performance. The differential equations are developed and solved by numerical integration and by an analytical method. Emphasis is placed on dropping influences of minor importance to simplify the computations. Consideration is also given to the influence of offset wheels, inclined shock struts, and friction due to ovalization of the shock-strut cylinder under bending loads.

NACA TN 3219

VISCOSITY CORRECTIONS TO CONE PROBES IN RAREFIED SUPERSONIC FLOW AT A NOMINAL MACH NUMBER OF 4. L. Talbot, University of California. November 1954. 39p. diagrs., photo., 4 tabs. (NACA TN 3219)

Viscosity correction data were obtained for a set of geometrically similar cone probes in supersonic rarefied air flow at a nominal Mach number of 4. Additional experiments were made to determine cone surface pressure distributions and the effects of variable orifice size on the measurement of cone surface pressure. Pressure distributions near the vertex were compared with the tangent-cone and linearized theories.

NACA TN 3242

PRELIMINARY RESULTS FROM FLOW-FIELD MEASUREMENTS AROUND SINGLE AND TANDEM ROTORS IN THE LANGLEY FULL-SCALE TUNNEL. Harry H. Heyson. November 1954. 19p. diagrs., photos. (NACA TN 3242)

Measurements of the flow angles and velocities near lifting helicopter rotors, both single and tandem, at a tip-speed ratio of 0.15 are presented and compared with those of theory. The comparison indicates that the theory is sufficiently accurate for use in preliminary design calculations. The flow behind a rotor is shown to be very much like the flow behind a wing.

NACA TN 3252

DESCRIPTION AND PRELIMINARY FLIGHT INVESTIGATION OF AN INSTRUMENT FOR DETECTING SUBNORMAL ACCELERATION DURING TAKE-OFF. Garland J. Morris and Lindsay J. Lina. November 1954. 19p. diagrs., photos. (NACA TN 3252)

An instrument actuated by longitudinal acceleration and impact pressure has been proposed which would give a quick and easily recognizable quantitative indication of loss in airplane acceleration during take-off. A preliminary evaluation from flight tests of a simplified prototype instrument mounted in a jet trainer has been made. The instrument was found to be satisfactory and the response of the indicator to simulated partial power loss was rapid.

NACA TN 3260

SMOKE STUDY OF NOZZLE SECONDARY FLOWS IN A LOW-SPEED TURBINE. Milton G. Kofskey and Hubert W. Allen. November 1954. 24p. diagrs., photos. (NACA TN 3260)

Still and motion pictures were made of boundary-layer and wake secondary-flow phenomena visualized by smoke. Two annular cascades of turbine nozzles were used, both designed for constant discharge angle but differing in blade shape and suction-surface velocity distribution. Flows were similar to those obtained with pressure and angle measurements at near-sonic airspeeds. Boundary-layer cross-channel and trailing-edge radial flows caused vortices and an accumulation of low-momentum air at the hub, which may affect flow in following blade rows. Motion of a downstream rotor blade row produced pulsations in trailing-edge radial flow. The motion-picture supplement may be obtained on loan from NACA Headquarters, Washington, D. C.

NACA TN 3268

SHEARING-STRESS MEASUREMENTS BY USE OF A HEATED ELEMENT. H. W. Liepmann and G. T. Skinner, California Institute of Technology. November 1954. 27p. diagrs. (NACA TN 3268)

The present report discusses the use of an instrument to determine the local skin-friction coefficient by measurement of heat transfer from small elements embedded in the surface. The range of application of such instruments is discussed and experimental data are presented to show that a simple instrument consisting of an ordinary hot-wire cemented into a groove in the surface can be used to obtain laminar and turbulent skin-friction coefficients with a single calibration.

NACA TN 3283

AERODYNAMIC FORCES, MOMENTS, AND STABILITY DERIVATIVES FOR SLENDER BODIES OF GENERAL CROSS SECTION. Alvin H. Sacks. November 1954. (i), 74p. diagrs., 2 tabs. (NACA TN 3283)

Formulas are developed for forces and moments in terms of the body shape and motions, and for stability derivatives in terms of the mapping functions of the cross sections. Relationships are found among the various derivatives, and calculations are made for several configurations. The influence of the squared terms in the pressure relation is demonstrated, and the use of the apparent mass concept is discussed in detail.

NACA TN 3286

GENERALIZED INDICIAL FORCES ON DEFORMING RECTANGULAR WINGS IN SUPERSONIC FLIGHT. Harvard Lomax, Franklyn B. Fuller and Loma Sluder. November 1954. 74p. diagrs., tab. (NACA TN 3286)

A method is presented for determining the time-dependent flow over a rectangular wing moving with a supersonic forward speed and undergoing small vertical distortions expressible as polynomials involving spanwise and chordwise distances. Results are expressed in terms of generalized indicial forces. Numerical results for Mach numbers of 1.1 and 1.2 are given for polynomials of the first and fifth degree in the chordwise and spanwise directions, respectively, on a wing of aspect ratio 4.

NACA TN 3291

EXPERIMENTAL INVESTIGATION OF NOTCH-SIZE EFFECTS ON ROTATING-BEAM FATIGUE BEHAVIOR OF 75S-T6 ALUMINUM ALLOY. W. S. Hyler, R. A. Lewis and H. J. Grover, Battelle Memorial Institute. November 1954. 47p. diagrs., photos., 12 tabs. (NACA TN 3291)

This investigation was initiated to study the influence of size, particularly the notch size, on extruded 75S-T6 aluminum-alloy test specimens. Unnotched and notched specimens with five different minimum-section diameters were tested. For each size a semicircular groove was tested and for the largest diameter specimen a V-notch was also tested. A method of surface preparation was selected that would produce comparable surface finishes in different-sized notched and unnotched specimens.

NACA TN 3292

INFLUENCE OF EXPOSED AREA ON STRESS-CORROSION CRACKING OF 24S ALUMINUM ALLOY. William H. Colner and Howard T. Francis, Armour Research Foundation. November 1954. 22p. diagrs., photos., tab. (NACA TN 3292)

Results are presented of a study of the "area effect" in 24S aluminum alloy. This effect is the phenomenon whereby small exposed areas show long times to stress-corrosion failure, whereas large areas show short times. The effects of stress level, degree of sensitivity of the alloy, and hydrogen peroxide concentration in the corrosion medium were studied. Hydrogen peroxide decomposition and the substitution of oxygen for peroxide were also investigated.

NACA TN 3305

SOME MEASUREMENTS AND POWER SPECTRA OF RUNWAY ROUGHNESS. James H. Walls, John C. Houbolt and Harry Press. November 1954. 27p. diagrs., tab. (NACA TN 3305)

Measurements of actual runway roughness obtained by a profile-survey method (engineer's level) are presented. Data were obtained from a survey of a relatively rough runway and a smooth runway. The results of this study are presented as roughness profiles of the runways surveyed and in the form of power spectra.

NACA TN 3308

AN EXPLORATORY INVESTIGATION OF SOME TYPES OF AEROELASTIC INSTABILITY OF OPEN AND CLOSED BODIES OF REVOLUTION MOUNTED ON SLENDER STRUTS. S. A. Clevenson, E. Widmayer, Jr. and Franklin W. Diederich. November 1954. 44p. diagrs., photos., 3 tabs. (NACA TN 3308. Formerly RM L53E07)

The aeroelastic instability of rigid open and closed bodies of revolution mounted on thin, flexible struts has been investigated experimentally at low speeds. Three types of instability were observed - coupled flutter, divergence, and an uncoupled oscillatory instability which consists in continuous or intermittent small-amplitude yawing oscillations. An attempt has been made to calculate the airspeeds and, in the case of the oscillatory phenomena, the frequencies at which these types of instability occur by using slender-body theory for the aerodynamic forces on the bodies.

NACA TN 3310

INVESTIGATION OF STATIC STRENGTH AND CREEP BEHAVIOR OF AN ALUMINUM-ALLOY MULTIWEB BOX BEAM AT ELEVATED TEMPERATURES. Eldon E. Mathauser. November 1954. 21p. diagrs., photos., 4 tabs. (NACA TN 3310)

Results of an investigation to determine static strength and creep behavior at elevated temperatures of 24S-T3 aluminum-alloy multiweb box beams are presented. Methods that were used to predict failure stresses in the static-strength tests were in good agreement with the experimental results. Creep deflections and creep lifetimes are presented for beams subjected to constant load and various heating conditions. Lifetime is satisfactorily predicted from material stress-rupture data when tensile failure occurs at both constant and varying temperatures.

NACA TN 3313

SOME MEASUREMENTS OF ATMOSPHERIC TURBULENCE OBTAINED FROM FLOW-DIRECTION VANES MOUNTED ON AN AIRPLANE. Robert G. Chilton. November 1954. 22p. diagrs., photo., tab. (NACA TN 3313)

The power spectrum of high-frequency turbulence in the atmosphere was calculated from measurements made in flight. The spectrum was found to display an inverse variation with the square of frequency. This variation is in agreement with the high-frequency asymptote of the spectrum form commonly associated with isotropic turbulence. Flow-direction vanes were used to measure vertical and horizontal components of gust velocity relative to the airplane and normal to the flight direction. The power spectral densities of the two components were, for practical purposes, equal.

NACA TN 3315

TENSILE AND COMPRESSIVE STRESS-STRAIN PROPERTIES OF SOME HIGH-STRENGTH SHEET ALLOYS AT ELEVATED TEMPERATURES. Philip J. Hughes, John E. Inge and Stanley B. Prosser. November 1954. 32p. diagrs., photos., 6 tabs. (NACA TN 3315)

Results of tensile and compressive stress-strain tests at temperatures up to 1,200° F are presented for SAE 4340, Hy-Tuf, Stainless W, and Inconel X sheet materials which had ultimate tensile strengths at room temperature in the 170 to 220 ksi range. Representative tensile and compressive stress-strain curves are given for each material at the test temperatures. Secant and tangent moduli, obtained from the compressive data, are included.

NACA TN 3343

SUBSONIC EDGES IN THIN-WING AND SLENDER-BODY THEORY. Milton D. Van Dyke. November 1954. 26p. diagrs. (NACA TN 3343)

A simple technique is presented for correcting the singularities predicted by thin-wing and slender-body theory at subsonic edges. Thus, Lighthill's rule for speeds on round-nosed airfoils in incompressible flow is extended to higher approximations, compressible flow, three-dimensional wings, sharp edges, and slender bodies of revolution.

NACA TN 3345

ARRANGEMENT OF FUSIFORM BODIES TO REDUCE THE WAVE DRAG AT SUPERSONIC SPEEDS. Morris D. Friedman and Doris Cohen. November 1954 23p. diagrs. (NACA TN 3345. Formerly RM A51I20)

Using linearized slender-body theory and reverse-flow theorems, the wave drag of a system of fusiform bodies at zero angle of attack and supersonic speeds is studied to determine the effect of varying the relative location of the component parts. It is found that in certain arrangements the interference effects are beneficial, and may even result in a two- or three-body system having no more wave drag than the principal body alone. The most favorable location appears to be one in which the maximum cross section of the auxiliary body is slightly forward of the Mach cone from the tail of the main body.

BRITISH REPORTS

N-33504*

Forest Products Research Lab. (Gt. Brit.)
TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. SEPETIR - PSEUDOSINDORA PALUSTRIS - SARAWAK. (POUNDS PER CUBIC FOOT AT 15 PER CENT MOISTURE CONTENT) PROGRESS REPORT TWENTY-FOUR. August 1954. 17p. (Forest Products Research Lab.)

Thirteen 5-ft 3-in. billets were used for obtaining yield data and two were used for processing trials. Good green veneer was smooth and free from defects except end splits, which were rather numerous and hindered spooling. The extreme straightness of the grain resulted in easy breakage and made high-speed power spooling impossible. Generally the veneer was similar in texture to afara. The heartwood and sapwood had similar drying properties but the sapwood is a greenish color very distinct from the pinkish heartwood. It is classified as being unsuited to British mills but is technically sound for plywood making and might be of value for this purpose in the country of origin.

N-34046*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF SURFACE FINISH ON THE FATIGUE RESISTANCE OF TWO ALUMINIUM ALLOYS. N. J. F. Gunn. March 1954. 19p. diagrs., 13 tabs. (RAE Tech. Note Met. 196)

Tests have been made on two aluminum alloys D.T.D. 683 and B.S.S. 6L1 to ascertain the effect of four finishes on their fatigue strength. The finishes were: rough machined, fine machined, circumferentially polished, and longitudinally polished. The fatigue:ultimate ratios for both materials were found to be approximately: rough machined - 0.30; fine machined - 0.30; circumferentially polished - 0.32; longitudinally polished - 0.34.

N-34048*

Royal Aircraft Establishment (Gt. Brit.)
A GENERALISATION OF THE NYQUIST STABILITY CRITERION WITH PARTICULAR REFERENCE TO PHASING ERROR. R. H. Merson. May 1954. 9p. diagr. (RAE Tech. Note GW 316)

The effect of phasing error on the stability of a two-dimensional linear servomechanism is considered and it is shown that the system will be stable if the phase margin at the cut-off frequency exceeds the phasing error. The more general case of a number of identical servos with cross coupling is investigated and a generlization of the Nyquist criterion for stability is formulated.

N-34049*

Royal Aircraft Establishment (Gt. Brit.)
THE DETERMINATION OF CALCIUM IN TITANIUM METAL. H. J. Allsopp. May 1954. 9p., 7 tabs. (RAE Tech. Note Met. 198)

In the method described, titanium is removed by volatilization as the tetrachloride and the calcium are estimated volumetrically using disodium-ethylenediaminetetra-acetate. The effect of reagent concentrations and some interfering elements has been studied.

N-34051*

Royal Aircraft Establishment (Gt. Brit.)
DIELECTRIC MEASUREMENTS ON SOME LAMINATING RESINS AND THE EFFECT OF MOISTURE ABSORPTION AND TEMPERATURE. A. A. Fyall and J. H. Sewell. June 1954. 29p. diagrs., 16 tabs. (RAE Tech. Note Chem. 1233)

Values are given for the dielectric constant and loss tangent of several resins having potential application in the fabrication of glass-fiber reinforced radomes. Dielectric properties were measured on dry materials and also on materials subjected, for varying periods of time, to tropical conditioning in a humidity chamber. When the resin composition could be varied, that giving the optimum dielectric performance was ascertained. Where possible, measured values were compared with those obtained theoretically. The merits of the resins are compared and their best values summarized.

N-34053*

Royal Aircraft Establishment (Gt. Brit.)
THE ESTIMATION OF SIZE ON GLASS FABRICS: TWO NEW METHODS. E. Haythornthwaite and R. B. King. June 1954. 15p. diagrs., photo., 3 tabs. (RAE Tech. Note Chem. 1231)

Two new methods for the estimation of the size content of glass fabrics have been examined. One method depends on the gasometric estimation of carbon dioxide formed from the carbon present on a fabric sample. The other is a modified volatile loss method suitable for control purposes and designed to minimize the errors inherent in previous methods. Excellent correlation between the results from the two methods was obtained.

N-34055*

Royal Aircraft Establishment (Gt. Brit.)
A NEW HIGH SPEED PHOTOGRAPHIC TECHNIQUE APPLIED TO THE INVESTIGATION OF BUBBLES BURSTING AT AN AIR-WATER INTERFACE. R. L. Aspden. July 1954. 26p. diagrs., photos., 3 tabs. (RAE Tech. Note Instn. 141)

The Colourflash system, a method of picture separation by frequency discrimination whereby a limited number of large negatives of optimum quality can be secured at a rate which is essentially unlimited, and with equipment containing no moving parts, is described in its application to the problems under consideration. A selection of photographs showing processes in the buildup and disintegration of smoke filled bubbles is included.

N-34056*

Royal Aircraft Establishment (Gt. Brit.)
CALIBRATION AND DESCRIPTION OF THE EXHAUSTER SECTION OF THE HIGH ALTITUDE TEST PLANT. E. Simpson and F. S. Margrie. May 1954. 47p. diagrs., photos. (RAE Tech. Note Aero 2303. Formerly RAE Tech. Memo. Aero 329)

This note gives a brief description of the Ex L. F. A. Exhauster Plant now installed at R. A. E. as a unit of the High Altitude Test Plant. The means used to calibrate the plant are described. Results of calibrations indicate that with different combinations of units, at mass flows varying from 1.5 to 4.5 lb/sec pressures of 0.75 inch Hg to 2 inches Hg absolute could be obtained, and at mass flows varying from 3 lb/sec to 8.5 lb/sec pressures of 1.35 inches Hg to 3.3 inches Hg were obtainable. Approximate relative efficiencies are given and lines of possible improvement indicated. A detailed description of the plant and the modifications introduced as a result of operational experience is given. This note is the first of a series describing and giving calibrations of various sections of the High Altitude Plant.

N-34057*

Aeronautical Research Council (Gt. Brit.)
A SIMPLE APPROACH TO THE THEORY OF SECONDARY FLOWS. J. H. Preston. December 10, 1953. 19p. diagrs. (ARC 16,394; FM 1996; EA 320)

A simple method is developed for computing the secondary trailing vorticity which arises when a nonuniform stream is turned. The essential results derived by Squire and Winter and by Hawthorne are obtained with a minimum of analysis and the reason for the secondary trailing vorticity is physically evident. It is shown that for a sudden deflection of a nonuniform stream, no trailing vorticity is set up in the exit flow and hence there is no secondary motion. It is also shown that for small angles of deflection there is no net circulation downstream of a cascade of finite dimensions and it is inferred that this should be true also for large deflections.

N-34106*

Royal Aircraft Establishment (Gt. Brit.)
A CROSSED-FIELDS MULTIPLIER. J. A. Roberts and D. C. Pressey. April 1954. 88p. diagrs., photos., tab. (RAE Tech. Note Arm. 516)

Fed-back d-c amplifiers controlling crossed electric and magnetic fields in a simple bucket cathode-ray tube, VCRX. 340, enable a natural product law to be used in this high-speed, four-quadrant multiplier for analogue computers. The development, design, and theoretical and measured performance are described. Direct measurement shows the static errors to be less than 1 percent of full output, while the change of scale-factor with frequency does not reach 1 percent until 10 kc/s. The power consumption is only 50 w total. The zero drift is small and the long-term stability excellent.

N-34111*

Aeronautical Research Council (Gt. Brit.)
ON THE TURBULENT BOUNDARY LAYER ON A FLAT PLATE OF FINITE WIDTH. A. A. Townsend. March 3, 1954. 10p. diagrs. (ARC 16,618; FM 2042)

A theory is developed for edge effect on the turbulent boundary layer on a flat plate of finite width by considering the equations of motion for the flow.

N-34113*

Aeronautical Research Council (Gt. Brit.)
AN EXPERIMENTAL INVESTIGATION OF THE INTERACTION OF A SHOCK WAVE WITH A SUBSONIC STREAM BOUNDED BY A WALL. D. W. Holder, A. Chinneck and G. E. Gadd. February 11, 1954. 17p. diagrs., photos., tab. (ARC 16,559; FM 2025)

A study has been made of a model of a boundary layer consisting of a subsonic stream bounded on one side by a wall and on the other by a supersonic main stream. The subsonic stream was approximately uniform at the point where it first met the main stream, but it became progressively less uniform downstream of this point because of mixing with the main stream and the growth of the boundary layer at the wall. Particular attention is given to the pressure rise which takes place at the wall when a wedge is attached to it. The pressure begins to rise ahead of the apex of the wedge, this upstream effect increases as the Mach number of the secondary stream is reduced.

MISCELLANEOUS

NACA Rept. 1133

Errata No. 1 on "MECHANISM OF START AND DEVELOPMENT OF AIRCRAFT CRASH FIRES." I. Irving Pinkel, G. Merritt Preston and Gerard J. Pesman. 1954.

NACA TN 1315

Errata No. 1 on "FREE-FALLS AND PARACHUTE DESCENTS IN THE STANDARD ATMOSPHERE." A. P. Webster. June 1947.

N-22389*

Advisory Group for Aeronautical Research and Development. SOME ASPECTS OF COMBUSTION OF LIQUID FUEL. Charles C. Graves and Melvin Gerstein. (Scheveningen Netherlands Conference, May 3-7, 1954) 26p. diagrs., photo. (AGARD AG16/M10)

In this paper the combustion of liquid sprays is considered in terms of such individual processes as fuel spray spreading and evaporation. In addition, the efficiency of combustion of liquid fuels in turbojet combustors as affected by fuel volatility, spray characteristics, and the burning rate of single drops is treated. The scope of this paper is limited to a discussion of these factors normally associated with diffusion flames.

N-25254*

Advisory Group for Aeronautical Research and Development. A SCHEME OF AUTOMATIC DATA REDUCTION FOR WIND TUNNELS. K. V. Diprose. (London AGARD Conference, September 3-11, 1953) 17p. diagrs., photos. (AGARD AG9/M5)

The need for automatic devices to speedup reduction of data obtained from wind tunnels in the RAE first became urgent during the war. Up to the present little of the analogue computing equipment suggested in the original plan has been constructed. One computer giving tunnel Mach number was constructed in 1948 and has been in operation ever since in the 10- by 7-foot high-speed tunnel. A "breadboard" model of a computer to calculate uncorrected force coefficients has been made. The design of plotting tables as an alternative form of output is well advanced. Their principal use will be in intermittent wind tunnels where time available for a complete run does not permit printing typed answers.

N-30835A*

Advisory Group for Aeronautical Research and Development. A NOTE ON THE USE OF STRAIN GAUGES IN WIND TUNNEL BALANCES. J. R. Anderson. (London AGARD Conference, September 3-11, 1953) 20p. diagrs., photo. (AGARD AG10/M6)

This paper records some of the experience obtained in the use of strain gage balances in the smaller high-speed wind tunnels of Aerodynamics Department, R.A.E. The discussion is therefore a little restricted in scope, being for the most part limited to the use of bonded, resistance type electrical strain gages in force and moment balances intended for use with models ranging from about 0.4 in. to 1.5 in. in diameter. Much of the discussion should prove of interest in the design of larger installations: for example, the comments which are made on the effects of temperature on the strain gages.

N-33567*

Advisory Group for Aeronautical Research and Development. FORMATION ET DEPOT DE CARBONE DANS LES FOYERS DE TURBOMACHINES D'AVIATION. C. Fouré. (Scheveningen Netherlands Conference, May 3-7, 1954) 21p. diagrs., photos. (AGARD AG12/M8)

Operating with accepted fuels, modern reactionary turbines are not seriously troubled by the formation of carbon deposits. The change towards high compression and towards the use of less powerful fuels alter this situation. The role of certain characteristics of fuels have been clarified. A great deal is yet to be learned about additives to reduce deposits, but modifications can be imagined which may reduce the formation of carbon during combustion in order to prevent eventual deposits on the walls.

N-33583*

DESIGN AND OPERATING TECHNIQUES OF VERTICAL SPIN TUNNELS. A. I. Neihouse. (Presented to Wind Tunnel and Model Testing Panel of Advisory Group for Aeronautical Research and Development, Paris, France, November 2-6, 1954) 16p. diagrs., photos., 2 tabs.

Dynamic tests in a spin tunnel, aided by auxiliary tools and techniques including analytical methods, offers a practical method for a better understanding

of the spinning motion and the recovery therefrom. Just how the moments and forces affect the picture, and just what part the stability characteristics of the airplane at large attitude angles play can be determined by proper research effort. That such effort is necessary has been demonstrated in the past and by experiences with current airplanes; that the problem of spin recovery may become more critical is likely. Adequate facilities to do spin research, however, should lead to eventual solution of the existing problem.

N-33609*

TRANSONIC WIND TUNNEL DEVELOPMENT OF THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS. H. Julian Allen. (Presented to Wind Tunnel and Model Testing Panel of Advisory Group for Aeronautical Research and Development, Paris, France, November 2-6, 1954) 22p. diagrs., photo.

The development of transonic wind tunnels at the Langley and Ames Aeronautical Laboratories of the NACA is discussed. Two types of wind tunnels suitable for transonic wind tunnel operation are described: the fixed geometry slotted-wall type and the variable-geometry ventilated wall (slotted or porous) type.

N-33610*

DEVELOPMENT OF TWO HYPERSONIC TEST FACILITIES AT THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS, AMES AERONAUTICAL LABORATORY. H. Julian Allen. (Presented to Wind Tunnel and Model Testing Panel of Advisory Group for Aeronautical Research and Development, Paris, France, November 2-6, 1954) 41p. diagrs., photos., tab.

Two facilities for hypersonic research which have been developed at the Ames Aeronautical Laboratory are discussed. The first facility is a wind tunnel which is of interest because of its ability to operate continuously over a wide range of speeds with a not-too-complex drive system; while the second is a combination wind tunnel and ballistics range which allows operation over an even wider range of speeds up to speeds which are very difficult to attain in a wind tunnel of the more conventional type.

UNPUBLISHED PAPERS

N-25802*

THE ROTATING WING AS A RADIATION PROBLEM. (Der rotierende Tragflügel als Strahlungsproblem). Wilhelm Ernsthausen. September 1954. 40p. diagrs., photos. (Trans. from Zeitschrift für angewandte Mathematik und Mechanik, v. 31, no. 1/2, Jan./Feb., 1951, p. 20-35)

The forces exerted upon a wing rotating in a compressible gas correspond to the reaction of its field of sound. Therefore, they may be determined from the energy capacity of this field. The investigation is based on the idea of starting with the field of sound and penetrating into the connections between flow and wave concepts. It deals with the determination of the flow forces stemming from the energy of the sound field which acts on the wing, with the mass motion describing the lift finding its expression in the field in the immediate neighborhood, and the radiation losses responsible for the drag finding theirs in the field in the distance.

N-33628*

APPLICABILITY OF THE LAW OF SIMILITUDE TO CAVITATION. (Zum Ähnlichkeitsgesetz für Hohlraumbildungen). A. Reinhardt. April 1954. 34p. diagrs., photo. (Trans. from Forschung auf dem Gebiete des Ingenieurwesens, Ed. B, v. 6, p. 1-12, Jan.-Feb., 1935, Forschungsheft 370)

Conclusions, derived from the theory of similitude, regarding caviation in flow engines were compiled, supplemented, and investigated as to their practical applicability. Two deviations from Newton's similitude of flow were recognizable in the test results. A number of tests were performed with a Kaplan turbine in order to check theoretical results.

DECLASSIFIED NACA REPORTS

THE FOLLOWING REPORTS HAVE BEEN DECLASSIFIED FROM CONFIDENTIAL, 10/29/54:

RM 8J05
RM 51D23
RM E6L11
RM E7J01
RM L8A14
RM L50L08
RM L52C31
RM L52J14

NACA RM A7L24

HIGH-SPEED WIND-TUNNEL TESTS OF A 1/78-SCALE MODEL OF THE LOCKHEED YP-80A AIRPLANE. Robert N. Olson and Leslie F. Lawrence. May 28, 1948. 52p. diagrs., photos. (NACA RM A7L24) (Declassified from Confidential, 10/12/54)

This report contains the results of a high-speed wind-tunnel investigation of a 1/78-scale model of the Lockheed YP-80A airplane, including a comparison of the relative aerodynamic characteristics of the 1/78-scale model, a 1/3-scale model, and a full-scale YP-80A airplane. Also included are the longitudinal stability and control characteristics of the 1/78-scale model with 0° and 45° leading-edge sweepback of the horizontal and vertical tail surfaces.

NACA RM L51K29

PROPELLER LIFT AND THRUST DISTRIBUTION FROM WAKE SURVEYS OF STAGNATION CONDITIONS. Robert E. Davidson. January 1952. 19p. diagrs. (NACA RM L51K29) (Declassified from Confidential, 10/12/54)

This paper gives formulas for propeller lift and thrust distribution in terms of wake-survey measurements of stagnation pressure rise through the propeller. Substantiative data are also included.

NACA RM L51L06

PROPELLER INDUCED ANGLES OF ATTACK AND SECTION ANGLES OF ATTACK FOR THE NACA 10-(3)(066)-03, 10-(3)(049)-03, 10-(3)(090)-03, 10-(5)(066)-03, AND 10-(0)(066)-03 PROPELLERS. William B. Igoe and Robert E. Davidson. May 1952. 80p. diagrs., 10 tabs. (NACA RM L51L06) (Declassified from Confidential, 10/12/54)

This paper presents the results of an induced angle-of-attack calculation using a method applicable to a propeller with arbitrary circulation distribution. Tables of induced angles of attack and section angles of attack and curves of wake-survey results are presented for the NACA 10-(3)(066)-03, 10-(3)(049)-03, 10-(3)(090)-03, 10-(5)(066)-03, and 10-(0)(066)-03 propellers. A brief description of the method of calculating propeller induced angles of attack is given.

NACA RM L51L28

THE EFFECT OF BLADE-SECTION CAMBER ON THE STATIC CHARACTERISTICS OF THREE NACA PROPELLERS. John H. Wood and John M. Swihart. April 1952. 40p. diagrs., photos. (NACA RM L51L28) (Declassified from Confidential, 10/12/54)

This paper contains the effect of blade-section camber on the static characteristics of the NACA 10-(0)(066)-03, 10-(3)(066)-03, and 10-(5)(066)-03 propellers (design lift coefficients of 0, 0.3, and 0.5, respectively). Blade angles from 0° to 16° were tested over a tip Mach number range from 0.28 to 1.02. The results indicate that the use of camber in the propeller design offers advantages in propeller performance and increases in stall-flutter speed at zero advance.

NACA RM L52A03

HINGE-MOMENT AND OTHER AERODYNAMIC CHARACTERISTICS AT TRANSONIC SPEEDS OF A QUARTER-SPAN SPOILER ON A TAPERED 45° SWEPTBACK WING OF ASPECT RATIO 3. Joseph E. Fikes. February 1952. 22p. diagrs., photo. (NACA RM L52A03) (Declassified from Confidential, 10/12/54)

Lift, drag, pitching moment, rolling moment, yawing moment, and spoiler hinge moment were obtained at transonic speeds by testing in the high velocity field over a reflection plane on the side wall of the Langley high-speed 7- by 10-foot tunnel on a wing having a quarter-chord sweepback of 45.58°, an aspect ratio of 3, a taper ratio of 0.5, and an NACA 64A010 section employing an inboard quarter-span plug spoiler. The investigation was made over a limited projection and angle-of-attack range from a Mach number of 0.70 to 1.10.

NACA RM L52A09

EFFECT OF CURRENT DESIGN TRENDS ON AIRPLANE SPINS AND RECOVERIES. Anshal I. Neihouse. January 1952. 6p. diagrs. (NACA RM L52A09) (Declassified from Confidential, 10/12/54)

Charts are presented which indicate that, owing to design of airplanes for transonic and supersonic flight, a wide range of mass distribution of the airplane is possible with accompaning effects upon the nature of the spin and upon the requirements for recovery.

NACA RM L52A11

PRELIMINARY INVESTIGATION OF CONTROL CHARACTERISTICS AT TRANSONIC SPEEDS OF A TAPERED 45° SWEPTBACK WING OF ASPECT RATIO 3 HAVING A HORN-BALANCED FULL-SPAN CONTROL. John G. Lowry and Joseph E. Fikes. April 1952. 22p. diagrs., photo. (NACA RM L52A11) (Declassified from Confidential, 10/12/54)

An experimental investigation was made at transonic speeds by testing in the high-velocity field over a sidewall reflection plane to determine hinge-moment and effectiveness characteristics of a horn-balanced control on an aspect-ratio 3, 45° sweptback wing. Lift, rolling moments, and control hinge moments were obtained through a limited angle-of-attack and control-deflection range from Mach numbers 0.70 to 1.10.

NACA RM L52A14

PRELIMINARY INVESTIGATION OF THE DRAG CHARACTERISTICS OF THE NACA RM-10 MISSILE AT MACH NUMBERS OF 1.40 AND 1.59 IN THE LANGLEY 4- BY 4-FOOT SUPERSONIC TUNNEL. Lowell E. Hasel, Archibald R. Sinclair and Clyde V. Hamilton, April 1952. 49p. diagrs., photos, 3 tabs. (NACA RM L52A14) (Declassified from Confidential, 10/12/54)

A 0.287-scale model of the RM-10 has been tested in the Langley 4- by 4-foot supersonic tunnel at Mach numbers of 1.59 and 1.40. Drag data were obtained from a conventional sting-supported model and from a wire-supported model. Base drag, skin-friction drag, forebody pressure drag, fin drag, and fin interference drag are discussed. The data at a Mach number of 1.59 are compared with that from other facilities.

NACA RM L52A17

ERROR IN AIRSPEED MEASUREMENT DUE TO STATIC-PRESSURE FIELD AHEAD OF AN OPEN-NOSE AIR-INLET MODEL AT TRANSONIC SPEEDS. Thomas C. O'Bryan. March 1952. 17p. diagrs., photos. (NACA RM L52A17) (Declassified from Confidential, 10/12/54)

Contains measurements of the static-pressure coefficient at several distances ahead of an open-nose air-inlet body at zero angle of attack, in the transonic speed range, by the NACA wing-flow method. Measurements are presented to show the effect of inlet-velocity ratio on the static pressure ahead of the inlet. Comparison of the experimental variation of the static-pressure coefficient ahead of the inlet is made with incompressible theory. Calculations are presented to show the effect of changing inlet geometry on the static-pressure coefficient ahead of the inlets.

NACA RM L52A22

THE CALCULATION OF CERTAIN STATIC AEROELASTIC PHENOMENA OF WINGS WITH TIP TANKS OR BOOM-MOUNTED LIFTING SURFACES. Franklin W. Diederich and Kenneth A. Foss. August 1952. 55p. diagrs., 2 tabs. (NACA RM L52A22) (Declassified from Confidential, 10/12/54)

A method is presented for calculating static aeroelastic phenomena of wings with concentrated aerodynamic forces at the tip. Some static aeroelastic characteristics of an unswept wing with a tip tank and of a sweptback wing with several boom-mounted lifting surface configurations have been calculated. These calculations indicate that such a lifting surface merits consideration as a device for relieving adverse aeroelastic effects.

NACA RM L52A23

PRELIMINARY INVESTIGATION AT TRANSONIC SPEEDS OF THE EFFECT OF BALANCING TABS ON THE HINGE-MOMENT AND OTHER AERODYNAMIC CHARACTERISTICS OF A FULL-SPAN FLAP ON A TAPERED 45° SWEPTBACK WING OF ASPECT RATIO 3. Vernard E. Lockwood and Joseph E. Fikes. April 1952. 27p. diagrs., photo., (NACA RM L52A23) (Declassified from Confidential, 10/12/54)

An experimental investigation was performed at transonic speeds in the high-velocity-flow field over a reflection plane in the Langley high-speed 7- by 10-foot tunnel to determine the balancing characteristics of an inset, an attached, and a detached tab on an aspect-ratio 3, 45° sweptback wing. Lift, rolling moments, and flap hinge moments were obtained through a range of angles of attack from 0° to 16° and a Mach number range from 0.7 to 1.1. Data are presented as parameters of the flap and tab.

NACA RM L52A25

LOW-SPEED STABILITY CHARACTERISTICS OF A COMPLETE MODEL WITH A WING OF W PLAN FORM. Edward C. Polhamus and Robert E. Becht. April 1952. 27p. diagrs., photo., tab. (NACA RM L52A25) (Declassified from Confidential, 10/12/54)

An investigation was conducted to determine the low-speed static longitudinal and lateral stability characteristics of a complete model equipped with a W wing of aspect ratio 6, taper ratio 0.6, and panel sweep angles of 45°. Included in the investigation are exploratory tests made in an attempt to delay the early separation in the wing-panel junctures by use of fences, vortex generators, and chord extensions.

NACA RM L52B11

INVESTIGATION OF THE HYDRODYNAMIC STABILITY AND RESISTANCE OF TWO STREAMLINE FUSELAGES. Bernard Weinflash and Charles L. Shuford, Jr. April 1952. 32p. diagrs., photos., tab. (NACA RM L52B11) (Declassified from Confidential, 10/12/54)

An investigation of a dynamic model was made to determine the effects of hull form, gross load, and aerodynamic trimming moments on the trim limits, trim, hydrodynamic moment, hydrodynamic resistance, total resistance, and rise of two streamline fuselage configurations modified by chine strips.

NACA RM L52B13

EFFECTS OF SOME PRIMARY VARIABLES OF RECTANGULAR VORTEX GENERATORS ON THE STATIC-PRESSURE RISE THROUGH A SHORT DIFFUSER. E. Floyd Valentine and Raymond B. Carroll. May 1952. 32p. diagrs., photo., tab. (NACA RM L52B13) (Declassified from Confidential, 10/12/54)

An investigation was made of a 2:1 area ratio diffuser of length equal to the inlet diameter with separate variation of several basic parameters for simple nontwisted rectangular vortex generators over a considerable range of inlet-boundary-layer thickness. Optimum values from the standpoint of static pressure rise were determined for angle of attack, spacing, aspect ratio, and span-to-inlet boundary-layer thickness. The static-pressure rise obtainable by conforming to these findings is given over the range of inlet-boundary-layer thickness.

NACA RM L52B15a

AN INVESTIGATION OF LONGITUDINAL CONTROL CHARACTERISTICS OF A WING-TIP CONTROL SURFACE ON A SWEPTBACK WING AT TRANSONIC SPEEDS BY THE NACA WING-FLOW METHOD. James P. Trant, Jr. June 1952. 23p. diagrs., photos., tab. (NACA RM L52B15a) (Declassified from Confidential, 10/12/54)

Longitudinal control effectiveness of a full-chord wing-tip control on a wing having 35° sweepback 12 percent thickness perpendicular to the quarter-chord line, an aspect ratio of 3.01, and a taper ratio of 0.605 was determined by the NACA wing-flow method at Mach numbers from about 0.65 to 1.1. Measurements were made of normal force, pitching moment, hinge moment, and angle of attack for three control deflections. One control deflection was also tested with an end plate attached to the root chord of the control surface.

NACA RM L52B18

THE EFFECTS ON THE AERODYNAMIC CHARACTERISTICS OF VARYING THE WING THICKNESS RATIO OF A TRIANGULAR WING-BODY CONFIGURATION AT TRANSONIC SPEEDS FROM TESTS BY THE NACA WING-FLOW METHOD. Albert W. Hall and James M. McKay. April 1952. 27p. diagrs., photo., 2 tabs. (NACA RM L52B18) (Declassified from Confidential, 10/12/54)

Tests were made by the NACA wing-flow method at Mach numbers from 0.75 to 1.07 to determine the aerodynamic characteristics of three triangular wing-fuselage models which differed only in wing thickness-chord ratio. All three wings had an aspect ratio of 2.31 with 6-, 9-, and 12-percent-thick biconvex sections and the fuselage had a fineness ratio of 12. Measurements were made of normal force, chord force, and pitching moment for various angles of attack. The test Reynolds number was 1.5×10^6.

NACA RM L52B25

EFFECTS OF HORIZONTAL-TAIL POSITION AND ASPECT RATIO ON LOW-SPEED STATIC LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A 60° TRIANGULAR-WING MODEL HAVING TWIN TRIANGULAR ALL-MOVABLE TAILS. Byron M. Jaquet. May 1952. 45p. diagrs., photos. (NACA RM L52B25) (Declassified from Confidential, 10/12/54)

Presents results of a low-speed investigation made in Langley stability tunnel to determine effects of horizontal tail position and aspect ratio on low-speed static longitudinal stability and control characteristics of a 60° triangular-wing model having twin-triangular-all-movable tails. All the force tests were made at a Mach number of 0.17 and a Reynolds number of 2.06×10^6. Comparison of results for single and twin tails are made.

NACA RM L52B26

FLIGHT MEASUREMENTS OF THE EFFECTS OF SURFACE CONDITION ON THE SUPERSONIC DRAG OF FIN-STABILIZED PARABOLIC BODIES OF REVOLUTION. H. Herbert Jackson. May 1952. 17p. diagrs., photos. (NACA RM L52B26) (Declassified from Confidential, 10/12/54)

Some measurements of the effects of various types of surface roughness on total drag and base drag were obtained on bodies of revolution in free flight. The Mach number and Reynolds number ranges varied from 0.80 to 2.2 and 15×10^6 to 75×10^6, respectively. The experimental drag coefficients of models having wavy surfaces, sand-coated surfaces, and pitted surfaces are compared with the drag coefficients of smooth models of the same configurations.

NACA RM L52C24

SKIN-FRICTION DRAG AND BOUNDARY-LAYER TRANSITION ON A PARABOLIC BODY OF REVOLUTION (NACA RM-10) AT A MACH NUMBER OF 1.6 IN THE LANGLEY 4- BY 4-FOOT SUPERSONIC PRESSURE TUNNEL. K. R. Czarnecki and Jack E. Marte. May 1952. 24p. diagrs., photos. (NACA RM L52C24) (Declassified from Confidential, 10/12/54)

There are presented the results of an investigation at $M = 1.6$ and over a Reynolds number range from 2×10^6 to 40×10^6 of the skin-friction drag and boundary-layer transition of a body of revolution (NACA RM-10). The results are compared with other available experimental data and with theory.

NACA RM L52C27

AN APPLICATION OF THE ROCKET-PROPELLED-MODEL TECHNIQUE TO THE INVESTIGATION OF LOW-LIFT BUFFETING AND THE RESULTS OF PRELIMINARY TESTS. Homer P. Mason and William N. Gardner. September 1952. 19p. diagrs., photos. (NACA RM L52C27) (Declassified from Confidential, 10/12/54)

An application of the rocket-propelled-model technique for the investigation of low-lift buffeting is presented, together with data obtained from three preliminary tests by this technique. A correlation between low-lift buffeting, wing dropping, and changes of trim normal force is shown.

NACA RM L52D08a

SMALL-SCALE TRANSONIC INVESTIGATION OF THE EFFECTS OF PARTIAL-SPAN LEADING-EDGE CAMBER ON THE AERODYNAMIC CHARACTERISTICS OF A 50° 38' SWEPTBACK WING OF ASPECT RATIO 2.98. William J. Alford, Jr. and Andrew L. Byrnes, Jr. June 1952. 28p. diagrs., photo., tab. (NACA RM L52D08a) (Declassified from Confidential, 10/12/54)

An investigation of two semispan wings having the same plan form was made in the Langley high-speed 7- by 10-foot tunnel over a Mach number range from 0.70 to 1.10 and a mean-test Reynolds number range from 745,000 to 845,000 to determine the effects of partial-span leading-edge camber on the aerodynamic characteristics of a sweptback wing. This paper presents the results of the wing-alone and wing-fuselage configurations with the wing quarter-chord line sweptback 50° 38' taper ratio 0.45, and NACA 64A-series airfoil sections tapered in thickness ratio. Lift, drag, pitching moment, and root-bending moment were obtained for all configurations.

NACA RM L52D15

A PRELIMINARY INVESTIGATION OF THE STATIC AND DYNAMIC LONGITUDINAL STABILITY OF A GRUMBERG HYDROFOIL SYSTEM. Norman S. Land, Derrill B. Chambliss and William W. Petynia. September 1952. 48p. diagrs., photos. (NACA RM L52D15) (Declassified from Confidential, 10/12/54)

A preliminary investigation was made in order to determine the static and dynamic longitudinal stability characteristics and the force characteristics of the Grunberg hydrofoil system, comprising a main lifting hydrofoil and planing-surface stabilizers. The static stability of the system was determined for several locations of the center of gravity. In smooth water the response to a sudden distrubance was observed. The behavior in waves of various lengths was observed at several speeds, moments of inertia, and locations of the center of gravity. The effects of gross load, hydrofoil and stabilizer incidence, speed, and center-of-gravity location on the lift-drag ratio were determined.

NACA RM L52D21

EFFECTS OF PLAN FORM, AIRFOIL SECTION, AND ANGLE OF ATTACK ON THE PRESSURES ALONG THE BASE OF BLUNT-TRAILING-EDGE WINGS AT MACH NUMBERS OF 1.41, 1.62, AND 1.96. Kennith L. Goin. September 1952. 52p. photos., diagrs. (NACA RM L52D21) (Declassified from Confidential, 10/12/54)

Base pressures were measured at angles of attack of 0° to 15° on two groups of untapered wings of aspect ratio 2.7, the first group being unswept and the second group having 45° of sweepback. Each group included airfoil sections with maximum thickness ratios of 3 to 10 percent and with varying amounts of trailing-edge bluntness. Also included in the investigation to indicate additional effects of wing plan form were a 45° delta wing and a rectangular wing of aspect ratio 5. All wings were tested with fixed transition at Reynolds numbers of between 1×10^6 and 2×10^6.

NACA RM L52D23a

A THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE LIFT AND DRAG CHARACTERISTICS OF A HYDROFOIL AT SUBCRITICAL AND SUPERCRITICAL SPEEDS. Kenneth L. Wadlin, Charles L. Shuford, Jr. and John R. McGehee. July 1952. 53p. diagrs., photo., tab. (NACA RM L52D23a) (Declassified from Confidential, 10/12/54)

A theoretical and experimental investigation was made of the effect of the free-water surface and rigid boundaries on the lift and drag of an aspect-ratio-10 hydrofoil at both subcritical and supercritical speeds. Approximate theoretical solutions for the effect of the free-water surface and rigid boundaries on lift and drag at supercritical speeds were developed. An approximate theoretical solution for the effect of these boundaries on drag at subcritical speeds was also presented. The agreement between theory and experiment at both supercritical and subcritical speeds is satisfactory for engineering calculations of hydrofoil characteristics from aerodynamic data.

NACA RM L52D25

CONTROL CHARACTERISTICS AT TRANSONIC SPEEDS OF A LINKED FLAP AND SPOILER ON A TAPERED 45° SWEPTBACK WING OF ASPECT RATIO 3. Vernard E. Lockwood and Joseph E. Fikes. July 1952. 24p. diagrs., photo. (NACA RM L52D25) (Declassified from Confidential, 10/12/54)

Lift, drag, pitching-moment, rolling-moment, yawing-moment, and hinge-moment characteristics of the model were obtained at transonic speeds by testing in the high-velocity field over a reflection plane on the side wall of the Langley high-speed 7- by 10-foot tunnel. The wing had a quarter-chord line sweepback of 45.58°, an aspect ratio of 3, a taper ratio of 0.5, and was approximately 7.6 percent thick. A quarter-span plug-type spoiler which was linked to rotate with the flap in the same direction was employed as a control-balancing device. The investigation was made over a limited projection and angle-of-attack range from a Mach number of 0.70 to 1.10.

NACA RM L52D30

PRESSURE DISTRIBUTIONS ON BODIES OF REVOLUTION AT SUBSONIC AND TRANSONIC SPEEDS. Richard I. Cole. July 1952. 47p. diagrs., photos., tab. (NACA RM L52D30) (Declassified from Confidential, 10/12/54)

Pressure distributions along the slender body and along prolate spheroids of fineness ratio 3 to 20 are compared at subsonic and transonic speeds with estimates at angles of attack up to 20°. The comparisons showed that the pressure distributions along the bodies can be predicted with fair accuracy.

NACA RM L52E12

SMALL-SCALE TRANSONIC INVESTIGATION OF THE EFFECTS OF FULL-SPAN AND PARTIAL-SPAN LEADING-EDGE FLAPS ON THE AERODYNAMIC CHARACTERISTICS OF A 50° $38'$ SWEPTBACK WING OF ASPECT RATIO 2.98. Kenneth P. Spreemann and William J. Alford, Jr. July 1952. 31p. diagrs., photo. (NACA RM L52E12) (Declassified from Confidential, 10/12/54)

An investigation was made in the Langley high-speed 7- by 10-foot tunnel over a Mach number range of 0.70 to 1.10 to determine the effects of a number of full-span and partial-span leading-edge-flap deflections on the aerodynamic characteristics of a semi-span model with the quarter-chord line sweptback 50° $38'$, aspect ratio 2.98, taper ratio 0.45, and NACA 64A series airfoil sections tapered in thickness ratio. Lift, drag, pitching moment, and bending moment were obtained for all configurations.

NACA RM L52E19

A THEORETICAL INVESTIGATION OF THE EFFECT OF A TARGET SEEKER SENSITIVE TO PITCH ATTITUDE ON THE DYNAMIC STABILITY AND RESPONSE CHARACTERISTICS OF A SUPERSONIC CANARD MISSILE CONFIGURATION. Ordway B. Gates, Jr. and Albert A. Schy. August 1952. 54p. diagrs., photo., tab. (NACA RM L52E19) (Declassified from Confidential, 10/12/54)

A theoretical investigation is presented of the longitudinal dynamic characteristics of an automatically stabilized supersonic canard missile equipped with a target seeker sensitive to pitch attitude. Effects of seeker gain, time delay, and nonlinearities, which include various dead spots in the target seeker, are considered. The results indicate that satisfactory stability and response characteristics may be obtained for the configuration considered subsequent to command or regulatory inputs but a dead spot in the target seeker causes undesirable steady-state errors in pitch attitude.

NACA RM L52F16

LATERAL-CONTROL INVESTIGATION AT TRANSONIC SPEEDS OF RETRACTABLE SPOILER AND PLUG-TYPE SPOILER-SLOT AILERONS ON A TAPERED 60° SWEPTBACK WING OF ASPECT RATIO 2. TRANSONIC-BUMP METHOD. Alexander D. Hammond and James M. Watson. August 1952. 19p. diagrs. (NACA RM L52F16) (Declassified from Confidential, 10/12/54)

Results and discussion of a lateral-control investigation of retractable spoiler and plug-type spoiler-slot ailerons on a wing with 60° sweepback of the quarter-chord line, aspect ratio 2, taper ratio 0.6, and an NACA 65A006 airfoil section are presented. Data were obtained through an angle-of-attack range of -2° to 18°, a projection range of -0.056 to 0.045 chord, and a Mach number range of 0.619 to 1.167. The plug-type spoiler-slot aileron was more effective in producing roll than the retractable spoiler aileron, particularly at the high angles of attack below the speed of sound.

NACA RM L52F24

CALIBRATION OF A COMBINED PITOT-STATIC TUBE AND VANE-TYPE FLOW ANGULARITY INDICATOR AT TRANSONIC SPEEDS AND AT LARGE ANGLES OF ATTACK OR YAW. Albin O. Pearson and Harold A. Brown. September 1952. 25p. diagrs., photos. (NACA RM L52F24) (Declassified from Confidential, 10/12/54)

The calibration of a combination pitot-static tube and vane-type flow-angularity indicator is presented for a Mach number range of approximately 0.60 to 1.11, an angle-of-attack range of -10° to 25°, and an angle-of-yaw range of -20° to 20°.

NACA RM L52G03

THE EFFECT OF VARIOUS AERODYNAMIC BALANCES ON THE LOW-SPEED LATERAL-CONTROL AND HINGE-MOMENT CHARACTERISTICS OF A 0.20-CHORD PARTIAL-SPAN OUTBOARD AILERON ON A WING WITH LEADING EDGE SWEPT BACK 51.3°. Alexander D. Hammond. September 1952. 40 p. diagrs., photo., tab. (NACA RM L52G03) (Declassified from Confidential, 10/12/54)

A wind-tunnel investigation at low speeds was made to determine the lateral-control and hinge-moment characteristics of an unsealed, plain-radius-nose, 20-percent-chord, flat-sided, partial-span outboard aileron equipped with either an overhang, a paddle, or a spoiler balance on a wing with leading edge swept back 51.3°, aspect ratio of 3.05, taper ratio of 0.49, and NACA 65_1-012 airfoil sections perpendicular to the 55.6-percent chord line.

NACA RM L52G08

HINGE-MOMENT AND CONTROL-EFFECTIVENESS CHARACTERISTICS OF AN OUTBOARD FLAP WITH AN OVERHANG NOSE BALANCE ON A TAPERED 35° SWEPTBACK WING OF ASPECT RATIO 4. TRANSONIC-BUMP METHOD. Robert F. Thompson and William C. Moseley, Jr. August 1952. 51p. diagrs. (NACA RM L52G08) (Declassified from Confidential, 10/12/54)

Lift, pitching-moment, rolling-moment, and flap hinge-moment coefficients were obtained through the transonic speed range on a wing having a quarter-chord sweepback of 35°, an aspect ratio 4, a taper ratio of 0.6, and an NACA 65A006 airfoil section parallel to free stream. The wing had a 30-percent-chord 0.43-span outboard flap-type control with a 22-percent-flap-chord overhang nose balance. The investigation was made through an angle-of-attack range of -6° to 16°, a Mach number range from 0.6 to 1.10, and a range of flap deflections which varied from about ±24° at a Mach number of 0.60 to ±12° at a Mach number of 1.10.

NACA RM L52G10

LOW-SPEED LATERAL-CONTROL INVESTIGATION OF A FLAP-TYPE SPOILER AILERON WITH AND WITHOUT A DEFLECTOR AND SLOT ON A 6-PERCENT-THICK, TAPERED, 45° SWEPTBACK WING OF ASPECT RATIO 4. James M. Watson. September 1952. 11p. diagrs. (NACA RM L52G10) (Declassified from Confidential, 10/12/54)

Results are presented of an investigation to determine the lateral-control characteristics of a deflector and slot arrangement in conjunction with a flap-type spoiler aileron on a 6-percent-thick wing with 45° sweepback of the quarter-chord line, an aspect ratio of 4, and a taper ratio of 0.6. Data were obtained through a range of angle of attack from -26° to 60°, projections of 0 and 0.05 chord for both the flap-type spoiler aileron and the deflector. The spoiler-deflector-slot combination was more effective than the spoiler alone in producing rolling moment.

NACA RM L52G16

TESTS OF A CENTERING SPRING USED AS AN ARTIFICAL FEEL DEVICE ON THE ELEVATOR OF A FIGHTER AIRPLANE. James J. Adams and James B. Whitten. September 1952. 18p. diagrs., photo., tab. (NACA RM L52G16) (Declassified from Confidential, 10/12/54)

Tests were made of a centering spring, which gave no variation of force gradient with impact pressure used as an artificial feel device for the elevator of a Chance Vought F4U-4B airplane equipped with power controls. The centering spring was unsatisfactory because of the large stick force encountered in landing. When a preloaded spring was included in the system to relieve the large landing force, and a bobweight was added to increase the force per g, the system satisfied the minimum handling-qualities requirements, but was still considered to provide insufficient centering tendency at high speeds.

NACA RM L52G22

THE EFFECTS OF CAMBER AND LEADING-EDGE-FLAP DEFLECTION ON THE PRESSURE PULSATIONS ON THIN RIGID AIRFOILS AT TRANSONIC SPEEDS. Milton D. Humphreys and John D. Kent. October 1952. 26p. diagrs., photos., tab. (NACA RM L52G22) (Declassified from Confidential, 10/12/54)

The effect of camber and leading-edge-flap deflection on the pressure pulsations on thin rigid airfoils at Mach numbers from 0.5 to 1.0 has been investigated for 6-percent-thick NACA 64A-series airfoils. The results of the pressure-pulsation investigation on these airfoils indicated that at the higher normal-force coefficients, either camber or leading-edge-flap deflection reduced the pressure-pulsation level over the entire chord.

NACA RM L52G24

EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF VORTEX GENERATORS ON THE MAXIMUM LIFT OF A 6-PERCENT-THICK SYMMETRICAL CIRCULAR-ARC AIRFOIL SECTION. William J. Bursnall. October 1952. 16p. diagrs., 2 tabs. (NACA RM L52G24) (Declassified from Confidential, 10/12/54)

The results of an experimental investigation of the effectiveness of several configurations of vortex generators in increasing the maximum lift of a 6-percent-thick symmetrical circular-arc airfoil section indicated that none of the configurations employed substantially increased the maximum lift.

NACA RM L52G25

A PRELIMINARY INVESTIGATION OF SHOCK-WAVE REFLECTIONS IN A SMALL CLOSED BALLISTIC RANGE WITH VARIOUS TYPES OF WALLS. A. P. Sabol. September 1952. 21p. photos., diagrs. (NACA RM L52G25) (Declassified from Confidential, 10/12/54)

The intensity of reflections from walls of shock waves, which were created by a bullet traveling near the speed of sound, was observed by shadow and schlieren methods. Results indicated that reflected waves are greatly reduced by the use of a wall material having good sound-absorbing characteristics, or by specially designed wall configurations.

NACA RM L52G31a

EFFECT OF THICKNESS, CAMBER, AND THICKNESS DISTRIBUTION ON AIRFOIL CHARACTERISTICS AT MACH NUMBERS UP TO 1.0. Bernard N. Daley and Richard S. Dick. October 1952. 76p. photos., diagrs., tab. (NACA RM L52G31a) (Declassified from Confidential, 10/12/54)

A modified open-throat-type wind tunnel developed for the purpose of obtaining two-dimensional-airfoil data at Mach numbers near 1.0 is presented and discussed. Tests of a group of related NACA airfoil sections varying in maximum thickness, design lift coefficient, and thickness distribution have been conducted in this wind tunnel at Mach numbers of 0.3 to about 1.0, and at corresponding Reynolds numbers from 0.7×10^6 to 1.6×10^6. Normal-force, drag, and moment coefficients are presented, together with representative schlieren photographs and pressure-distribution diagrams.

NACA RM L52H04

HEAT TRANSFER AND SKIN FRICTION FOR TURBULENT BOUNDARY LAYERS ON HEATED OR COOLED SURFACES AT HIGH SPEEDS. Coleman duP. Donaldson. October 1952. 20p. diagr., 3 tabs. (NACA RM L52H04) (Declassified from Confidential, 10/12/54)

The method presented in NACA TN 2692 for evaluating the skin friction of a turbulent boundary layer in compressible flow on an insulated surface is extended to evaluate the turbulent skin friction and heat transfer in compressible flow on a surface which is heated or cooled. The results of this analysis are in good agreement with the heat transfers measured in flight on the NACA RM-10 missile up to Mach number of 3.8.

NACA RM L52H07

INVESTIGATION OF THREE TAPERED 45° SWEPTBACK CAMBERED AND TWISTED WINGS COVERING A SIMULTANEOUS VARIATION IN ASPECT RATIO AND THICKNESS RATIO AND OF ONE RELATED SYMMETRICAL WING AT TRANSONIC SPEEDS BY THE WING-FLOW METHOD. Harold I. Johnson. March 1953. 55p. diagrs., photos., 2 tabs. (NACA RM L52H07) (Declassified from Confidential, 10/12/54)

An investigation at transonic speeds was made to study the effects of aspect ratio of a 45° sweptback wing for the case where thickness ratio is varied in a logical manner with aspect ratio. The effects of camber and twist were also investigated. The Mach numbers ranged from 0.65 to 1.17 and the Reynolds numbers ranged from 230,000 to 620,000. Results showed that the lowest-aspect-ratio, thinnest wing tested had the best aerodynamic characteristics in

all important respects. The addition of camber and twist reduced the maximum lift-drag ratios over most of the speed range tested but increased the maximum lift coefficient at all speed.

NACA RM L52H11

A STUDY OF THE FLOW FIELD BEHIND THE TRIANGULAR HORIZONTAL TAIL OF A CANARD AIRPLANE AT APPROXIMATELY THE VERTICAL-TAIL LOCATION BY MEANS OF A TUFT GRID. Joseph L. Johnson, Jr. October 1952. 18p. diagrs., tab. (NACA RM L52H11) (Declassified from Confidential, 10/12/54)

An investigation of the flow field behind the horizontal triangular tail of a canard model by means of a tuft grid placed at approximately the vertical-tail location (about 6.0 horizontal-tail root chords behind the horizontal tail) indicated that trailing vortices from the horizontal tail produced a sidewash field over the model which probably accounted for the variation in the static directional stability and damping-in-yaw characteristics of canard models reported in previous investigations.

NACA RM L52H20

A TRANSONIC INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS OF PLATE- AND BELL-TYPE OUTLETS FOR AUXILIARY AIR. William J. Nelson and Paul E. Dewey. September 1952. 25p. diagrs., photos. (NACA RM L52H20) (Declassified from Confidential, 10/12/54)

The aerodynamic characteristics of several plate-type and bell-mouthed outlets representative of current design practice have been investigated at Mach numbers from 0.7 to 1.3. These data show that the effect of an external stream on the discharge coefficient of such outlets is determined primarily by the rate of discharge relative to the free-jet flow rate. For outlets of the types tested, low-speed data may probably be applied at transonic Mach numbers if the free-jet characteristics of the outlet are first corrected for the effects of Reynolds number and Mach number on the discharge characteristics of the outlet discharging into infinite space. Total-pressure surveys through the jet wake are compared at Mach numbers of 0.7, 1.1, and 1.3 for the different outlets investigated. Static-pressure distribution in the vicinity of circular outlets is shown for several Mach numbers and discharge rates.

NACA RM L52H21

INVESTIGATION OF THE VARIATION WITH REYNOLDS NUMBER OF THE BASE, WAVE, AND SKIN-FRICTION DRAG OF A PARABOLIC BODY OF REVOLUTION (NACA RM-10) AT MACH NUMBERS OF 1.62, 1.93, AND 2.41 IN THE LANGLEY 9-INCH SUPERSONIC TUNNEL. Eugene S. Love, Donald E. Coletti and August F. Bromm, Jr. October 1952. 62p. diagrs., photos., (NACA RM L52H21) (Declassified from Confidential, 10/12/54)

Results are presented from an investigation at M = 1.62, 1.93, and 2.41 of the variation with Reynolds number of the base, wave, and skin-friction drag of a parabolic body of revolution (NACA RM-10). Comparisons are made with theory and other experimental data. An empirical expression relating the Reynolds number of transition to Mach number is presented as well as an explanation of the behavior of base pressure with varying Reynolds number.

NACA RM L52I02

INVESTIGATION AT HIGH AND LOW SUBSONIC MACH NUMBERS OF TWO SYMMETRICAL 6-PERCENT-THICK AIRFOIL SECTIONS DESIGNED TO HAVE HIGH MAXIMUM LIFT COEFFICIENTS AT LOW SPEEDS. Nicholas J. Paradiso. October 1952. 37p. diagrs., photo., 2 tabs. (NACA RM L52I02) (Declassified from Confidential, 10/12/54)

Results are presented of an investigation at both high and low subsonic Mach numbers of two newly derived symmetrical 6-percent-thick airfoil sections which are of a family of airfoil sections designed for high maximum lift at low subsonic speeds. As compared to previously tested sections of this family, the sections of this investigation have less blunt leading edges. Included are results for Reynolds numbers up to 9×10^6 and for two locations of surface roughness.

NACA RM L52I03

THRUST LOADING OF THE NACA 3-(3)(05)-05 EIGHT-BLADE DUAL-ROTATING PROPELLER AS DETERMINED FROM WAKE SURVEYS. Robert J. Platt, Jr. October 1952. 44p. diagrs., photo. (NACA RM L52I03) (Declassified from Confidential, 10/12/54)

Wake-survey measurements of the thrust loading of the NACA 3-(3)(05)-05 eight-blade dual-rotating propeller are presented to supplement the previously published force-test results for this propeller. The data cover a blade-angle range from 65° to 80°, measured at 0.75R, at forward Mach numbers from 0.35 to 0.925.

NACA RM L52I08

FORCE TESTS OF THREE THIN WINGS OF MODERATELY LOW ASPECT RATIO AT HIGH SUBSONIC MACH NUMBERS. Gareth H. Jordan. October 1952. 22p. diagrs. (NACA RM L52I08) (Declassified from Confidential, 10/12/54)

Results are presented of force tests made in the Langley 24-inch high-speed tunnel on three thin wings of moderately low aspect ratio at high subsonic Mach numbers to determine the effect of leading-edge shape and section profile on the aerodynamic characteristics. The range of angle of attack was from -2° to 8° and the range of Mach number was from 0.30 to about 0.90.

NACA RM L52I09

ANALYTICAL STUDY OF STATIC AND LOW-SPEED PERFORMANCE OF THIN PROPELLERS USING TWO-SPEED GEAR RATIOS TO OBTAIN OPTIMUM ROTATIONAL SPEEDS. Jean Gilman, Jr. November 1952. 52p. diagrs., 4 tabs. (NACA RM L52I09) (Declassified from Confidential, 10/12/54)

This paper presents methods of estimating the static and low-speed performance of thin propellers when operating at optimum rotational speeds. The importance, under certain conditions, of incorporating variable gearing is illustrated by specific examples. The effect of camber on static thrust is also investigated, and it is shown that thin propellers having moderately cambered blade sections can produce 15 to 20 percent more static thrust than propellers having symmetrical blade sections.

NACA RM L52K18a

A STUDY OF THE USE OF VARIOUS HIGH-LIFT DEVICES ON THE HORIZONTAL TAIL OF A CANARD AIRPLANE MODEL AS A MEANS OF INCREASING THE ALLOWABLE CENTER-OF-GRAVITY TRAVEL. Joseph L. Johnson, Jr. January 1953. 25p. diagrs., 2 tabs. (NACA RM L52K18a) (Declassified from Confidential, 10/12/54)

This paper contains results of a low-speed power-off static longitudinal stability and control investigation to study the use of various high-lift devices on the horizontal tail of a canard airplane model as a means of increasing the allowable center-of-gravity travel.

NACA RM L52K28a

AVERAGE SKIN-FRICTION COEFFICIENTS FROM BOUNDARY-LAYER MEASUREMENTS ON A OGIVE-CYLINDER BODY IN FLIGHT AT SUPERSONIC SPEEDS. J. Dan Loposer. January 1953. 11p. diagrs., photo. (NACA RM L52K28a) (Declassified from Confidential, 10/12/54)

Boundary-layer measurements on a rocket-powered free-flight model to determine average skin-friction coefficients have been made on an ogive-cylinder body of fineness ratio 15.9. Average skin-friction coefficients were obtained for the body area ahead of the fins over a range of Mach number from 1.3 to 2.5 and over a range of Reynolds number from 90.3×10^6 to 162.9×10^6 (based on axial body length to the measurement station). Comparison of the experimental data with a flat-plate skin-friction theory by Van Driest showed good agreement.

NACA RM L52L02

A COMPARISON OF GUST LOADS MEASURED IN FLIGHT ON A SWEPT-WING AIRPLANE AND AN UNSWEPT-WING AIRPLANE. Jack Funk and Harry C. Mickleboro. June 1953. 16p. diagrs., 2 tabs. (NACA RM L52L02) (Declassified from Confidential, 10/12/54)

An unswept-wing airplane and a 35° swept-wing airplane were flown in rough air to investigate effects of sweep on gust loads and gust selectivity. The swept-wing airplane experienced lower loads in rough air than the unswept-wing airplane. The ratio of loads on the two airplanes was equal to the cosine of the angle of sweep and to the ratio of the lift-curve slopes from either low-speed wind-tunnel data or calculated from the empirical formula $\frac{6A \cos \Lambda}{A + 2 \cos^2 \Lambda}$, where A is aspect ratio and Λ is the angle of sweep. Only small differences were shown in the gust selectivity characteristics of the two airplanes.

NACA RM L52L09

WING AND FUSELAGE LOADS MEASURED IN FLIGHT ON THE NORTH AMERICAN B-45 AND F-82 AIRPLANES. Paul W. Harper. February 1953. 35p. diagrs., 4 tabs. (NACA RM L52L09) (Declassified from Confidential, 10/12/54)

Flight investigations were conducted to determine the wing and fuselage loads on the B-45 and F-82 airplanes by means of calibrated strain-gage installations at each wing- and tail-fuselage juncture. The tests covered a Mach number range of approximately 0.3 to 0.75. The aerodynamic loads measured for the B-45 airplane were substantially as predicted by theory, but the loads on the F-82 airplane were in disagreement with theory. A gradual outboard shift in wing center of pressure with increasing Mach number was noted for both airplanes.

NACA RM L52L11

EXPERIMENTAL INVESTIGATION OF THE FLOW FIELD BEHIND AN ASPECT-RATIO-10 HYDROFOIL NEAR THE WATER SURFACE. Arthur W. Carter and Roger V. Butler. February 1953. 31p. diagrs., photos., tab. (NACA RM L52L11) (Declassified from Confidential, 10/12/54)

An investigation was made at subcritical speeds of the flow field behind an aspect-ratio-10 hydrofoil operating at a depth below the free-water surface of 0.75 chord. The downwash and water surface profiles were measured behind the hydrofoil over a range of lateral and longitudinal positions of interest for tandem hydrofoil applications. The experimental data were compared with theoretical predictions based on two-dimensional flow.

NACA RM L52L22

FREE-FLIGHT-TUNNEL INVESTIGATION OF THE LOW-SPEED STABILITY AND CONTROL CHARACTERISTICS OF A MODEL HAVING A FUSELAGE OR RELATIVELY FLAT CROSS SECTION. John W. Paulson and Joseph L. Johnson, Jr. February 1953. 30p. diagrs., photo., tab. (NACA RM L52L22) (Declassified from Confidential, 10/12/54)

Results are presented of an experimental investigation in the Langley free-flight tunnel to determine the dynamic lateral stability and control characteristics of a model having a relatively flat cross-section fuselage. Tests were made with several vertical-tail configurations and with the leading-edge flap retracted and extended.

NACA RM L52L26a

EFFECTS OF ROUGHNESS AND REYNOLDS NUMBER ON THE NONLINEAR LIFT CHARACTERISTICS OF A WING WITH MODIFIED HEXAGONAL AIRFOIL SECTIONS. Milton A. Schwartzberg. February 1953. 18p. diagrs., photo. (NACA RM L52L26a) (Declassified from Confidential, 10/12/54)

Nonlinear lift characteristics of a low-aspect-ratio wing with modified hexagonal airfoil sections at low Reynolds numbers were observed at Mach numbers from 0.379 to 0.896. Effects of increased Reynolds numbers and of surface roughness on the linearity of the lift curves were investigated.

NACA RM L53A19

SOME TORSIONAL-DAMPING MEASUREMENTS OF LAMINATED BEAMS AS APPLIED TO THE PROPELLER STALL-FLUTTER PROBLEM. Atwood R. Heath, Jr. April 1953. 14p. diagrs., photos., tab. (NACA RM L53A19) (Declassified from Confidential, 10/12/54)

The structural damping in the torsion mode of vibration of a series of untwisted, laminated thin beams simulating propeller blades is presented. The number of laminations were varied, as well as the bonding material and the method of joining laminations. Application of the data to the calculation of the minimum flutter speed of thin propeller blades indicates that appreciable gains in the minimum flutter speed may be obtained for laminated blades using a Cycleweld bond.

NACA RM L53B19

WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF VARIOUS DORSAL-FIN AND VERTICAL-TAIL CONFIGURATIONS ON THE DIRECTIONAL STABILITY OF A STREAMLINED BODY OF TRANSONIC SPEEDS. TRANSONIC-BUMP METHOD. Harold S. Johnson and William C. Hayes. April 1953. 22p. diagrs., photo., tab. (NACA RM L53B19) (Declassified from Confidential, 10/12/54)

Yawing-moment coefficients were obtained for several dorsal-fin and vertical-tail configurations in combination with a streamlined body through a large angle-of-sideslip range and a Mach number range of 0.59 to 1.11. The results indicated that dorsal fins improved the directional stability characteristics of the body alone and the body—vertical-tail configuration. A ring tail was more effective at small angles of sideslip and less effective at large angles of sideslip than a tapered low-aspect-ratio vertical tail.

NACA RM L53C10

A PRELIMINARY INVESTIGATION OF AERODYNAMIC CHARACTERISTICS OF SMALL INCLINED AIR OUTLETS AT TRANSONIC MACH NUMBERS. Paul E. Dewey. April 1953. 21p. photos., diagrs. (NACA RM L53C10) (Declassified from Confidential, 10/12/54)

The aerodynamic characteristics of several outlets with inclined or curved axes discharging air into a transonic stream have been investigated. The data presented herein show the discharge coefficient of such outlets and static-pressure distribution in the vicinity of the outlets for several values of stream Mach number and discharge flow parameter. Tuft observations, showing the vortex formation caused by the outlet discharge from a perpendicular and an inclined outlet, are also presented.

NACA RM L53D21

MEASUREMENTS OF AERODYNAMIC CHARACTERISTICS AT TRANSONIC SPEEDS OF AN UNSWEPT AND UNTAPERED NACA 65-009 AIRFOIL MODEL OF ASPECT RATIO 3 WITH 1/4-CHORD PLAIN FLAP BY THE NACA WING-FLOW METHOD. Harold I. Johnson. June 1953. 35p. diagrs., photo. (NACA RM L53D21) (Declassified from Confidential, (10/12/54)

Lift, pitching-moment, and hinge-moment data obtained from wing-flow tests of an unswept, untapered NACA 65-009 airfoil model of aspect ratio 3.01 equipped with 1/4-chord full-span plain flap are presented. Effects of flap gap and of roughness were investigated. The Mach number range of the tests was 0.65 to 1.10 and the Reynolds number range was 0.5×10^6 to 0.9×10^6.

NACA RM L53D30

CALCULATION OF AERODYNAMIC FORCES ON AN INCLINED DUAL-ROTATING PROPELLER. John L. Crigler and Jean Gilman, Jr. June 1953. 24p. diagrs. (NACA RM L53D30) (Declassified from Confidential, 10/12/54)

This paper presents a method of calculating the fluctuating aerodynamic forces on a dual-rotating propeller the thrust axis of which is inclined at an angle to the air stream. Sample calculations are made and the results are analyzed to show some of the effects encountered with this type of operation.

NACA RM L53E12

EFFECTS OF COMPRESSIBILITY AT MACH NUMBERS UP TO 0.8 ON INTERNAL-FLOW CHARACTERISTICS OF A COWLING-SPINNER COMBINATION EQUIPPED WITH AN EIGHT-BLADE DUAL-ROTATION PROPELLER. Gene J. Bingham and Arvid L. Keith, Jr. June 1953. 39p. diagrs., photos. (NACA RM L53E12) (Declassified from Confidential, 10/12/54)

An investigation has been conducted to study the effects of compressibility for Mach numbers up to 0.8 on the internal-flow characteristics of an NACA 1-series cowling-spinner combination equipped with a dual-rotation propeller. Two propellers having 24-percent-thick shank sections were studied; one had the propeller shanks extended to the spinner surface and the juncture sealed, and the other had a raised platform-type juncture with the gap required to allow blade-angle changes located outside of the spinner boundary layer. The effects of variations in inlet height and rate of internal compression on the internal-flow characteristics were also studied. Total- and static-pressure distributions and average impact pressure coefficients measured at the inlet and at a diffuser station are presented.

NACA RM L53E28a

INVESTIGATION AT TRANSONIC SPEEDS OF THE HINGE-MOMENT AND LIFT-EFFECTIVENESS CHARACTERISTICS OF A SINGLE FLAP AND A TANDEM FLAP ON A 60° DELTA WING. Delwin R. Croom and Harleth G. Wiley. July 1953. 16p. diagrs. (NACA RM L53E28a) (Declassified from Confidential, 10/12/54)

This paper presents the results of an investigation to determine the comparative hinge-moment and lift-effectiveness characteristics of a single flap and a tandem flap on a semispan 60° delta-wing model at transonic speeds by the transonic-bump method. The delta-wing model was a flat plate with beveled leading and trailing edges, a maximum thickness ratio of 0.045, 60° sweepback at the leading edge, a taper ratio of 0, and an aspect ratio of 2.31. Lift and hinge moments were obtained through a Mach number range of 0.60 to 1.11. The tandem flap had less variation of C_{h_δ} (hinge-moment coefficient per degree flap deflection) with Mach number than did the single flap and the lift effectiveness was only about 50 percent of that obtained with the single flap.

NACA RM L53F16a

LOW-SPEED INVESTIGATION OF THE LATERAL CONTROL CHARACTERISTICS OF THREE TIP AILERONS ON A 60° TRIANGULAR WING. Stanley M. Gottlieb. August 1953. 24p. diagrs., photo. (NACA RM L53F16a) (Declassified from Confidential, 10/12/54)

An investigation has been made at a Reynolds number of 9×10^6 and a Mach number of 0.15 of the lateral control characteristics of three wing-tip ailerons on a 6-percent-thick, 60° triangular-wing-fuselage combination. The controls consisted of two half-delta ailerons having areas equal to 0.077 and 0.138 times the wing-semispan area and a full-delta aileron having an area equal to 0.138 times the wing-semispan area. The tests, which included measurements of rolling moments, hinge moments, yawing moments, and lateral force, were made through ranges of angle of attack and deflection from -12° to 38° and from -20° to 20°, respectively.

NACA RM L53G08

INVESTIGATION TO DETERMINE EFFECTS OF RECTANGULAR VORTEX GENERATORS ON THE STATIC-PRESSURE DROP THROUGH A 90° CIRCULAR ELBOW. E. Floyd Valentine and Martin R. Copp. September 1953. 35p. diagrs., photos. (NACA RM L53G08) (Declassified from Confidential, 10/12/54)

An investigation was made of a constant-area, circular 90° elbow of mean radius or curvature equal to its diameter with several arrangements of simple, nontwisted, rectangular vortex generators. They were installed at the inlet and also at stations 15°, 30°, and 60° into the elbow. The effect of the vortex generators on the pressure drop measured between the inlet and a station 4 diameters downstream of the elbow is given for one inlet-boundary-layer thickness.

NACA RM L53G23

TRANSONIC AERODYNAMIC CHARACTERISTICS OF AN NACA 64A006 AIRFOIL SECTION WITH A 15-PERCENT-CHORD LEADING-EDGE FLAP. Milton D. Humphreys. September 1953. 44p. diagrs., photos. (NACA RM L53G23) (Declassified from Confidential, 10/12/54)

Two-dimensional airfoil section normal-force, drag, pitching-moment, flap normal-force, and hinge-moment characteristics obtained on an NACA 64A006 airfoil section equipped with a 15-percent-chord leading-edge flap are presented for Mach numbers from 0.5 to 1.0. The leading-edge flap effected a general improvement in the force characteristics at Mach numbers up to 0.8 by alleviating flow separation at high normal-force coefficients.

NACA RM L53G23a

THE EFFECT OF CONTROL-SURFACE-SERVO NATURAL FREQUENCY ON THE DYNAMIC PERFORMANCE CHARACTERISTICS OF AN ACCELERATION CONTROL SYSTEM APPLIED TO A SUPERSONIC MISSILE. Anthony L. Passera and Martin L. Nason. September 1953. 28p. diagrs., 3 tabs. (NACA RM L53G23a) (Declassified from Confidential, 10/12/54)

A theoreotical investigation is made to determine the effect of the natural frequency of a second-order control-surface servo upon the dynamic performance characteristics of a normal-acceleration control system with respect to accuracy of control and accumulator volume of flow and peak rate of volume flow for several missile scale sizes and flight conditions in response to a step-input command. This paper seeks a compromise value of natural frequency that yields a control system with moderate volume flow and peak rate of volume flow along with good accuracy of control.

NACA RM L53H13

THE AERODYNAMIC CHARACTERISTICS AT TRANSONIC SPEEDS OF AN ALL-MOVABLE, TAPERED, 45° SWEPTBACK, ASPECT-RATIO-4 TAIL DEFLECTED ABOUT A SKEWED HINGE AXIS AND EQUIPPED WITH AN INSET UNBALANCING TAB. James M. Watson. September 1953. 40p. diagrs. (NACA RM L53H13) (Declassified from Confidential, 10/12/54)

This paper contains the results of an investigation at transonic speeds of an all-movable, aspect-ratio-4, taper-ratio-0.6 tail swept back 45° at the quarter-chord line, and deflected about a skewed hinge axis located behind the centers of pressure. The tail was equipped with an inset tab. Lift, pitching-moment, and hinge-moment data are presented for various tail angles of attack and deflections and tab deflections through a Mach number range of 0.61 to 1.21 obtained by the transonic-bump technique.

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Research Abstracts

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CURRENT NACA REPORTS

NACA TM 1380

CONTRIBUTION TO THE THEORY OF TAIL-WHEEL SHIMMY. (Beitrag zur Theorie des Spornradflatterns). M. Melzer. December 1954. 37p. diagrs., 7 tabs. (NACA TM 1380. Trans. from Focke-Wulf Flugzeugbau G. m. b. H., Bremen, Technische Berichte, v. 7, no. 2, 1940)

A basic theoretical and experimental investigation is made of the shimmy behavior of a swiveling landing gear, the experimental tests being conducted with a small wheel mounted over a continuous belt. Effects of wheel loading, rolling velocity, rearward position of the wheel with respect to the swivel axis, tire elasticity, and torsional flexibility of the fuselage are investigated both experimentally and theoretically. A major theoretical conclusion is that the motion of a landing gear moving in a straight line without fuselage elasticity is stable for a sufficiently large rearward position of the wheel behind the swivel axis, and this conclusion is well verified quantitatively by the experimental data.

NACA TN 3240

THEORETICAL CALCULATIONS OF THE LATERAL STABILITY DERIVATIVES FOR TRIANGULAR VERTICAL TAILS WITH SUBSONIC LEADING EDGES TRAVELING AT SUPERSONIC SPEEDS. Percy J. Bobbitt. December 1954. 68p. diagrs., photos., 5 tabs. (NACA TN 3240)

Pressure-distribution expressions and stability derivatives have been derived for zero-end-plate triangular vertical tails performing yawing, rolling, and constant-lateral-acceleration motions by a method for solving supersonic-conical flow boundary-value problems. In addition, by using the yawing and constant-lateral-acceleration results, the damping of the vertical tail oscillating laterally in yaw has been approximated to the first order in frequency. End-plate effects have been discussed and suggestions made to aid in their evaluation. In this connection the complete-end-plate and no-end-plate stability derivatives for the sideslip motion obtained from other sources have been considered. The pressure-distribution expressions and stability derivatives presented are valid for a range of Mach numbers for which the leading edge is subsonic and the trailing edge supersonic.

NACA TN 3251

A THEORETICAL INVESTIGATION OF THE SHORT-PERIOD DYNAMIC LONGITUDINAL STABILITY OF AIRPLANE CONFIGURATIONS HAVING ELASTIC WINGS OF 0° TO 60° SWEEPBACK. Milton D. McLaughlin. December 1954. 39p. diagrs., 2 tabs. (NACA TN 3251)

An analytical investigation utilizing the semirigid approach was made to determine the effects of wing flexibility on the dynamic longitudinal stability of thin-wing airplane configurations. The configurations were assumed to vary in wing sweep angle from 0° to 60°, in center-of-gravity location from 25 percent mean aerodynamic chord to 45 percent mean aerodynamic chord, and in ratio of wing mass to airplane mass from 0.15 to 0.50. Solutions were obtained in the form of frequency and damping of the flexible wing mode and of the airplane short-period stability mode. Results are compared with those obtained by simplified methods.

NACA TN 3267

BOUNDARY-LAYER TRANSITION AT MACH 3.12 WITH AND WITHOUT SINGLE ROUGHNESS ELEMENTS. Paul F. Brinich. December 1954. 41p. diagrs. (NACA TN 3267)

Transition on a hollow cylinder alined with the air stream was studied in a Mach 3.12 wind tunnel at Reynolds numbers from 1×10^5 to 7×10^5 per inch. Transition was observed from surface-temperature distributions and schlieren photographs with and without single roughness elements. Without roughness, the transition Reynolds number varied as the square root of the stream Reynolds number per inch. The results obtained with roughness followed the trends of Dryden's low-speed correlation. The degree of roughness required was found to be three to seven times as great as for low-speed flows.

NACA TN 3280

ELECTRICAL ANALOGIES FOR STIFFENED SHELLS WITH FLEXIBLE RINGS. R. H. MacNeal, California Institute of Technology. December 1954. 35p. diagrs., 2 tabs. (NACA TN 3280)

First, an electrical analogy is developed for a circular shell with a straight axis and variable radius. This analogy is extended to noncircular cylinders. Then an electrical analogy is derived for

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rings with variable radii of curvature; a simplified circuit for circular rings is also presented. The simplifications that occur when the rings are assumed to be rigid are discussed. Finally, results are given for two sample problems solved on an analog computer. The second problem concerns a cantilever conical shell and illustrates the manner in which the shell and ring circuits are interconnected.

NACA TN 3288

ON THE ANALYSIS OF LINEAR AND NONLINEAR DYNAMICAL SYSTEMS FROM TRANSIENT-RESPONSE DATA. Marvin Shinbrot. December 1954. 51p. diagrs., 6 tabs. (NACA TN 3288)

A general theory of the so-called "equations-of-motion" methods for linear dynamical systems is developed first. It is then shown that when viewed from this general point of vantage, all of these linear methods can be extended in a perfectly natural way to apply to nonlinear systems. In addition, through use of this theory, a new method, possessing certain advantages over previous methods, is derived. Application of this method is demonstrated by several examples.

NACA TN 3301

COMPARISON OF FLUTTER CALCULATIONS USING VARIOUS AERODYNAMIC COEFFICIENTS WITH EXPERIMENTAL RESULTS FOR SOME RECTANGULAR CANTILEVER WINGS AT MACH NUMBER 1.3. Herbert C. Nelson and Ruby A. Rainey. November 1954. 22p. diagrs., 2 tabs. (NACA TN 3301)

A general Rayleigh analysis is used as a basis for developing four methods of flutter analysis that are applied to twelve rectangular low-aspect-ratio wings with aspect ratios ranging from 3.00 to 4.55. These wings were previously tested at a Mach number of 1.3 by progressively varying certain wing parameters until flutter occurred. The four methods of flutter analysis used are: section coefficients for harmonically pitching and translating rectangular wings in a Rayleigh type of analysis, two-dimensional coefficients in a Rayleigh type of analysis, total coefficients for harmonically pitching and translating rectangular wings in a representative-section analysis, and two-dimensional coefficients in a representative-section analysis. Each of the four methods involves two degrees of freedom, namely, first bending and first torsion of a cantilever wing. Comparison of the analytical and experimental results indicates that the use of aerodynamic coefficients derived on the basis of three-dimensional flow leads to a significant improvement in the correlation of theory and experiment.

NACA TN 3304

INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS OF A MODEL WING-PROPELLER COMBINATION AND OF THE WING AND PROPELLER SEPARATELY AT ANGLES OF ATTACK UP TO 90°. John W. Draper and Richard E. Kuhn. November 1954. 72p. diagrs., photos., tab. (NACA TN 3304)

Results are presented of a wind-tunnel investigation of the effects of slipstream for two large-diameter propellers on the aerodynamic characteristics of a wing model. The investigation covered angles of attack from -10° to 90° and thrust coefficients representing free-stream velocities from zero to the normal range of cruising flight. An appreciable increase in the angle of attack for maximum lift with increasing power is indicated. A modification of the method of Smelt and Davies for estimating the effects of slipstreams on the lift-curve slope is presented. Performance calculations for an assumed vertical take-off airplane are also included. Forces and moments on the wing-propeller combination and on the wing and propellers separately are included. A large nose-up pitching moment on the propeller itself was found at high angles of attack.

NACA TN 3306

AN INVESTIGATION OF A LIFTING 10-PERCENT-THICK SYMMETRICAL DOUBLE-WEDGE AIRFOIL AT MACH NUMBERS UP TO 1. Milton D. Humphreys. November 1954. 35p. diagrs., photos., tab. (NACA TN 3306)

Subsonic and transonic pressure-distribution and drag-coefficient measurements on a two-dimensional 10-percent-thick symmetrical double-wedge airfoil for a range of angles of attack are presented and compared with theory and existing experimental data.

NACA TN 3307

AN INVESTIGATION OF A WING-PROPELLER CONFIGURATION EMPLOYING LARGE-CHORD PLAIN FLAPS AND LARGE-DIAMETER PROPELLERS FOR LOW-SPEED FLIGHT AND VERTICAL TAKE-OFF. Richard E. Kuhn and John W. Draper. December 1954. 94p. diagrs., photos. (NACA TN 3307)

An investigation of the effectiveness of a wing equipped with large-chord plain flaps and auxiliary vanes in rotating the effective thrust vector from two large-diameter propellers to a near vertical attitude for vertical take-off and low-speed flight has been conducted in the Langley 300 mph 7- by 10-foot tunnel. The model consisted of a semispan wing equipped with a 60-percent-chord and a 30-percent-chord plain flap. Two large-diameter overlapping propellers, driven by electric motors, were used. The tests covered a range of angle of attack from 0° to 90° and a thrust-coefficient range representative of free-flight velocities from zero to the normal range of cruising velocities.

NACA TN 3309

MECHANICAL PROPERTIES AT ROOM TEMPERATURE OF FOUR CERMETS OF TUNGSTEN CARBIDE WITH COBALT BINDER. Aldie E. Johnson, Jr. December 1954. 16p. diagrs., photo., tab. (NACA TN 3309)

Room-temperature stress-strain curves are presented for compression, tension, and shear loadings on four compositions of tungsten carbide with cobalt binder. Values of modulus of elasticity, modulus of rigidity, Poisson's ratio in the elastic region, ultimate strength, density, and hardness for the four materials are tabulated.

NACA TN 3312

INITIAL EXPERIMENTS ON FLUTTER OF UNSWEPT CANTILEVER WINGS AT MACH NUMBER 1.3. W. J. Tuovila, John E. Baker and Arthur A. Regier. November 1954. 19p. diagrs., photos., 2 tabs. (NACA TN 3312. Formerly RM L8J11)

This paper contains experimental data for the bending torsion flutter of unswept cantilever wings at Mach number of 1.3. Comparison with the theory of flutter at supersonic speeds indicates that the theory is applicable in predicting cantilever-wing flutter. These preliminary experiments consider also various overall effects of center-of-gravity location, elastic-axis location, mass-density parameter, section shape, and some wing-tip moments of inertia.

NACA TN 3316

SOME MEASUREMENTS OF NOISE FROM THREE SOLID-FUEL ROCKET ENGINES. Leslie W. Lassiter and Robert H. Heitkotter. December 1954. 21p. diagrs. (NACA TN 3316)

Results of a systematic experimental investigation of the sound field of one type of rocket engine are given. These comprise frequency spectra and overall pressure data as obtained along a semicircle of 50-foot radius about the engine. The spectra are shown to be of random nature and the angular distribution is shown to have a maximum at an angle of about 45° off the jet axis downstream of the nozzle. Frequency spectra and overall pressure magnitudes are also given for a few isolated points in the sound fields of two other solid-fuel rockets.

NACA TN 3320

FLIGHT MEASUREMENTS OF DRAG AND BASE PRESSURE OF A FIN-STABILIZED PARABOLIC BODY OF REVOLUTION (NACA RM-10) AT DIFFERENT REYNOLDS NUMBERS AND AT MACH NUMBERS FROM 0.9 TO 3.3. H. Herbert Jackson, Charles B. Rumsey and Leo T. Chauvin. November 1954. 20p. diagrs., photos. (NACA TN 3320. Formerly RM L50G24)

Free-flight tests at supersonic speeds have been made to determine the Reynolds number effects on total drag and base drag of a fin-stabilized parabolic-arc body of revolution having a body fineness ratio of 12.2 and designated the NACA RM-10 configuration. The Reynolds number range of 14×10^6 to 210×10^6 was obtained by testing full-scale and half-scale models through the Mach number range from 0.9 to 3.3.

NACA TN 3328

THEORETICAL AND EXPERIMENTAL INVESTIGATION OF HEAT TRANSFER BY LAMINAR NATURAL CONVECTION BETWEEN PARALLEL PLATES. A. F. Lietzke. December 1954. 23p. diagrs. (NACA TN 3328)

For the experimental work, parallel walls (one heated uniformly and the other cooled uniformly) were simulated by an annulus with an inner-to-outer diameter ratio near 1. The theoretical results are presented in equations for the velocity and temperature profiles and the ratio of actual temperature drop across the fluid to temperature drop for pure conduction. No experimental measurements were made of the velocity and temperature profiles, but the experimental results are compared with theory on the basis of the ratio of the actual temperature drop to the temperature drop for pure conduction. Good agreement was obtained between theory and experiment for axial temperature gradients above 40° F/ft.

NACA TN 3333

CORROSION OF METALS OF CONSTRUCTION BY ALTERNATE EXPOSURE TO LIQUID AND GASEOUS FLUORINE. Richard M. Gundzik and Charles E. Feiler. December 1954. 10p. photos., 3 tabs. (NACA TN 3333)

The corrosion of 3S-0 and 52S-0 aluminum, AISI 347 and 321 stainless steels, "A" nickel, and low-leaded brass by alternate exposure to liquid and gaseous fluorine has been determined for periods of up to 3-1/2 months. Under the conditions of the experiments, the corrosion of these metals was found to be negligible.

NACA TN 3341

AN ANALYTICAL ESTIMATION OF THE EFFECT OF TRANSPIRATION COOLING ON THE HEAT-TRANSFER AND SKIN-FRICTION CHARACTERISTICS OF A COMPRESSIBLE TURBULENT BOUNDARY LAYER. Morris W. Rubesin. December 1954. 56p. diagrs. (NACA TN 3341)

An analysis based on mixing-length theory is presented which indicates that surface blowing associated with transpiration cooling systems produces large reductions in both the heat-transfer and skin-friction coefficients for a turbulent boundary layer on a flat plate. The numerical results are restricted to the case of air blowing into air. The effects of blowing are indicated to be similar for high-speed, compressible flow to those for low-speed, incompressible flow.

NACA TN 3344

THEORETICAL AND EXPERIMENTAL INVESTIGATION OF AERODYNAMIC-HEATING AND ISOTHERMAL HEAT-TRANSFER PARAMETERS ON A HEMISPHERICAL NOSE WITH LAMINAR BOUNDARY LAYER AT SUPERSONIC MACH NUMBERS. Howard A. Stine and Kent Wanlass. December 1954. 48p. diagrs., photo., tab. (NACA TN 3344)

Measurements of the heat-transfer parameter, $Nu/\sqrt{Re}$, based on local flow conditions just outside the boundary layer and length of boundary-layer run were carried out on the heated, isothermal surface of a hemisphere-cylinder for a Mach number of 1.97 and Reynolds numbers based on body diameter from 0.60×10^6 to 2.28×10^6. An approximate method for calculating the distribution of heat-transfer parameter, applicable to any body of revolution, was developed which agrees well with the experimental results.

NACA TN 3348

A SYSTEM FOR MEASURING THE DYNAMIC LATERAL STABILITY DERIVATIVES IN HIGH-SPEED WIND TUNNELS. Henry C. Lessing, Thomas B. Fryer and Merrill H. Mead. December 1954. 42p. diagrs., photo. (NACA TN 3348)

A two-degree-of-freedom system in which rolling oscillations are forced is described. Details of the system, the theory, and the method of operation are discussed. Tests are described in which certain of the aerodynamic derivatives were simulated, and the results of these tests, as well as the results of a wind-tunnel investigation of a simple model, are presented.

BRITISH REPORTS

N-34221*

Forest Products Research Lab. (Gt. Brit.)
INVESTIGATIONS INTO GLUES AND GLUING. PROGRESS REPORT EIGHTY - APRIL 1954. THE DURABILITY OF ASSEMBLY GLUES - SERIES A. REPORT ON THE PLY-CLAD FRAMES AFTER SEVEN AND A HALF YEAR'S EXPOSURE. R. A. G. Knight, L. S. Doman and G. E. Soane. 12p., 3 tabs. (Supersedes Progress Reports 47 and 64) (Forest Products Research Lab.)

An investigation is being conducted of the long-term durability of all types of plywood glues tested under conditions ranging from normal indoor storage to full exposure. Results for a 7-1/2 year period are presented.

N-34234*

Aeronautical Research Council (Gt. Brit.)
THE APPLICATION OF CAMBER AND TWIST TO SWEPT WINGS IN INCOMPRESSIBLE FLOW. G. G. Brebner. 1954. 59p. diagrs., 2 tabs. (ARC CP 171)

This report provides a method of calculating the effect of a certain type of camber on the chordwise and spanwise loading of any wing in incompressible potential flow. A detailed description is given of the method of calculating the loading on a given cambered swept wing. The design of wings incorporating camber and twist to produce required chordwise and spanwise loadings is treated in detail. It is shown that at any spanwise position only one particular combination of camber and incidence will give a required chordwise loading.

N-34235*

Aeronautical Research Council (Gt. Brit.)
A NOTE ON THE BOUNDARY LAYER AND STALLING CHARACTERISTICS OF AEROFOILS. D. D. Carrow. 1954. 20p. diagrs. (ARC CP 174)

A qualitative explanation is suggested for the changes which occur in the stalling characteristics of airfoils as the Reynolds number is increased. This explanation is based on the variation, with Reynolds number, in the state of the boundary layer along the upper surface at just below the stalling incidence. Examples are given of the effect of Reynolds number and of leading edge roughness on the stalling characteristics of several airfoils, the changes from one type of stall to another being explained, in each case, by an alteration in the type of transition region. Five major types of stall are explained according to the manner in which the flow separation at the stall develops.

N-34322*

Aeronautical Research Council (Gt. Brit.)
STRESS CONCENTRATIONS AT A CUT-OUT IN A SWEPT WING. E. H. Mansfield. 1954. 21p. diagrs., 5 tabs. (ARC R & M 2823; ARC 14,249. Formerly RAE Structures 114)

The stress concentrations are determined for a panel, bounded by main load-carrying members and an oblique edge, such as might occur at a cut-out in a swept wing. The solutions given are exact and cover the effects of a member along the oblique edge and of closely spaced stringers attached to the panel.

N-34323*

Aeronautical Research Council (Gt. Brit.)
FLIGHT TRIALS OF A ROCKET-PROPELLED TRANSONIC RESEARCH MODEL: THE R. A. E. - VICKERS ROCKET MODEL, PARTS I TO IV. Staff of the Supersonics Division, Flight Section. 1954. 63p. diagrs., photos., 2 tabs. (ARC R & M 2835; ARC 13,658. Formerly RAE Aero 2357)

The main body of the report contains a historical review of the project, brief descriptions of the test vehicles and experimental techniques, and the detailed analysis of the final successful flight trial. It is concluded that the method is an extremely difficult one and that the results it gives do not justify the effort it demands. Detailed descriptions of the test vehicle and its ancillary equipment are given in appendices; the work leading up to the final trial and the experimental methods and techniques are described. The model was air-launched at 36,000 feet above a ground radar station.

N-34324*

Aeronautical Research Council (Gt. Brit.)
THE FREQUENCY RESPONSE OF THE ORDINARY ROTOR BLADE, THE HILLER SERVO-BLADE, AND THE YOUNG-BELL STABILISER. G. J. Sissingh. 1954. 19p. diagrs., 2 tabs. (ARC R & M 2860; ARC 13,592. Formerly RAE Aero 2367)

The report deals with the frequency response of pivoted gyratory systems, and in particular, with the response of the ordinary rotor blade, the Hiller servo-blade, and the Young-Bell stabilizer to sinusoidal disturbances caused by pitching oscillations with constant amplitude. Explicit formulas are given for each individual system and the effect of the frequency ratio on the control characteristics of the Bell stabilizer and the Hiller servo-blade is shown by vector loci.

N-34325*

Aeronautical Research Council (Gt. Brit.)
WATER AND AIR PERFORMANCE OF SEAPLANE HULLS AS AFFECTED BY FAIRING AND FINENESS RATIO. A. G. Smith and J. E. Allen. 1954. 27p. diagrs., 5 tabs. (ARC R & M 2896; ARC 13,644. Formerly MAEE F/Res/219)

An analysis is made of data on the variation of hull air drag with length-beam ratio and degree of local fairing, and of the maximum beam loading permitted for reasonable hydrodynamic performance. The effect of length-beam ratio on hull structure weight is also discussed. Charts are given to help in the selection of the best hull form for any given design conditions. From these may be estimated dimensions, air drag, and the maximum beam loading to give a reasonable standard of water performance.

N-34326*

Aeronautical Research Council (Gt. Brit.)
A NOTE ON THE DYNAMIC STABILITY OF AIRCRAFT AT HIGH-SUBSONIC SPEEDS WHEN CONSIDERING UNSTEADY FLOW. W. J. G. Pinsker. 1954. 28p. diagrs., 7 tabs. (ARC R & M 2904; ARC 13,567. Formerly RAE Aero 2378)

The effect of an increase in speed relative to the speed of sound on the unsteady flow around a harmonically oscillating airfoil, is to increase the lag of the aerodynamic forces and moments behind the deflection when the frequency is small. It is shown theoretically that this will result in a serious deterioration of the damping of both the lateral oscillation and the high frequency longitudinal oscillation with high Mach numbers. Use is made of derivatives calculated for flutter purposes to estimate the unsteady derivatives at aircraft oscillation frequencies. Illustrative examples are presented.

N-34327*

Aeronautical Research Council (Gt. Brit.)
METHODS OF TESTING REINFORCED PLASTICS, PARTS I AND II. F. T. Bartwell. 1954. 34p. diagrs., photos., 13 tabs. (ARC R & M 2702; ARC 11,375. Formerly ARC 10,095; Strut 1088)

An experimental comparison has been made between five types of tensile tests including novel types designed to enable axial loading conditions to be approached more readily than is the case with established methods. Examination of the results of 240 tests indicates that significant differences can occur between the results of different tests and that there is also a significant variation between the properties of material cut from different parts of the same sheet. It is concluded that the results, obtained when testing paper-base material by novel methods, are sufficiently good to justify development of a simplified apparatus of similar type for general use.

N-34328*

Aeronautical Research Council (Gt. Brit.)
THE INFLUENCE OF THICKNESS/CHORD RATIO ON SUPERSONIC DERIVATIVES FOR OSCILLATING AEROFOILS. W. P. Jones. 1954. 17p. diagrs., 3 tabs. (ARC R&M 2679. Formerly ARC 10,871; 0.678; FM 1153)

By the use of Temple and Jahn's theory for the oscillating flat plate and Busemann's theory for airfoils in steady motion, derivatives are obtained for symmetrical circular-arc and double-wedge airfoils describing low frequency oscillations at supersonic speeds. It is known that theoretically the torsional aerodynamic damping for a flat plate oscillating about an axis forward of the two-thirds chord position is negative at low frequencies for a limited range of supersonic speeds. In this report, however, it is shown that the effect of increasing thickness/chord ratio is to decrease the range of speeds for which the aerodynamic damping is negative, and for which the degree of freedom flutter is possible. The present theory also allows for the forward movement of the center of pressure from the half-chord position as the airfoil thickness is increased, and leads to better estimates of the stiffness derivatives for an actual airfoil. In practice the center of pressure is not at half-chord as predicted by linear theory.

N-34329*

Aeronautical Research Council (Gt. Brit.)
THEORETICAL CALCULATIONS OF THE DISTRIBUTION OF AERODYNAMIC LOADING ON A DELTA WING. H. C. Garner. 1954. 33p. diagrs., 9 tabs. (ARC R & M 2819. Formerly ARC 12,222; Perf. 538; S & C 2295)

The distribution of velocity potential has been calculated for a thin, flat, delta wing at small incidence. The method introduces novel functions with 10 arbitrary constants to express the doublet distribution over the wing and a special numerical integration to evaluate the downwash at 10 chosen points on the surface. Three different forms of the doublet distribution are employed and lead to three independent solutions of the resulting simultaneous equations. One object of the paper is to form the first step towards a fundamental comparison with measured pressure distributions.

N-34331*

Forest Products Research Lab. (Gt. Brit.)
INVESTIGATION INTO GLUES AND GLUING. PROGRESS REPORT EIGHTY-ONE - JUNE 1954. THE COMPARATIVE DURABILITY OF PLYWOOD GLUES IN ENGLAND AND IN NIGERIA (SERIES IV). FOURTH YEAR'S ANALYSIS. J. F. S. Carruthers and M. S. Burridge. 10p., 3 tabs. (Supersedes Progress Reports 62, 69, and 74) (Forest Products Research Lab.)

Progress made on the evaluation of the comparative durability of plywood adhesives in England and in Nigeria is summarized. The adhesives evaluated were of phenol-, resorchinol-, melamine-, and fortified and normal urea-formaldehyde types. Test results are presented for plywood joints bonded with each type of adhesive over a 4-year period in four different environments.

N-34383*

Royal Aircraft Establishment (Gt. Brit.)
EFFECT OF WING FLEXIBILITY ON LANDING IMPACT OF A FLYING-BOAT HULL. D. Williams. September 1954. 6p. (RAE Tech. Note Structures 136)

It is shown that wing flexibility cannot be the cause of the discrepancy between theoretical and experimental values for the interval between touchdown and maximum impact force.

N-34385*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF HARD ANODIC COATINGS ON THE FATIGUE STRENGTH OF D. T. D. 364B ALUMINIUM ALLOY. E. G. Savage, E. G. F. Sampson and J. K. Curran. June 1954. 10p. diagrs., 4 tabs. (RAE Tech. Note Met. 200)

Wöhler-type fatigue tests were made on D. T. D. 364B aluminum alloy test pieces which had been anodised under conditions previously described in order to produce hard coatings of about 0.001- or 0.002-inch thickness. Control tests were made on unanodised test pieces. Film thickness, surface roughness, and change of dimensions were also determined. Hard anodising reduced the fatigue strength of the test pieces by about one half, the reductions being of the same order for each thickness of coating. The anodic treatment increased the average roughness of the surfaces from about 4 to 50 microinches and increased the diameter of the test pieces by about 60 percent of the total film thickness. A possible method of reducing the ill-effects of hard anodising is described and further work is proposed.

N-34386*

Royal Aircraft Establishment (Gt. Brit.)
SOME PROBLEMS IN AERODYNAMICS AND THEIR SOLUTION BY ELECTRICAL ANALOGY. D. Küchemann and S. C. Redshaw. August 1954. 16p. (RAE Tech. Note Aero 2323)

Some purely aerodynamical phenomena, which might profitably be investigated by means of electrical analogue computers, are described. No attempt has been made to furnish a complete catalogue of problems but rather to present current issues, the solution of which would aid the development of practical aerodynamics. Consideration has only been given to those questions which can be solved more suitably by an analogue computor rather than by a digital machine, although the feasibility of partially solving certain of them by the use of an analogue computer, and completing the work with a digital machine, is mentioned. In scope, the survey includes two- and three-dimensional airfoils as well as interference and a number of special problems. The relative merits of the various forms of analogue computors are not extensively discussed.

N-34388*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF HEATING STEELS TO MODERATELY ELEVATED TEMPERATURES. G. Meikle and M. S. Binning. June 1954. 18p. diagrs., 5 tabs. (RAE Tech. Note Met. 199)

A review has been made of available information on the strength of structural steels up to temperatures of the order of 350° C. Experiments have been made to determine the strength of aircraft steels from 100° C to 350° C and the effect of heating at selected temperatures for different periods was determined. The percentage loss in strength and Young's Modulus was found to be fairly constant for all the ferritic steels at any particular temperature. No evidence was obtained that the length of time of heating, up to 1000 hours, had any additional deleterious effect.

N-34390*

Royal Aircraft Establishment (Gt. Brit.)
THE STRENGTH OF ANNEALED AND HEAT-TREATED GLASS. F. G. J. Brown and J. Ellis. July 1954. 60p. diagrs., 7 tabs. (RAE Structures 167)

This report develops statistical methods of choosing allowable design stresses for annealed and heat-treated glass. The results are easy to apply but additional fundamental knowledge of some properties of glass is needed before they can be used to the best advantage. The report draws attention to these gaps in existing knowledge and makes recommendations for further research.

N-34392*

Ministry of Supply (Gt. Brit.)
THE CREEP AND FATIGUE PROPERTIES OF SOME WROUGHT COMPLEX ALUMINIUM BRONZES. J. McKeown, D. N. Mends, E. S. Bale and A. D. Michael. September 1954. 27p. diagrs., photos., 5 tabs. (MOS S & TM 9/54)

The work described in this report is primarily concerned with the effect of aluminum content on the creep and fatigue properties of complex aluminum bronzes containing 5-percent each of iron and nickel; the effect of heat treatment on such alloys and the effect of the addition of small amounts of high melting point elements on the creep properties of alloys containing 9- and 10.5-percent aluminum with 5-percent each of iron and nickel.

N-34393*

Royal Aircraft Establishment (Gt. Brit.)
THE FLOW FIELD OF WEDGE-SHAPED AND CONICAL FLAME FRONTS AT LOW SPEEDS. J. Weber. August 1954. 12p. diagrs. (RAE Tech. Note Aero 2318)

The analytical representation of flame fronts by source sheets is discussed and examples are given for the streamlines and the pressure distribution on them for the incompressible flow past two-dimensional wedge-shaped and for conical flame fronts.

N-34394*

Royal Aircraft Establishment (Gt. Brit.)
A CURVE FOLLOWER FOR DISCONTINUOUS CURVES ON 35mm. FILM. O. H. Lange and G. J. Herring. August 1954. 16p. diagrs. (RAE Tech. Note GW 334)

A photo-electric system is described by means of which the voltage analogue of the ordinates of the curve of a single-valued function can be obtained to

an accuracy of approximately 2 percent of the maximum ordinate. No restriction is placed on the maximum slope of the curve, which is fed into the machine as a trace on a film which may be of any length. Circuits for the electronic components are given and some applications are indicated.

N-34401*

Royal Aircraft Establishment (Gt. Brit.) CONSIDERATION OF SOME NEW LOW-DENSITY MATERIALS. G. A. Horridge. June 1954. 18p. diagrs., photos. (RAE Tech. Note Chem. 1232)

It would be an advantage from the point of view of structural efficiency to have a material that can be moulded to form primary structures with a specific gravity considerably less than existing reinforced plastics. There is available at present a range of low-density core materials which are used for sandwich construction but a consideration of foamed resins has not yet shown any promise that they can be used as a basis for a low-density primary structural material. . This is because absolute strengths are low and orientated reinforcement in the foam has not improved the mechanical properties for competition with existing primary materials. An alternative method to reduce the specific gravity of reinforced plastics lies in the use of glass tubes instead of fibers as reinforcement. Results of tests on such materials have so far been promising and theoretical considerations show both the limits of the effectiveness of such reinforcement and the direction in which to aim to produce a material of given properties.

N-34402*

Marine Aircraft Experimental Establishment (Gt. Brit.) METHOD FOR REDUCING SEAPLANE TAKE-OFF DISTANCES TO STANDARD CONDITIONS. J. A. Hamilton. April 1954. 44p. diagrs., photos., 10 tabs. (MAEE F/Res/245)

In this report are developed methods for the reduction of seaplane take-off distances to standard conditions of weight, wind, and ambient temperature. The expressions derived are applicable to the waterborne run and to the airborne run up to the 50-foot height point. The methods may be applied to take-off with simulated engine failure. The theoretical results are in good agreement with measurements made on reciprocating engined seaplanes of 9000 lb and 78, 000 lb weight for winds up to 20 knots, weight changes of 20 percent, and a temperature range of 2° to 32° C. However, the general application of the corrections should be limited to temperature changes of less than 10° C, weight changes of less than 10 percent, and wind changes of less than 10 knots. These ranges should be adequate for the majority of flight trials conducted in one location.

N-34406*

Aeronautical Research Council (Gt. Brit.) THE GROWTH OF A VORTEX IN TURBULENT FLOW. H. B. Squire. March 18, 1954. 6p. diagrs. (ARC 16,666; FM 2053)

The growth of a line vortex with time and the spread of a trailing vortex behind a wing due to turbulence are considered. It is shown that the eddy viscosity for this type of motion may be taken to be proportional to the circulation round the vortex and the solution is then similar to the solution for the growth of a vortex in laminar flow. The method is applied to calculate the distance behind a wing for which the trailing vortices will touch one another.

MISCELLANEOUS

NACA TN 1401

Errata No. 1 on "INTRODUCTION TO THE PROBLEM OF ROCKET-POWERED AIRCRAFT PERFORMANCE." H. Reese Ivey, Edward N. Bowen, Jr. and Lester F. Oborny. December 1947.

NACA TN 3201

Errata No. 1 on "DIRECTIONAL STABILITY CHARACTERISTICS OF TWO TYPES OF TANDEM HELICOPTER FUSELAGE MODELS." James L. Williams. May 1954.

NACA TN 3261

Errata No. 1 on "A METHOD FOR EVALUATING THE EFFECTS OF DRAG AND INLET PRESSURE RECOVERY ON PROPULSION-SYSTEM PERFORMANCE." Emil J. Kremzier. August 1954.

N-25292*

Advisory Group for Aeronautical Research and Development. DESIGN AND OPERATION OF INTERMITTENT SUPERSONIC WIND TUNNELS. A. Ferri and S. M. Bogdonoff. May 1954. 108p. diagrs., photo. (AGARDograph 1)

A study has been made of the operating characteristics of intermittent wind tunnels, particularly of the blowdown type. For the same test Mach and Reynolds numbers, the blowdown tunnel is considerably cheaper to build and to operate than the comparable continuous tunnel. For tests of many different setups, flexibility may be more important than long running time. Typical construction, test setup, instrumentation, and extensions to the transonic and hypersonic region have been discussed. Some examples of operating intermittent tunnels are also given.

UNPUBLISHED PAPERS

N-33708*

FLOW NEAR THE FORWARD TIP OF A HIGHLY SWEPT WING AT MEDIUM ANGLES OF ATTACK - PART I. (Écoulement au Voisinage de la Pointe Avant d'une Aile a Forte Flèche aux Incidences Moyennes). Robert Legendre. (Presented at Eighth International Congress of Theoretical and Applied Mechanics, Istanbul, August 1952). November 1954. 18p. diagrs. (Trans. from Recherche Aéronautique, no. 30, 1952, p. 3-8)

An interpretation is made of the turbulent flow which originates at the forward tip of a highly swept wing as soon as the angle of attack is about 10°. The case considered is a plane, triangular, infinitely slender wing. The method employed is Jones' method of transverse sections. When the angle of attack of a highly swept wing is sufficient, well-defined vortices appear on the upper side of the wing. They correspond approximately to the field which would be induced by two rectilinear free vortices originating at the wing tip.

N-33709*

FLOW NEAR THE FORWARD TIP OF A HIGHLY SWEPT WING AT MEDIUM ANGLES OF ATTACK - PART II. (Écoulement au Voisinage de la Pointe Avant d'une Aile a Forte Flèche aux Incidences Moyennes). Robert Legendre. (Presented at Eighth International Congress of Theoretical and Applied Mechanics, Istanbul, August 1952). November 1954. 12p. diagrs. (Trans. from Recherche Aéronautique, no. 31, Jan.-Feb., 1953, p. 3-6)

The flow which originates in the neighborhood of the forward tip of a highly swept wing at medium angles of attack was previously schematized by the field of two isolated vortices. This study replaces the schematic representation by the field of the vortex sheets attached to the two leading edges of the wing. It is limited to the setting-up and the discussion of the integral-differential equation of the problem.

DECLASSIFIED NACA REPORTS

We have

THE FOLLOWING REPORTS HAVE BEEN DECLASSIFIED FROM CONFIDENTIAL, 11/30/54:

RM E8B27a
RM E8B27b
RM E9B01
RM L52B29
RM L52C19
RM L52D28
RM L53B27
RM L53C27

NACA RM A50G06

LOW-SPEED INVESTIGATION OF A 0.16-SCALE MODEL OF THE X-3 AIRPLANE - LONGITUDINAL CHARACTERISTICS. Noel K. Delany and Nora-Lee F. Hayter. September 8, 1950. 80p. diagrs., photos., 2 tabs. (NACA RM A50G06) (Declassified from Confidential, 10/29/54)

The low-speed, static, longitudinal characteristics of a model of the X-3 airplane have been determined with the wing flaps neutral and deflected. An investigation was also made of the effects of jettisonable-nose fins, landing gear and doors, scoops, and pilot's canopy on the longitudinal characteristics of the model. The X-3 airplane utilizes a wing of aspect ratio 3.01, a 4.5-percent-thick hexagonal section, and a taper ratio of 0.4. The wing was equipped with plain leading-edge flaps and split trailing-edge flaps.

NACA RM A50H02

EFFECT OF DIHEDRAL CHANGE ON THE THEORETICAL DYNAMIC LATERAL RESPONSE CHARACTERISTICS OF A LOW-ASPECT-RATIO STRAIGHT-WING SUPERSONIC AIRPLANE. Donovan R. Heinle. December 7, 1950. 35p. diagrs., 2 tabs. (NACA RM A50H02) (Declassified from Confidential, 10/29/54)

Theoretical calculations were made of the lateral-stability characteristics of a supersonic straight-wing low-aspect-ratio airplane. A Reeves Electronic Analog Computer was used to plot time histories of the lateral response to various distrubances and to obtain values of period, damping, and the roll excitation parameter. The effect of a change to negative geometric dihedral and changes in the yawing moment due to roll derivative $\left(C_{n_p}\right)$ were investigated.

NACA RM A51A16

LOW-SPEED INVESTIGATION OF A 0.16-SCALE MODEL OF THE X-3 AIRPLANE - LATERAL AND DIRECTIONAL CHARACTERISTICS. Noel K. Delany and Nora-Lee F. Hayter. March 16, 1951. 56p. diagrs., photos., tab. (RM A51A16) (Declassified from Confidential, 10/29/54)

A wind-tunnel investigation has been made of the low-speed, static, lateral, and directional characteristics of a model of an early design of the X-3 airplane with the wing flaps neutral and deflected. Measurements were also made of the fluctuations in rolling moment with time. The model utilized a wing having an aspect ratio of 3.01, a 4.5-percent-thick hexagonal section, and a taper ratio of 0.4. The wing was equipped with plain leading-edge flaps and split trailing edge flaps.

NACA RM A51H23

AERODYNAMIC CHARACTERISTICS OF A LEADING-EDGE SLAT ON A 35° SWEPT-BACK WING FOR MACH NUMBERS FROM 0.30 TO 0.88. John A. Kelly and Nora-Lee F. Hayter. December 1951. 49p. diagrs., tab. (NACA RM A51H23) (Declassified from Confidential, 11-30-54)

North American Aviation, Inc., has furnished the NACA with data obtained from tests which were made at Mach numbers from 0.300 to 0.883 to determine the lift, drag, and pitching-moment characteristics of a semispan model of a 35° sweptback wing with a leading-edge slat. The wing was tested in the presence of a fuselage. Measurements were made of the pressures acting on the slat in the retracted and full-open positions. These pressure data were analyzed to ascertain the slat opening-force characteristics for two possible circular-arc slat tracks which could be used for automatic operation of the slat.

NACA RM A51J25a

A SUMMARY OF AVAILABLE KNOWLEDGE CONCERNING SKIN FRICTION AND HEAT TRANSFER AND ITS APPLICATION TO THE DESIGN OF HIGH-SPEED MISSILES. Morris W. Rubesin, Charles B. Rumsey and Steven A. Varga. November 1951. 17p. diagrs. (NACA RM A51J25a) (Declassified from Confidential, 10/29/54)

A review is made of the existing information concerning boundary-layer characteristics: the temperature recovery, the skin-friction coefficients, the heat-transfer coefficients of both the laminar and turbulent boundary layers, and the position of the transition from laminar to turbulent flow. Comparison is made between existing flight data and results computed by the boundary-layer momentum-integral method in a preliminary attempt to establish some rational way of approaching the design of a missile whose Mach number range and body geometry are markedly different from those of existing data.

NACA RM A52I19a

INVESTIGATION OF AN NACA 4-(5)(05)-041 FOUR-BLADE PROPELLER WITH SEVERAL SPINNERS AT MACH NUMBERS UP TO 0.90. Robert M. Reynolds, Donald A. Buell and John H. Walker. December 1952. 86p. diagrs., photos., 6 tabs. (NACA RM A52I19a) (Declassified from Confidential, 10/29/54)

This paper presents the propeller characteristics of the NACA 4-(5)(05)-041 four-blade, single-rotation propeller in combination with two NACA 1-series spinners and two extended cylindrical spinners for a wide range of blade angles at Mach numbers up to 0.90. Included are data for the propeller operating at negative thrust at low forward speeds and operating at near-static conditions. A description of the 1000-horsepower propeller dynamometer is included.

NACA RM A52J17

CORRELATION OF BUFFET BOUNDARIES PREDICTED FROM WIND-TUNNEL TESTS WITH THOSE MEASURED DURING FLIGHT TESTS ON THE F8F-1 AND X-1 AIRPLANES - TRANSONIC-BUMP METHOD. Andrew Martin and James F. Reed. December 1952. 22p. diagrs., photos., tab. (NACA RM A52J17) (Declassified from Confidential, 10/29/54)

Wing-fuselage-combination models of the F8F-1 and X-1 airplanes have been tested in the Ames 16-foot high-speed wind tunnel utilizing the transonic-bump technique. Presented for these models are the lift and pitching-moment coefficients, and fluctuating wing-bending-moment and wake-pressure data. Comparisons are presented of buffet boundaries estimated from these data with flight-determined buffet boundaries.

NACA RM E52A14

DYNAMIC RESPONSE OF TURBINE-BLADE TEMPERATURE TO EXHAUST-GAS TEMPERATURE FOR GAS-TURBINE ENGINES. Richard Hood and William E. Phillips, Jr. February 1952. 41p. photos., diagrs. (NACA RM E52A14) (Declassified from Confidential, 11-30-54)

The frequency response of blade temperature to exhaust gas temperature is presented for two locations in the blade and at several operating conditions. The frequency response was determined by Fourier analysis of transient data. Two analytical methods are presented, and the results are compared with experimental data. The dynamic response of turbine-blade temperature to exhaust-gas temperature exhibited the form of an approximate first-order lag. The results are used to predict blade temperature for a typical controlled and uncontrolled gas-turbine engine.

NACA RM L8L31

THEORETICAL INVESTIGATION OF THE DYNAMIC LATERAL STABILITY CHARACTERISTICS OF DOUGLAS DESIGN NO. 39C, AN EARLY VERSION OF THE X-3 RESEARCH AIRPLANE. Charles V. Bennett. January 18, 1949. 39p. diagrs., 2 tabs. (NACA RM L8L31) (Declassified from Confidential, 10/29/54)

Contains results of calculations made to determine the neutral oscillatory stability boundaries, period and time to damp of the oscillatory mode, and motions following distrubances. The calculations were made for Mach numbers of 0.75 and 2.3 at an altitude of 35,000 feet and for the landing condition at sea level.

NACA RM L9K08

STABILITY AND CONTROL CHARACTERISTICS AT LOW SPEED OF A 1/4-SCALE BELL X-5 AIRPLANE MODEL. LONGITUDINAL STABILITY AND CONTROL. William B. Kemp, Jr. Robert E. Becht and Albert G. Few, Jr. March 14, 1950. 51p. diagrs., photos. (NACA RM L9K08) (Declassified from Confidential, 10/29/54)

An investigation was conducted to determine the longitudinal stability and control characteristics at low speed of a 1/4-scale model of a preliminary X-5 airplane design. Tests were made through a range of wing sweep angles from 20° to 60° and several flap and slat configurations were investigated.

NACA RM L9L06

SPIN-TUNNEL INVESTIGATION OF A MODEL OF A 60° DELTA-WING AIRPLANE TO DETERMINE THE SPIN, RECOVERY, AND LONGITUDINAL TRIM CHARACTERISTICS THROUGHOUT AN EXTENSIVE RANGE OF MASS LOADINGS. Walter J. Klinar and Ira P. Jones, Jr. February 15, 1950. 56p. diagrs., photos., 6 charts, 4 tabs. (NACA RM L9L06) (Declassified from Confidential, 10/29/54)

An investigation has been conducted in the Langley 20-foot free-spinning tunnel to determine the spin and recovery characteristics of a 60° delta-wing model for a wide range of mass loadings. Variations were made in the relative density, center of gravity, and inertia yawing-moment parameter. In addition to the normal single-tail configuration, dual-vertical-tail configurations were also investigated. Glide tests were performed on the model and force tests were conducted from 0° to 90° angle of attack both on the model used for the dynamic tests and on a somewhat larger model to determine if any unusual trimming tendencies above the stall existed.

NACA RM L50B28

THEORETICAL INVESTIGATION OF THE DYNAMIC LATERAL STABILITY CHARACTERISTICS OF THE DOUGLAS X-3 RESEARCH AIRPLANE, STUDY 41-B. Charles V. Bennett. April 27, 1950. 31p. diagrs., 3 tabs. (NACA RM L50B28) (Declassified from Confidential, 10/29/54)

Contains results of calculations made to determine the period and damping of the lateral oscillation. The calculations were made for a Mach number of 0.75 at sea level and 35,000 feet and for Mach numbers of 1.2 and 2.0 at 35,000 and 50,000 feet. The effects of adding a rate gyro and the effects of certain geometric modifications were studied.

NACA RM L50C17a

STABILITY AND CONTROL CHARACTERISTICS AT LOW SPEED OF A 1/4-SCALE BELL X-5 AIRPLANE MODEL. LATERAL AND DIRECTIONAL STABILITY AND CONTROL. William B. Kemp, Jr. and Robert E. Becht. June 20, 1950. 97p. diagrs., photos. (NACA RM L50C17a) (Declassified from Confidential, 10/29/54)

An investigation was conducted to determine the lateral and directional stability and control characteristics at low speed of a 1/4-scale model of a preliminary Bell X-4 airplane design. Tests were made through a range of sweep angles from 20° to 60°, and several flap and slat configurations were investigated.

NACA RM L50E02a

LONGITUDINAL CHARACTERISTICS AT MACH NUMBER OF 1.24 OF 1/30-SCALE SEMISPAN MODEL OF BELL X-5 VARIABLE-SWEEP AIRPLANE WITH WING SWEPT BACK 60° FROM TESTS BY NACA WING-FLOW METHOD. Norman S. Silsby, Garland J. Morris and Robert M. Kennedy. October 12, 1950. 17p. diagrs., photos., tab. (NACA RM L50E02a) (Declassified from Confidential, 10/29/54)

Tests were made by the NACA wing-flow method to determine the longitudinal characteristics of a 1/30-scale semispan model of the Bell X-5 variable-sweep airplane with the wing in the 60° sweptback position and with tail incidences of -2° and -6°. Lift, drag, and pitching-moment results for various angles of attack are presented for a Mach number of 1.24. The Reynolds number was about 1×10^{6}.

NACA RM L50F23

STABILITY CHARACTERISTICS AT LOW SPEED OF A 1/4-SCALE BELL X-5 AIRPLANE MODEL WITH VARIOUS MODIFICATIONS TO THE BASIC MODEL CONFIGURATIONS. Robert E. Becht and Albert G. Few, Jr. August 16, 1950. 47p. diagrs., photo. (NACA RM L50F23) (Declassified from Confidential, 10/29/54)

An investigation was conducted to determine the low-speed longitudinal and lateral stability characteristics of a 1/4-scale model of a preliminary Bell X-5 airplane design incorporating dive brakes and several wing and fuselage modifications. Tests were made at 20° and 60° wing-sweep angles.

NACA RM L50I28

THE EFFECT OF SWEEPBACK ON THE LONGITUDINAL CHARACTERISTICS AT A MACH NUMBER OF 1.24 OF A 1/30-SCALE SEMISPAN MODEL OF THE BELL X-5 AIRPLANE FROM TESTS BY THE NACA WING-FLOW METHOD. Garland J. Morris, Robert M. Kennedy and Norman S. Silsby. November 27, 1950. 22p. diagrs., photos., tab. (NACA RM L50I28) (Declassified from Confidential, 10/29/54)

Tests were made by the NACA wing-flow method to determine the effect of sweepback angle on the longitudinal characteristics of a 1/30-scale semispan model of the Bell X-5 variable-sweep airplane with wings in the 40° and 50° positions. A test was also made with the fuselage alone. Lift, drag, and pitching-moment results for various angles of attack are presented for a Mach number of 1.24. The results are compared with the results of a previous test with the wing in the 60° position. The Reynolds number was about 1×10^6.

NACA RM L50J27

STABILITY AND CONTROL CHARACTERISTICS OF A 1/4-SCALE BELL X-5 AIRPLANE MODEL IN THE LANDING CONFIGURATION. Robert E. Becht. 38p. diagrs., photos. (NACA RM L50J27) (Declassified from Confidential, 10/29/54)

An investigation was conducted to determine the stability and control characteristics of a 1/4-scale model of a preliminary Bell X-5 airplane design in the landing configuration with and without dive brakes. Tests were made at wing sweep angles of 20° and 60°.

NACA RM L50K15

LONGITUDINAL-CONTROL EFFECTIVENESS AND DOWNWASH CHARACTERISTICS AT A MACH NUMBER OF 1.24 OF A 1/30-SCALE SEMISPAN MODEL OF THE BELL X-5 AIRPLANE AS DETERMINED BY THE NACA WING-FLOW METHOD. Richard H. Sawyer, Robert M. Kennedy and Garland J. Morris. January 8, 1951. 37p. diagrs., photos., tab. (NACA RM L50K15) (Declassified from Confidential, 10/29/54)

An investigation was made at a Mach number of 1.24 by the NACA wing-flow method to determine the longitudinal control effectiveness and downwash characteristics of a 1/30-scale semispan model of the variable sweep Bell X-5 airplane with the wing of the model swept back 60°, 50°, and 40°. Lift, drag, and pitching moments were obtained for various angles of attack for several horizontal tail settings and with tail off for each angle of sweep of the wing. The Reynolds number was about 1×10^6.

NACA RM L50L11a

EFFECTS OF A FUSELAGE FLAP DIVE BRAKE ON THE AERODYNAMIC CHARACTERISTICS OF 1/30-SCALE SEMISPAN MODEL OF THE BELL X-5 VARIABLE-SWEEP AIRPLANE AT A MACH NUMBER 1.24 AS DETERMINED BY THE NACA WING-FLOW METHOD. Robert M. Kennedy. February 8, 1951. 15p. diagrs., photos., tab. (NACA RM L50L11a) (Declassified from Confidential, 10/29/54)

An investigation was made by the NACA wing-flow method to determine the effect of a fuselage flap dive brake on the longitudinal characteristics of a 1/30-scale semispan model of the Bell X-5 variable-sweep airplane with the wing in the 60° sweptback position. Lift, drag, and pitching-moment results for various angles of attack are presented for a Mach number of 1.24. The results are compared with the results of a previous test without the dive brake. The Reynolds number of the tests was about 1×10^6.

NACA RM L50L19

STATIC LONGITUDINAL STABILITY AND DYNAMIC CHARACTERISTICS AT HIGH ANGLES OF ATTACK AND AT LOW REYNOLDS NUMBERS OF A MODEL OF THE X-3 SUPERSONIC RESEARCH AIRPLANE. Sanger M. Burk, Jr. and Burton E. Hultz. February 6, 1951. 76p. diagrs., photos., 4 tabs. (NACA RM L50L19) (Declassified from Confidential, 10/29/54)

An investigation was conducted in the Langley 20-foot free-spinning tunnel on a dynamic model and a static model representative of a supersonic airplane having a long nose and small wing to determine the motions and trim conditions possible

at high angles of attack. Tests were also conducted in the Langley 300 mph 7- by 10-foot tunnel on the static model to determine the effect of higher Reynolds numbers. The results of the investigation, in general, indicate that scale effect may appreciably influence free dynamic results obtained at low Reynolds numbers and high angles of attack on a design having a very long nose and a very small wing.

NACA RM L51H20a

SOME FLYING-QUALITIES STUDIES OF A TANDEM HELICOPTER. Kenneth B. Amer. October 1951. 29p. diagrs., photos. (NACA RM L51H20a) (Declassified from Confidential, 11-30-54)

Initial results of an investigation of the flying qualities of a representative tandem helicopter are presented. A comparison is made with previously published flying-qualities requirements based on studies of several single-rotor helicopters. A method is presented which gives promise of improving the longitudinal flying qualities of tandem helicopters with little weight penalty.

NACA RM L51I25

PRESSURE DISTRIBUTION AT LOW SPEED ON A 1/4-SCALE BELL X-5 AIRPLANE MODEL. William B. Kemp, Jr. and Albert G. Few, Jr. December 1951. 86p. diagrs., photos. (NACA RM L51I25) (Declassified from Confidential, 10/29/54)

An investigation was conducted at 20° and 60° sweep to determine the low-speed pressure distribution on the wing, wing slat, wing leading-edge fillet, and fuselage of a 1/4-scale model of a preliminary Bell X-5 airplane design. Included in the tests were investigations of nose-inlet velocity ratios with the jet exit duct fully open and partially closed.

NACA RM L51J18

WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF VARIOUS ASYMMETRIC CANOPY MODIFICATIONS ON THE BEHAVIOR OF DESCENDING PARACHUTES. Stanley H. Scher. February 1952. 20p. diagrs., photos., tab. (NACA RM L51J18) (Declassified from Confidential, 11/1/54)

Presented herein are the results of free-spinning tunnel tests made to determine the behavior in descent of eighteen 14-inch-diameter hemispherical and quasi-conical parachutes, having some various types of asymmetric canopy modifications and each having a cylindrical weight suspended below the parachute. The asymmetric modifications were made in an attempt to provide an appreciable lateral flight component of the parachute and cylinder.

NACA RM L51K22

INVESTIGATION OF THE LOW-SPEED AERODYNAMIC CHARACTERISTICS OF A VARIABLE-SWEEP AIRPLANE MODEL WITH A TWISTED AND CAMBERED WING. William B. Kemp, Jr., Robert E. Becht and Albert G. Few, Jr. February 1952. 62p. diagrs., photos. (NACA RM L51K22) (Declassified from Confidential, 10/29/54)

An investigation was conducted to determine the aerodynamic characteristics at low speed of a variable sweep airplane model with a twisted and cambered wing designed to have a uniform load distribution at a Mach number of 1.10 and a lift coefficient of 0.25 and 50° sweep. Comparison is made with data obtained on the same model with an untwisted, uncambered wing of the same geometric plan form. Also included in the investigation is the effect of partial-span split flaps.

NACA RM L51K27

INVESTIGATION OF THE DISTRIBUTION OF LIFT, DRAG, AND PITCHING MOMENT BETWEEN THE WING AND FUSELAGE OF A 1/30-SCALE SEMI-SPAN MODEL OF THE BELL X-5 AIRPLANE AT A MACH NUMBER OF 1.24 BY THE NACA WING-FLOW METHOD. Norman S. Silsby and Garland J. Morris. January 1952. 32p. diagrs., photos., tab. (NACA RM L51K27) (Declassified from Confidential, 10/29/54)

An investigation was made at a Mach number of 1.24 by the NACA wing-flow method to determine the distribution of lift, drag, and pitching moment between the wing and fuselage, the root bending moments of the wings, and the effect of wing flexibility (at 60° sweep) on the longitudinal stability characteristics of a 1/30-scale semispan model of the variable-sweep Bell X-5 airplane. Lift, drag, pitching moments, and wing root bending moments were obtained for various angles of attack. The Reynolds number was about 1.0×10^{6}.

NACA RM L52G21

THE VERTICAL-TAIL LOADS MEASURED DURING A FLIGHT INVESTIGATION ON A JET-POWERED BOMBER AIRPLANE. T. V. Cooney. May 1953. 32p. diagrs., photo. (NACA RM L52G21) (Declassified from Confidential, 11-30-54)

The vertical-tail loads measured in rudder kicks and gradual sideslips during a flight investigation of a jet bomber are presented, and the results are given of an analysis of the measured data to determine the vertical-tail lift-coefficient parameters $C_{L_{\alpha}}$ and $C_{L_{\delta}}$. The flight tests were performed at two altitudes, 20,000 feet and 30,000 feet, and covered the Mach number range from 0.30 to 0.76.

NACA RM L52I19a

THE EFFECTS OF A SMALL JET OF AIR EXHAUSTING FROM THE NOSE OF A BODY OF REVOLUTION IN SUPERSONIC FLOW. Eugene S. Love. November 1952. 45p. diagrs., photos. (NACA RM L52I19a) (Declassified from Confidential, 10/29/54)

Results are presented which show the effects at a Mach number of 1.62 of a small jet of air exhausting from the nose of an elliptical body of revolution upon boundary-layer transition and the viscous, pressure, and total drag of the forebody. Tests were conducted at Reynolds numbers of 2.13×10^6 and 7.66×10^6. The maximum range of thrust coefficients for the small jet was from 0 to about -0.085.

NACA RM L52I22

AN ANALYSIS OF ESTIMATED AND EXPERIMENTAL TRANSONIC DOWNWASH CHARACTERISTICS AS AFFECTED BY PLAN FORM AND THICKNESS FOR WING AND WING-FUSELAGE CONFIGURATIONS. Joseph Weil, George S. Campbell and Margaret S. Diederich. November 1952. 92p. diagrs., 2 tabs. (NACA RM L52I22) (Declassified from Confidential, 10/29/54)

This paper presents a summary of the effects of changes in wing plan form and thickness ratio on the downwash characteristics of wing and wing-fuselage configurations in the Mach number range between 0.6 and 1.1. Data obtained by the transonic-bump technique at two tail heights have been compared with theoretical estimations made in the subsonic and supersonic Mach number range.

NACA RM L52J09

INVESTIGATION AT TRANSONIC SPEEDS OF THE EFFECT OF A POSITIVE-LIFT BALANCING TAB ON THE HINGE-MOMENT AND LIFT CHARACTERISTICS OF A FULL-SPAN FLAP ON A TAPERED 45° SWEPTBACK WING OF ASPECT RATIO 3. Vernard E. Lockwood and Joseph E. Fikes. November 1952. 22p. diagrs., photo. (NACA RM L52J09) (Declassified from Confidential, 10/29/54)

Lift and hinge moments of a wing with a flap and balancing tab were obtained at transonic speeds by testing in the high-velocity field over a reflection plane on the side wall of the Langley high-speed 7- by 10-foot tunnel. The wing has a quarter-chord-line sweepback of 45.58° and aspect ratio of 3, and a taper ratio of 0.5 and was approximately 7.6 percent thick. The control consisted of 25.4-percent-chord full-span flap linked to an auxiliary lifting surface. The investigation was made over a limited tab-deflection and angle-of-attack range from M = 0.70 to 1.10 at a flap deflection of 3.9°.

NACA RM L52J10

EFFECTS OF SWEEPBACK AND TAPER ON THE FORCE AND CAVITATION CHARACTERISTICS OF ASPECT-RATIO-4 HYDROFOILS. Douglas A. King and Norman S. Land. December 1952. 61p. diagrs., photos., tab. (NACA RM L52J10) (Declassified from Confidential, 10/29/54)

An investigation was made to determine the effect of sweep and taper ratio on the cavitation and hydrodynamic characteristics of semispan hydrofoils of aspect ratio 4 and NACA 65A006 airfoil section. Sweep increased cavitation speed slightly, and taper had negligible effect. The large hydrodynamic twisting of the 60° swept hydrofoil obscured the effects of sweep. Complete cavitation limited the lift attainable to about 2000 lb/sq ft, 1210 lb/sq ft for the hydrofoil with 60° sweep. Chordwise progression of cavitation on unswept hydrofoil moved the center of pressure rearward.

NACA RM L52J13

A WIND-TUNNEL INVESTIGATION AT LOW SPEEDS OF THE AERODYNAMIC CHARACTERISTICS OF VARIOUS SPOILER CONFIGURATIONS ON A THIN 60° DELTA WING. Harleth G. Wiley and Martin Solomon. November 1952. 20p. diagrs. (NACA RM L52J13) (Declassified from Confidential, 10/29/54)

Results are presented of a preliminary wind-tunnel investigation at low speeds and angles of attack up to 36° to determine the rolling- and yawing-moment characteristics of various locations and configurations of spoilers on a thin 60° delta wing of constant thickness. Presented also are the effects of wing slots and spoiler perforations.

NACA RM L52J24

CHARACTERISTICS OF FLAP-TYPE SPOILER AILERONS AT VARIOUS LOCATIONS ON A 60° DELTA WING WITH A DOUBLE SLOTTED FLAP. Delwin R. Croom. December 1952. 31p. diagrs., 3 tabs. (NACA RM L52J24) (Declassified from Confidential, 10/29/54)

This paper contains results and discussion of a wind-tunnel investigation at low speeds of spoiler-type controls located at various chordwise and spanwise positions on a thin delta wing equipped with a double-slotted flap. Results indicated a spoiler located on the flap gave rolling-moment coefficients that varied fairly linearly with spoiler projections and were about the same magnitude for the flap-retracted or the flap-deflected condition.

NACA RM L52J31
National Advisory Committee for Aeronautics.
MEASUREMENTS OF FLUCTUATING PRESSURES ON A 1/4-SCALE MODEL OF THE X-1 AIRPLANE WITH A 10-PERCENT-THICK WING IN THE LANGLEY 16-FOOT TRANSONIC TUNNEL.
Louis W. Habel and Seymour Steinberg. January 1953. 29p. diagrs., photos. (NACA RM L52J31)
(Declassified from Confidential, 11-30-54)

Pressure fluctuations have been measured near the trailing edge of the wing and near the leading edge of the tail of a 1/4-scale mode of the X-1 airplane with a 10-percent-thick wing in the Langley 16-foot transonic tunnel. Results are presented for a Mach number range from 0.70 to 1.00 and an angle-of-attack range from about -4° to about 15° with and without vortex generators installed on the wings. Frequency analyses of the pressure fluctuations made while tests were in progress are presented for several test conditions.

NACA RM L52K19
National Advisory Committee for Aeronautics.
AERODYNAMIC CHARACTERISTICS OF TWO DELTA WINGS AT MACH NUMBER 4.04 AND CORRELATIONS OF LIFT AND MINIMUM-DRAG DATA FOR DELTA WINGS AT MACH NUMBERS FROM 1.62 TO 6.9. Edward F. Ulmann and Robert W. Dunning. December 1952. 20p. diagrs. (NACA RM L52K19)
(Declassified from Confidential, 10/29/54)

Tests were made in the Langley 9- by 9-inch Mach number 4 blowdown jet to obtain the aerodynamic characteristics of two semispan delta wings of aspect ratio 2.31 having 8-percent-thick double-wedge airfoil sections and maximum-thickness locations at 18 and 60 percent chord. The data are presented together with the results of previous tests on the same and similar delta wings at other Mach numbers and show methods of correlating lift and drag data on sharp-edge delta wings at supersonic Mach numbers.

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1146

AERODYNAMIC FORCES AND LOADINGS ON SYMMETRICAL CIRCULAR-ARC AIRFOILS WITH PLAIN LEADING-EDGE AND PLAIN TRAILING-EDGE FLAPS. Jones F. Cahill, William J. Underwood, Robert J. Nuber and Gail A. Cheesman. 1953. ii, 38p. diagrs., photos., 5 tabs. (NACA Rept. 1146. Formerly RM L6K22; RM L7H04; RM L50H17a)

A two-dimensional wind-tunnel investigation has been made of 6- and 10-percent-thick symmetrical circular-arc airfoil sections equipped with 0.15-chord plain leading-edge flaps and 0.20-chord plain trailing-edge flaps. The tests consisted of measurements of the aerodynamic forces and surface pressures at low Mach numbers (about 0.15) and several Reynolds numbers (0.7×10^6 to 18×10^6 based on the airfoil chord). A generalized method is developed that permits the determination of the chordwise pressure distribution over sharp-edge airfoils with plain leading- and trailing-edge flaps of arbitrary size and deflection.

NACA Rept. 1149

ON TRANSONIC FLOW PAST A WAVE-SHAPED WALL. Carl Kaplan. 1953. ii, 12p. (NACA Rept. 1149. Formerly TN 2748)

The simplified nonlinear differential equation for transonic flow past a wavy wall is solved by the method of integration in series. A general procedure for the solution of the resulting recurrence formulas is shown and illustrated by a number of examples. A numerical test of convergence is applied to a key power series in k, the transonic similarity parameter, and leads to the conclusion that smooth symmetrical potential flow past the wavy wall is no longer possible when the critical value of the stream Mach number is exceeded.

NACA Rept. 1155

A COMPARISON OF THE EXPERIMENTAL SUBSONIC PRESSURE DISTRIBUTIONS ABOUT SEVERAL BODIES OF REVOLUTION WITH PRESSURE DISTRIBUTIONS COMPUTED BY MEANS OF THE LINEARIZED THEORY. Clarence W. Matthews. 1953. ii, 29p. diagrs., tab. (NACA Rept. 1155. Formerly TN 2519; RM L9F28)

A comparison is made of the theoretical and experimental subsonic compressible pressure-coefficient distributions about several bodies of revolution. The results show that the linearized theory predicts the subsonic pressure coefficients over the central portion of the body. An extrapolation of the theory into the supercritical range does not predict the rearward shift of the negative pressure peak which occurs after the flow becomes critical. Two equations are presented for approximately determining the subsonic compressible pressure-coefficient distributions from the incompressible pressure-coefficient distributions.

NACA Rept. 1158

PREDICTION OF FLAME VELOCITIES OF HYDROCARBON FLAMES. Gordon L. Dugger and Dorothy M. Simon. 1954. ii. 10p. diagrs., 4 tabs. (NACA Rept. 1158. Formerly RM E52J13)

The effects of four combustible-mixture variables on the laminar flame velocities of hydrocarbon-oxygen-nitrogen mixtures are predicted by semitheoretical methods based on (1) Semenov equation (thermal mechanism), (2) Tanford-Pease equation (active-particle-diffusion mechanism), and (3) Manson equation (momentum-pressure-drop equation using active-particle concentrations). A semiempirical factor, calculated from flame velocity data, is required by each of these equations. When these factors are calculated for each variable separately, mean deviations between calculated and measured flame velocities are 2 to 15 percent for the variable studied, namely, hydrocarbon structure, equivalence ratio, oxygen-nitrogen ratio, and initial temperature. When the semiempirical factor for one variable is used to predict the effect of another variable, the mean deviations are approximately doubled. Empirical equations are summarized which give better predictions, but require more constants.

NACA Rept. 1161

AVERAGE SKIN-FRICTION DRAG COEFFICIENTS FROM TANK TESTS OF A PARABOLIC BODY OF REVOLUTION (NACA RM-10). Elmo J. Mottard and J. Dan Loposer. 1954. ii, 7p. diagrs., photos. (NACA Rept. 1161. Formerly TN 2854)

Average skin-friction drag coefficients were obtained from boundary-layer total-pressure measurements on a parabolic body of revolution (NACA RM-10, basic fineness ratio 15) in water at Reynolds numbers from 4.4×10^6 to 70×10^6. The tests were made in the Langley tank No. 1 with the body sting-mounted at a depth of two maximum body diameters. The arithmetic mean of three drag measurements taken around the body was in good agreement with flat-plate results, but, apparently because of the slight surface wave caused by the body, the distribution of the boundary layer around the body was not uniform over part of the Reynolds number range.

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NACA TN 3163

USE OF A HOT-WIRE ANEMOMETER IN SHOCK-TUBE INVESTIGATIONS. Darshan Singh Dosanjh, Johns Hopkins University. December 1954. ii, 98p. diagrs., photos. (NACA TN 3163)

The use of the hot-wire anemometer in experimental investigations of the transient flow phenomena in a shock tube is examined. The response of a hot-wire to a transient step-function type of change in flow conditions is experimentally studied and a criterion for predicting the right compensation is postulated and experimentally verified. Besides using the hot-wire for actual wave phenomena and for flow studies, it has been very successfully used as a timing and/or triggering device in shock-tube work.

NACA TN 3317

DESIGN CONSIDERATIONS FOR WINGS HAVING MINIMUM DRAG DUE TO LIFT. Warren A. Tucker. December 1954. 26p. diagrs. (NACA TN 3317)

The problem of increasing the range of supersonic aircraft by the use of twisted and cambered wings is considered, primarily for the purpose of developing a rational method for the selection of a design lift coefficient. Relations and curves are presented from which a suitable selection may be made, depending on the relative importance of maximum range and top speed.

NACA TN 3319

OPERATING CHARACTERISTICS OF AN ACCELERATION RESTRICTOR AS DETERMINED BY MEANS OF A SIMULATOR. Arthur Assadourian. December 1954. 20p. diagrs., photos. (NACA TN 3319)

The operating characteristics of an acceleration restrictor were determined from tests on a simulator consisting of a control stick geared to a magnetic brake unit and an analog computer. The restrictor worked on the principle of stopping the elevator motion by means of a brake when a signal which was a function of normal acceleration, pitching acceleration, and pitching velocity reached a certain preset value. The results obtained with three brake-operating signals are presented.

NACA TN 3321

ANALYTICAL DETERMINATION OF THE MECHANISM OF AN AIRPLANE SPIN RECOVERY WITH DIFFERENT APPLIED YAWING MOMENTS BY USE OF ROTARY-BALANCE DATA. Sanger M. Burk, Jr. December 1954. 43p. diagrs., 2 tabs. (NACA TN 3321)

An analytical investigation has been undertaken in an attempt to learn more about the factors which make up a spin and the mechanism of recovery therefrom. Use is made of rotary-balance data and a step-by-step integration process of Euler's equations of motion allowing six degrees of freedom. The present study makes an analysis of an airplane recovery from a right spin where constant applied antispin yawing moments due to application of 800 and 1,600 pounds of force at the left wing tip are considered.

NACA TN 3327

APPROXIMATE EFFECT OF LEADING-EDGE THICKNESS, INCIDENCE ANGLE, AND INLET MACH NUMBER ON INLET LOSSES FOR HIGH-SOLIDITY CASCADES OF LOW CAMBERED BLADES. Linwood C. Wright. December 1954. 38p. diagrs. (NACA TN 3327)

An approximate analysis of cascade induction loss variations with incidence angle, Mach number, and leading-edge thickness is presented along with computational results in the form of curves. Results are based on the solution of the energy, continuity, and integrated momentum equations under the assumption that the blade leading-edge pressure approaches zero at appreciable incidence angles. Results indicate that relatively small blade leading-edge radii (of the order of 2 percent of blade gap) lead to good inlet characteristics for the average conditions generally encountered in compressors. The desirability of avoiding high stagger angles is indicated by representative inlet loss against incidence angle curves for stagger angles of 45°, 60°, and 75°.

NACA TN 3329

SHOCKS IN HELICAL FLOWS THROUGH ANNULAR CASCADES OF STATOR BLADES. Robert Wasserman and Arthur W. Goldstein. December 1954. 27p. diagrs. (NACA TN 3329)

A method is presented for calculating supersonic potential flows in annular cascades of blades by the method of characteristics. It is found that helical flows may be adjoined by helical shocks of uniform strength; these constitute a considerable addition to the class of simple flows available for designing cascades of lifting blades. It was also found that by selection of the proper variables, the derivatives of the velocity components, which occur in the characteristic equations, could be combined into an exact differential. This form of the equation facilitated computations. A flow and several cascade designs were computed.

NACA TN 3332

BURNING TIMES OF MAGNESIUM RIBBONS IN VARIOUS ATMOSPHERES. Kenneth P. Coffin. December 1954. 37p. diagrs., photos. (NACA TN 3332)

Some details of the mechanism of the combustion of magnesium ribbons were investigated in mixture of oxygen (17 to 100 percent) and inert gases (A, N_2, He, A-H_2O mixtures). Photographs indicated vapor-phase reaction rather than surface reaction. Burning times were calculated for a vapor-phase process with diffusion and heat transfer. Experimental trends were closely predicted; actual numerical values agreed to well within an order of magnitude.

NACA TN 3334

FRICTION OF POSSIBLE SOLID LUBRICANTS WITH VARIOUS CRYSTAL STRUCTURES. Marshall B. Peterson and Robert L. Johnson. December 1954. 32p. diagrs., photos., 2 tabs. (NACA TN 3334)

A number of solids with CdI_2, $CdC1_2$, and MoS_2 types of layer lattice were tested in a low-speed friction apparatus for lubrication effectiveness. Some solids with these structures performed in a manner similar to MoS_2 in that they did lubricate effectively over extended periods of sliding, namely, CdI_2, $CdC1_2$, and PbI_2, $CoC1_2$, and WS_2; other layer-lattice solids that were effective are HgI_2 and Ag_2SO_4. Not all were effective lubricants. Some low-shear-strength solids that did not have a layer lattice were tested and gave surface protection. Effectiveness as a solid lubricant seemed to be associated with the formation of adherent films on both mating specimens.

NACA TN 3354

GUST EXPERIENCE OF A HELICOPTER AND AN AIRPLANE IN FORMATION FLIGHT. Almer D. Crim. December 1954. 12p. diagrs., photos., 2 tabs. (NACA TN 3354)

A single-rotor helicopter and an airplane have been flown in formation in rough air for the purpose of measuring and comparing their responses to gusts. Rough-air flights were also made by the helicopter alone at several different airspeeds over the same ground path.

NACA TN 3379

A SURVEY OF BACKGROUND AND AIRCRAFT NOISE IN COMMUNITIES NEAR AIRPORTS. K. N. Stevens, Bolt Beranek and Newman, Inc. December 1954. 36p. diagrs., tab. (NACA TN 3379)

An extensive survey has been made of background and aircraft noise levels in residential communities in eight cities having major airports. The measurements were made in areas up to a distance of 12 miles from the airports, and the areas were chosen to be under regularly used flight paths. Readings of background noise were obtained primarily in the octave bands 75 to 150, 300 to 600, and 1,200 to 2,400 cps, about 25 such spectra being taken in each area. Octave-band spectra were obtained from magnetic tape recordings of the noise of about 250 aircraft in flight, representing substantially all commercial types.

BRITISH REPORTS

N-34306*

Royal Aircraft Establishment (Gt. Brit.)
SCALE EFFECTS OF HIGH SUBSONIC AND TRANSONIC SPEEDS, AND METHODS FOR FIXING BOUNDARY-LAYER TRANSITION IN MODEL EXPERIMENTS. A. B. Haines, D. W. Holder and H. H. Pearcey. September 1954. 60p. diagrs., photos. (RAE Tech. Note Aero 2338)

This note is concerned with the major scale effects that arise at high subsonic speeds from the differences between the conditions under which laminar and turbulent boundary layers separate and behave after separation. The scale effects arising in wind tunnel tests made at low Reynolds numbers may often be minimized by fixing transition to turbulent flow by introducing an artificial disturbance such as that producted by excrescences attached to the surface. Several methods which can be used to fix transition are described, and the results obtained by using them are compared.

N-34307*

Royal Aircraft Establishment (Gt. Brit.)
THE VERTICAL SPINNING TUNNEL AT THE NATIONAL AERONAUTICAL ESTABLISHMENT, BEDFORD. A. E. Clarke and R. L. Maltby. September 1954. 20p. diagrs., photos. (RAE Tech. Note Aero 2339)

The Spinning Tunnel at the National Aeronautical Establishment is described. The choice of size and type of tunnel as well as some of the more interesting features of the design are discussed. The description has been made before the tunnel was completed and some of what has been written may need revision in the light of experience.

N-34308*

Royal Aircraft Establishment (Gt. Brit.)
REQUIREMENTS FOR UNIFORMITY OF FLOW IN SUPERSONIC WIND TUNNELS. D. E. Morris and K. G. Winter. September 1954. 9p. diagr. (RAE Tech. Note Aero 2340)

An analysis is made of the effects of nonuniformity of flow on the pressure measurements on the surface of a model and also on the force and moment measurements, and standards of flow uniformity are derived. A brief analysis is made of the errors in model manufacture and their effects on force and pressure measurements. Using the same standards as were used in deducing the requirements for flow uniformity, it is concluded that present standards of model manufacture are satisfactory overall, though for accurate pressure plotting tests at low supersonic Mach numbers, a higher standard is desirable.

N-34407*

Aeronautical Research Council (Gt. Brit.)
A NOTE ON THE SOUND FROM WEAK DISTURBANCES OF A NORMAL SHOCK WAVE. Alan Powell. April 15, 1954. 10p. diagrs. (ARC 16,728; FM 2062)

The disturbances of a shock wave by sound waves or temperature fluctuations are studied in one dimension to a first order approximation. In general, both sound waves and temperature fluctuations arise behind the shock wave. Expressions are given for their amplitudes, and calculated for $\gamma = 1.4$. Sound waves colliding with the shock wave are amplified, but sound waves are almost annihilated by weak shock waves if originally travelling in the same direction as the shock wave. Small temperature fluctuations give rise to much sound, on an acoustical scale.

N-34408*

Aeronautical Research Council (Gt. Brit.)
NOTES ON THE STABILITY OF PHYSICAL SYSTEMS. P. E. W. Grensted. February 4, 1954. 3p. (ARC 16,532; S & C 2859; 0.1104)

The term "stability" has to be used with caution when applied to physical systems in general. Suggestions are made concerning the way in which the term can be legitimately applied. A note is included on the behavior of a nonlinear system over a finite period of time.

N-34411*

Aeronautical Research Council (Gt. Brit.)
DECAY OF TURBULENCE BEHIND A GRID (DYNAMICAL THEORY). D. Meksyn. February 4, 1954. 7p. (ARC 16,530; FM 2019)

It is the purpose of this paper to show that the law of decay of turbulence behind a grid is determined mainly by dynamical connections of the flow, and that it can be obtained by combining the equation of the mean flow with the differential equations for the mean flow. It is shown that the gradual transformation of the linear law of decay of small eddies can be satisfactorily explained and is in general agreement with experimental results.

N-34412*

Aeronautical Research Council (Gt. Brit.)
THOUGHTS ON BOUNDARY LAYER NOISE. Alan Powell. April 15, 1954. 5p. (ARC 16,727; FM 2061)

The problem of boundary-layer noise is discussed as being the predominating noise in high speed aircraft (except in regions intercepting the "cone" of intense jet noise). This boundary-layer noise may be very powerful. The methods by which sound can be generated are considered. In general, the noise arising from the flow past a fixed surface is of complex origin, and the problem has been divided into aerodynamic or "layer noise," surface noise, panting noise, and wake noise.

N-34493*

Royal Aircraft Establishment (Gt. Brit.)
CALCULATION OF THE LOAD DISTRIBUTION OVER A WING WITH ARBITRARY CAMBER AND TWIST AT SONIC SPEED. K. W. Mangler. August 1954. 55p. diagrs. (RAE Aero 2515)

A method is developed for the calculation of the load distribution due to camber and twist over a thin wing at sonic speed (or, more generally, over wings for which $A^2|M^2-1|$ is small (A aspect ratio, M Mach number)). The calculation is based on the usual assumptions of linearized potential flow without friction and shock waves. Application of the method involves the solution of a given integral equation, which for a general planform has to be solved numerically. Some simple examples show the effect of twist and camber on the load distribution and on the suction force along the leading edge of a delta wing.

N-34494*

Nat. Gas Turbine Establishment (Gt. Brit.)
THE REMOVAL OF POROSITY FROM INVESTMENT CASE COMPRESSOR BLADES MADE FROM 0.2 PER CENT CARBON, 18 PER CENT CHROMIUM, 2 PER CENT NICKEL STAINLESS STEEL. J. E. Northwood. February 1954. 31p. diagrs., photos., 5 tabs. (NGTE Memo. M. 142)

This Memorandum describes an investigation carried out at the National Gas Turbine Establishment on the elimination of porosity from investment cast 0.2 percent carbon, 18 percent chromium, 2 percent nickel stainless steel. A description is given of attempts to minimize porosity in long thin compressor blades by inducing directional solidification from tip to root. The methods involved the achievement of either a temperature gradient in the mould or a temperature gradient in the freezing metal by the use of chills. An attempt was also made to produce blades by centrifugal casting. All these tests gave unsatisfactory results. A description is given of "pour-out" tests and other work which led to the use of high mould temperatures between 1300° and 1380° C for the satisfactory production of relatively sound castings.

N-34496*

Royal Aircraft Establishment (Gt. Brit.)
FLOW DIRECTION MEASUREMENTS IN SUPERSONIC WIND TUNNELS. D. J. Raney. September 1954. 18p. diagrs. (RAE Tech. Note Aero 2342)

Some general requirements for satisfactory flow direction measurements in supersonic tunnels are stated and examples are given of the design and calibrations of typical yawmeters. The results of flow direction measurements made in two tunnels are given and some of the flow characteristics are discussed.

N-34497*

Nat. Gas Turbine Establishment (Gt. Brit.)
OBSERVATIONS ON THE SURGING OF VARIOUS LOW-SPEED FANS AND COMPRESSORS. A. G. Smith and P. J. Fletcher. July 1954. 30p. diagrs., tab. (NGTE Memo. M. 219)

In the course of testing fans and compressors over a period of years various forms of low disturbances have been noticed at low coefficients. Some of the disturbances were spectacular and a remarkable variation in the type of disturbance was found. This report has been prepared in view of the current interest in surging phenomena. On various fans, four abnormal types of flow have been observed. These abnormal flows have been called "surges" though two of the types did not exhibit the oscillation implied by the name. The commonest surge regime involved the existence of a single band of reverse flow or disturbed flow rotating in the sense of the rotor, but at a lower speed.

N-34498*

Royal Aircraft Establishment (Gt. Brit.)
A POTASSIUM VAPOUR HOT-CATHODE RECTIFIER. I. A. Mossop. July 1954. 19p. diagrs., photos., tab. (RAE Tech. Note EL. 74)

Alkali vapor diodes, in which the vapor acts both as a conducting gas and as a coating for the cathode, have many features which warrant their consideration for use as power rectifiers in aircraft. An experimental potassium vapor diode has been constructed and its anode characteristics have been measured. Apart from requiring a higher envelope temperature and having a higher arc drop, its performance was found to be similar to that reported in the U. S. A. for a caesium filled tube. A method of presenting a complete anode characteristic, as a cathode ray tube trace, is described; it should be useful for measurements on other heavy current discharge tubes, such as thyratrons. Provision is made for direct calibration of both the voltage and current axes as well as for a simple check on these calibrations and on the linearity of the amplifiers.

N-34499*

Royal Aircraft Establishment (Gt. Brit.)
ALLOYS OF TITANIUM WITH IRON. D. A. Sutcliffe. July 1954. 15p. diagrs., 8 tabs. (RAE Tech. Note Met.201)

Binary titanium iron alloys containing up to 9.18 percent iron by weight have been prepared by arc melting. Tensile, hardness, and impact tests have been made on the alloys at room temperature. The results show that additions of iron cause a steady increase in hardness and strength with a corresponding loss in ductility. An alloy containing 3.0 percent iron had a Vickers hardness of 242 D. P. N.; a U. T. S. of 45.6 tons/sq inch and a percent elongation of 24; the impact strength as determined on Izod specimens of substandard size was 3.7 ft-lbs (approximately half that of the basis titanium). A survey of the literature is included and details are given of the published work on the titanium iron phase diagram and the effect of iron on the mechanical properties of titanium.

N-34501*

Aeronautical Research Council (Gt. Brit.)
STRESS ANALYSIS OF MULTI-WEB BOXES. W. S. Hemp. March 21, 1954. 18p. diagrs. (ARC 16,767; Strut 1706)

Particular solutions given are constant stress solution, pure shear solution, bending by tip shear force, distributed pressure, and anti-symmetric internal stress system (root constraint in torsion). These particular solutions are incomplete and have to be supplemented by the solutions of problems formulated in given equations. Solutions to these supplementary problems are best obtained by approximate methods using Castigliango's Theorem of Stationary Strain Energy. An example is worked out for root constraint for the case of tip shear force.

N-34502*

Aeronautical Research Council (Gt. Brit.)
THE HOT-WIRE ANEMOMETER FOR TURBULENCE MEASUREMENTS. PART IV. B. Wise and D. L. Schultz. April 15, 1954. 42p. diagrs. (ARC 16,726; FM 1527c; Oxford Univ., Engineering Lab. No. 71)

An account is given of some measurements of both turbulence level and spectra at subsonic and supersonic speeds. An investigation of the steady-state heat-loss law over the transonic range is also described.

N-34503*

Aeronautical Research Council (Gt. Brit.)
THERMO-ELASTICITY. W. S. Hemp. April 1954. 8p. (ARC 16,766; Strut. 1683)

A continuous solid body is referred to rectangular axes. The body is assumed "elastic"; that is, the components of strain are taken to be single valued functions of the components of stress and the temperature T. The body is subjected to a quasi-static loading by forces (X, Y, Z) per unit volume and (X_V, Y_V, Z_V) per unit of external surface. The temperature T' of the surrounding medium at the surface of the body and the "heat transfer coefficient" or "external conductivity" h is assumed to be known. Both the mechanical and thermal loading are varied with the time t, but not so rapidly as to excite vibration in the body. The problem solved is the calculation of the deformation, stress, and temperature distribution as functions of the time.

N-34504*

Aeronautical Research Council (Gt. Brit.)
THE DESIGN AND CONSTRUCTION OF HOT-WIRE ANEMOMETERS FOR HIGH SPEED FLOWS. D. L. Schultz. March 4, 1954. 10p. diagrs., photos., tab. (ARC 16,635; FM 2046; TP 424; Oxford Univ., Engineering Lab. No. 68)

Factors influencing the design of high speed hot-wire anemometers are discussed and it is shown that, for fluctuation measurements, tungsten is the most suitable wire material. A technique for spot welding the wire to steel supports is described and complete probe assemblies suitable for use at transonic and supersonic airspeeds at least up to M = 1.8 at atmospheric stagnation pressure are illustrated.

N-34505*

Aeronautical Research Council (Gt. Brit.)
ON THE STABILITY OF ACCELERATED MOTION. A. R. Collar. May 1954. 9p. (ARC 16,831; S and C 2908)

In the case of certain sets of equations such as arise in problems of aircraft stability the coefficients vary with speed in related ways. It is shown that in such systems a particular form of acceleration enables a general solution to be obtained; the result may be regarded as a generalization of the treatment of sets of equations with constant coefficients.

MISCELLANEOUS

N-33571*

NOTES ON HELICOPTER FLIGHT RESEARCH. John P. Reeder. (Presented to Flight Test Panel of Advisory Group for Aeronautical Research and Development, Paris, France, November 29 - December 4, 1954) 29p. diagrs., photos.

The NACA entered the field of rotary-wing research and flight testing some 23 years ago with studies of the autogiro. This experience served as a background for helicopter research and the first helicopter was received for flight testing in 1944. This paper briefly reviews some of the knowledge gained from flight tests. One problem studied is that of blade stalling. More recently the study of the flying qualities of a helicopter has been undertaken. This has included speed stability, maneuver stability, and turn and lateral-oscillation characteristics. Other current projects include instrument flying studies and the helicopter loads program.

UNPUBLISHED PAPERS

N-33814*

THE STATUS OF RESEARCH IN THE FIELD OF HEAT TRANSFER. E. Schmidt. June 1954. 31p. diagrs., photos. (Trans. from Zeitschrift des Vereines deutscher Ingenieure, v. 76, no. 42, October 15, 1932, p. 1025-1032)

The complexity of the field of heat transfer and its problems is discussed. Theory succeeds in presenting complete solutions for only a few simple cases. A summary is given of the measuring methods and results in the most important individual cases of heat transfer. Questions not yet clarified and problems to be dealt with in the future are pointed out. We shall have to make a strenuous effort in order to maintain the lead Germany has had so far in view of the fact that in America much emphasis is being placed on problems of heat transfer.

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Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1143

A VECTOR STUDY OF LINEARIZED SUPERSONIC FLOW APPLICATIONS TO NONPLANAR PROBLEMS. John C. Martin. 1953. ii, 34p. diagrs., tab. (NACA Rept. 1143. Formerly TN 2641)

A vector study of the partial-differential equation of steady linearized supersonic flow is presented. General expressions are derived which relate the velocity potential in the stream to the conditions on the disturbing surfaces. Problems concerning nonplanar systems are investigated, and methods are derived for the solution of some simple problems. The damping in roll is found for rolling tails consisting of four, six, and eight rectangular fins.

NACA Rept. 1152

THEORY AND PROCEDURE FOR DETERMINING LOADS AND MOTIONS IN CHINE-IMMERSED HYDRODYNAMIC IMPACTS OF PRISMATIC BODIES. Emanuel Schnitzer. 1953. ii, 29p. diagrs. (NACA Rept. 1152. Formerly TN 2813)

A theoretical method is derived for computing the motions and hydrodynamic loads during water landings of prismatic bodies involving appreciable immersion of the chines. A simplified method of computation covering flat-plate and V-bottom bodies with beam-loading coefficients greater than unity is given as a separate section. Comparisons of theory with experiment are presented as plots of impact lift coefficient and maximum draft-beam ratio against flight-path angle and as time histories of loads and motions. Fair agreement is found to exist for chine-immersed landings for angles of dead rise of 0° and 30°, beam-loading coefficients from 1 to 36.5, flight-path angles from 2° to 90°, and trims from 6° to 45°.

NACA Rept. 1154

ANALYSIS OF LANDING-GEAR BEHAVIOR. Benjamin Milwitzky and Francis E. Cook. 1953. iii, 45p. diagrs., photo., 3 tabs. (NACA Rept. 1154. Formerly TN 2755)

The behavior of the conventional oleo-pneumatic landing gear during impact is analyzed. The applicability of the analysis to actual landing gears is established by comparing calculated results with drop-test data. In addition to the more exact treatment, studies are made to determine the effects of variations in such parameters as the force-deflection characteristics of the tire, the orifice discharge coefficient, and the polytropic exponent for the air-compression process in the shock strut, which may not be known accurately in practical design problems. An investigation is also made to determine the extent to which representation of the system can be simplified and still yield useful results. Generalized solutions for the behavior of a simplified system, which may be useful in preliminary design, are presented for a wide range of landing-gear and impact parameters.

NACA Rept. 1159

IMPINGEMENT OF WATER DROPLETS ON WEDGES AND DOUBLE-WEDGE AIRFOILS AT SUPERSONIC SPEEDS. John S. Serafini. 1954. ii, 24p. diagrs. (NACA Rept. 1159. Formerly TN 2971)

An analytical solution has been obtained for the equations of motion of water droplets impinging on a wedge in a two-dimensional supersonic flow field with a shock wave attached to the wedge. The closed-form solution yields analytical expressions for the equation of the droplet trajectory, the local rate of impingement and the impingement velocity at any point on the wedge surface, and the total rate of impingement. The analytical expressions are utilized to determine the impingement on the forward surfaces of diamond airfoils in supersonic flow fields with attached shock waves. The results presented include the following conditions: droplet diameters from 2 to 100 microns, pressure altitudes from sea level to 30,000 feet, free-stream static temperatures from 420° to 460° R, free-stream Mach numbers from 1.1 to 2.0, semiapex angles for the wedge from 1.14° to 7.97°, thickness-to-chord ratios for the diamond airfoil from 0.02 to 0.14, chord lengths from 1 to 20 feet, and angles of attack from zero to the inverse tangent of the airfoil thickness-to-chord ratio.

NACA RM A54I23

A HEATED-WIRE LIQUID-WATER-CONTENT INSTRUMENT AND RESULTS OF INITIAL FLIGHT TESTS IN ICING CONDITIONS. Carr B. Neel. January 1955. 33p. diagrs., photos., tab. (NACA RM A54I23)

A flight model of the heated-wire instrument was tested in natural icing conditions, and was shown to provide reliable measurements of liquid-water content. The rapid response of the instrument enabled detailed study of cloud structure. Cloud-duct tests showed measurements could be made up to 700 mph. Results of the flight measurements substantiated the high values of water content previously predicted. The highest value measured was 3.7 grams per cubic meter.

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NACA TM 1354

GENERAL THEORY OF CONICAL FLOWS AND ITS APPLICATION TO SUPERSONIC AERODYNAMICS. (La théorie générale des mouvements coniques et ses applications a l'aérodynamique supersonique). Paul Germain. PREFACE. M. J. Peres. January 1955. vii, 333p. diagrs. (NACA TM 1354. Trans. from Office National d'Études et de Recherches Aéronautiques, Pub. 34, 1949)

The report deals with a method of studying the equation of cylindrical waves particularly indicated for the solution of certain aerodynamic problems. The method reduces problems of a hyperbolic equation to problems of harmonic functions. The study has been applied toward setting up the fundamental principles, to developing their investigation up to calculation of the pressures on the visualized obstacles, and to showing how the initial field of "conical flows" was considerably enlarged by a procedure of integral superposition.

NACA TN 3149

PREDICTION OF LOSSES INDUCED BY ANGLES OF ATTACK IN CASCADES OF SHARP-NOSED BLADES FOR INCOMPRESSIBLE AND SUBSONIC COMPRESSIBLE FLOW. James J. Kramer and John D. Stanitz. January 1955. 45p. diagrs. (NACA TN 3149)

A method of computing the losses in total pressure caused by a nonzero angle of attack at the inlet to a row of sharp-nosed blades is developed for both incompressible and subsonic compressible flow. The results of the analysis indicate for the range of variables considered that increases in upstream flow angle cause sharp rises in total-pressure loss coefficient and corresponding drops in static-pressure coefficient for negative angles of attack, but for positive angles of attack and upstream flow angles less than 60° there is little variation in total-pressure loss coefficient with upstream flow angle.

NACA TN 3264

STUDY OF THE MOMENTUM DISTRIBUTION OF TURBULENT BOUNDARY LAYERS IN ADVERSE PRESSURE GRADIENTS. Virgil A. Sandborn and Raymond J. Slogar. January 1955. 79p. diagrs., photos. (NACA TN 3264)

Experimental evaluation and analysis were made of mean and turbulent terms of the equations of motion and the stress tensor at four stations in a turbulent boundary layer with a progressively increasing adverse pressure gradient. Evaluation of terms of the stress tensor indicated that $\rho\overline{v^2}$, $\rho\overline{w^2}$, and $-\rho\overline{uv}$ are of equal order of magnitude, while $\rho\overline{u^2}$ is roughly four times larger near the wall. The term $\frac{\partial \overline{v^2}}{\partial y}$ of the y-direction equation of motion was found to be as large as any term of the x-direction equation.

NACA TN 3266

EXPERIMENTAL EVALUATION OF MOMENTUM TERMS IN TURBULENT PIPE FLOW. Virgil A. Sandborn. January 1955. 40p. diagrs. (NACA TN 3266)

Terms of the longitudinal- and radial-direction turbulent momentum equations were experimentally evaluated in a 4-inch-diameter pipe from total- and static-pressure data and hot-wire anemometer surveys. Terms of the r-direction momentum equation were found to be as large as terms of the x-direction equation. Direct comparisons were made with turbulence measurements obtained using the constant-current and constant-temperature systems of hot-wire anemometry. The two systems agree equally well within the experimental accuracy of the measurements.

NACA TN 3311

DESCRIPTION AND ANALYSIS OF A ROCKET-VEHICLE EXPERIMENT ON FLUTTER INVOLVING WING DEFORMATION AND BODY MOTIONS. H. J. Cunningham and R. R. Lundstrom. January 1955. 26p. diagrs., photos., 2 tabs. (NACA TN 3311. Formerly RM L50I29)

Flight tests and a mathematical analysis were carried out to demonstrate and confirm a type of subsonic flutter involving rigid-body motions and wing deformations. For the configuration considered, the period of the oscillation was approximately 100 chords per cycle which is well within the range of period found in dynamic-stability work on rigid aircraft with free controls. A mathematical analysis based on two-dimensional incompressible flow provided a conservative prediction of the airspeed at which the low-frequency flutter occurred. Wing-bending stiffness is the important parameter for preventing such flutter.

NACA TN 3318

ON THE SMALL-DISTURBANCE ITERATION METHOD FOR THE FLOW OF A COMPRESSIBLE FLUID WITH APPLICATION TO A PARABOLIC CYLINDER. Carl Kaplan. January 1955. 36p. diagrs., tab. (NACA TN 3318)

The Prandtl-Busemann small-disturbance method is applied to a parabolic cylinder and compared with the Janzen-Rayleigh or M_{∞}^2-expansion solution for the same shape. As expected, the small-disturbance and M_{∞}^2-expansion developments are but two different arrangements of the actual solution. Notwithstanding this agreement, it is concluded that the curtailed small-disturbance solution is not suitable for the calculation of subsonic flow past a shape (like the parabolic cylinder) which does not possess a control parameter such as, for example, a thickness coefficient. The small-disturbance solution for the parabolic cylinder is examined from the point of view of thin-airfoil theory. The series development of the fluid speed at the surface in powers of the ratio of the radius of curvature of the vertex and the abscissa measured from the vertex agrees with the results of second-order thin-airfoil theory.

NACA TN 3323

CHARTS FOR ESTIMATING PERFORMANCE OF HIGH-PERFORMANCE HELICOPTERS. Alfred Gessow and Robert J. Tapscott. January 1955. 36p. diagrs. (NACA TN 3323)

Theoretically derived charts are presented for use in predicting profile-drag—thrust ratios of rotors having hinged blades with -8° twist. The charts are considered applicable to rotor-operating conditions

in which high tip-speed ratios or large rotor angles of attack are encountered; however, they do not include the effects of compressibility. Limit lines showing the conditions of onset of stall are included in the charts, and the effects of blade twist on the stall limits are discussed.

NACA TN 3324

A NOTE ON THE DRAG DUE TO LIFT OF RECTANGULAR WINGS OF LOW ASPECT RATIO. Edward C. Polhamus. January 1955. 24p. diagrs. (NACA TN 3324)

Methods of estimating the induced drag of low-aspect-ratio wings are discussed and compared with experiment. The profile drag due to lift is also discussed and a method is developed which relates the effect of aspect ratio on the profile drag due to lift to an "effective" two-dimensional lift coefficient. A simple expression for this effective two-dimensional lift coefficient in terms of the aspect ratio is derived and used to correlate experimental values of profile drag due to lift for rectangular wings in the low-aspect-ratio range.

NACA TN 3331

ANALYSIS OF LAMINAR FORCED-CONVECTION HEAT TRANSFER IN ENTRANCE REGION OF FLAT RECTANGULAR DUCTS. E. M. Sparrow. January 1955. 42p. diagrs. (NACA TN 3331)

The simultaneous development of temperature and velocity profiles in the entrance region of a flat rectangular duct is studied. The flow is laminar with constant properties and negligible dissipation. Two thermal conditions for the duct walls are considered: (1) both walls have the same uniform temperature throughout; (2) one wall is at uniform temperature, the other wall is insulated. Thermal and velocity boundary layers are calculated using the Kármán-Pohlhausen method. Nusselt numbers are reported for Prandtl number in the range 0.01 to 50. For simultaneously developing profiles, the Nusselt number is found not to be a function at Graetz number alone, as it is for an unchanging parabolic velocity profile throughout.

NACA TN 3335

METHODS FOR RAPID GRAPHICAL EVALUATION OF COOLED OR UNCOOLED TURBOJET AND TURBOPROP ENGINE OR COMPONENT PERFORMANCE (EFFECTS OF VARIABLE SPECIFIC HEAT INCLUDED). Jack B. Esgar and Robert R. Ziemer. January 1955. 45p. diagrs. (NACA TN 3335)

Curves based on the thermodynamic properties of air and combustion gases for a hydrogen-carbon ratio of 0.167 are presented to relate parameters affecting each engine component. The curves cover a range of flight Mach numbers from 0 to 3.0, compressor pressure ratios from 1 to 30, turbine-inlet temperatures from 1500° to 3000° R, and afterburner temperatures from 2800° to 3500° R. Except for extreme cases, the curves are accurate to at least 3° R in temperature and 1 percent in pressure ratio, fuel-air ratio, and specific thrust. Procedures required for performance evaluation are explained for both uncooled engines with no compressor bleed and for engines utilizing both compressor bleed and turbine cooling.

NACA TN 3337

INVESTIGATION OF TEMPERATURE LIMITATION OF VARIOUS LUBRICANTS FOR HIGH-TEMPERATURE 20-MILLIMETER-BORE BALL BEARINGS. Z. N. Nemeth and W. J. Anderson. January 1955. 31p. diagrs., photos., 2 tabs. (NACA TN 3337)

Twenty-millimeter-bore tool-steel ball bearings, equipped with either a beryllium copper or an Inconel cage, were operated with liquid and with solid lubricants at temperatures from 100° to 1000° F at a speed of 2500 rpm and a thrust load of 110 lb. Solid lubricants were more effective than fluid lubricants at the higher temperatures. Graphite provided effective lubrication to 1000° F with bearings equipped with either a beryllium copper or an Inconel cage; molybdenum disulfide, to 850° F with a bearing equipped with an Inconel cage. A silicone-diester blend, the best high-temperature liquid lubricant, provided effective lubrication to 700° F and allowed operation of the bearing at 850° F although the bearing operation was rough and friction torque was high.

NACA TN 3346

PREDICTION OF DOWNWASH BEHIND SWEPT-WING AIRPLANES AT SUBSONIC SPEED. John DeYoung and Walter H. Barling, Jr. January 1955. 104p. diagrs., 3 tabs. (NACA TN 3346)

The numerical integration method presented enables a rapid prediction of downwash. The principal effects of the rolling-up of the wake are treated as corrections to the flat-sheet wake. A simple approximate correction for the effect of the fuselage is applied. Computing forms and charts of pertinent functions are included. Agreement with available experimental data is good.

NACA TN 3353

EFFECTIVE MOMENT OF INERTIA OF FLUID IN OFFSET, INCLINED, AND SWEPT-WING TANKS UNDERGOING PITCHING OSCILLATIONS. James R. Reese and John L. Sewall. January 1955. 27p. diagrs., 6 tabs. (NACA TN 3353)

Fluid-dynamics studies were made of simplified model fuel tanks undergoing pitching oscillations. The tanks were pylon mounted, centrally mounted at angles of sweep, and inclined at angles of attack. The effective moment of inertia of the fluid was determined experimentally for the various tank configurations over a tank-fullness range from empty to full. For full pylon-mounted and swept-wing tanks, comparisons of experimental and theoretical solutions for the effective moment of inertia of fluid showed good agreement. Studies of the effect of vertical, horizontal, and diffused baffles in pylon-mounted tanks showed that the effective moment of inertia of the fluid was considerably less without baffles. Diffused baffles were found to have high damping characteristics in pylon-mounted tanks and very low damping characteristics in centrally mounted tanks.

NACA TN 3356

EFFECT OF LAG OF SIDEWASH ON THE VERTICAL-TAIL CONTRIBUTION TO OSCILLATORY DAMPING IN YAW OF AIRPLANE MODELS. Lewis R. Fisher and Herman S. Fletcher. January 1955. 38p. diagrs., photos. (NACA TN 3356)

Two models were tested which permitted, in effect, a systematic variation of the sidewash gradient at the vertical tail. For the first model, this variation was accomplished by mounting auxiliary fins forward of the vertical tail; for the second model, it was done by altering the vertical location of the wing on the fuselage. The unsteady damping-in-yaw and directional-stability parameters are compared with the steady derivatives obtained for the same models to establish the effects of the sidewash and the lag of the sidewash on these lateral stability derivatives.

NACA TN 3357

THE EFFECTS OF VARIOUS PARAMETERS, INCLUDING MACH NUMBER, ON PROPELLER-BLADE FLUTTER WITH EMPHASIS ON STALL FLUTTER. John E. Baker. January 1955. 40p. diagrs., 3 tabs. (NACA TN 3357. Formerly RM L50L12b)

The effect of many parameters significant to wing flutter as well as blade twist was studied on several untwisted rotating models to determine their significance with respect to propeller stall flutter. The minimum values of the flutter-speed coefficient were found to be slightly greater than 1.0 at subcritical Mach numbers. Of the few parameters that raised the minimum flutter-speed coefficients, forward movement of the section center-of-gravity location and Mach number at supercritical speeds were most significant. The effect of Mach number was of such significance that a tentative criterion for designing completely flutter-free thin supersonic propellers is indicated.

NACA TN 3360

SOME EFFECTS OF PROPELLER OPERATION AND LOCATION ON ABILITY OF A WING WITH PLAIN FLAPS TO DEFLECT PROPELLER SLIPSTREAMS DOWNWARD FOR VERTICAL TAKE-OFF. John W. Draper and Richard E. Kuhn. January 1955. 28p. diagrs., photo. (NACA TN 3360)

An investigation has been conducted of the effects of propeller blade angle, mode of propeller rotation, propeller location, and ratio of wing chord to propeller diameter on the ability of a wing with plain flaps to deflect the propeller slipstream downward in order to achieve vertical take-off. The basic model consisted of a semispan wing with 30-percent-chord and 60-percent-chord plain flaps. Two large-diameter overlapping propellers driven by electric motors were used.

NACA TN 3361

AERODYNAMIC CHARACTERISTICS OF NACA 0012 AIRFOIL SECTION AT ANGLES OF ATTACK FROM 0° TO 180°. Chris C. Critzos, Harry H. Heyson and Robert W. Boswinkle, Jr. January 1955. 21p. diagrs. (NACA TN 3361)

The aerodynamic characteristics of the NACA 0012 airfoil section are presented for an angle-of-attack range extending through 180°. Data were obtained at a Reynolds number of 1.8×10^{6} with the airfoil surfaces smooth and with roughness applied at the leading and trailing edges and at a Reynolds number of 0.5×10^{6} with the airfoil surfaces smooth. The tests were conducted in the Langley low-turbulence pressure tunnel at Mach numbers no greater than 0.15.

NACA TN 3364

INVESTIGATION OF EFFECTIVENESS OF LARGE-CHORD SLOTTED FLAPS IN DEFLECTING PROPELLER SLIPSTREAMS DOWNWARD FOR VERTICAL TAKE-OFF AND LOW-SPEED FLIGHT. Richard E. Kuhn and John W. Draper. January 1955. 42p. diagrs., photo., tab. (NACA TN 3364)

An investigation of the effectiveness of a wing equipped with large-chord slotted flaps and an auxiliary vane in rotating the effective thrust vector of propellers to a near-vertical direction for vertical take-off and low-speed flight has been conducted. The model consisted of a semispan wing equipped with 60-percent-chord and 30-percent-chord slotted flaps. Two large-diameter overlapping propellers, driven by electric motors, were used. The effect of wing incidence, propeller blade angle, and an auxiliary vane on the ability of the wing equipped with slotted flaps to deflect the propeller slipstreams downward were also investigated. A few tests covered an angle-of-attack range from 0° to 90° and a thrust-coefficient range representing free-flight velocities from zero to the normal range of cruising velocity.

NACA TN 3366

A METHOD FOR STUDYING THE TRANSIENT BLADE-FLAPPING BEHAVIOR OF LIFTING ROTORS AT EXTREME OPERATING CONDITIONS. Alfred Gessow and Almer D. Crim. January 1955. 27p. diagrs. (NACA TN 3366)

A method is presented for studying the transient behavior of the flapping motion, as well as for calculating the steady-state flapping amplitudes, of free-to-cone and seesaw rotors operating at extreme flight conditions. The method is general and can be applied to blades of any airfoil section, mass distribution, twist, plan-form taper, root cutout, and flapping-hinge geometry. Stall and compressibility effects can also be accounted for. Applications of the method to the calculation of the stability of the flapping motion of unloaded rotors and to the transient blade motion resulting from arbitrary control inputs under conditions of extreme stall are included.

NACA TN 3387

USE OF NONLINEARITIES TO COMPENSATE FOR THE EFFECTS OF A RATE-LIMITED SERVO ON THE RESPONSE OF AN AUTOMATICALLY CONTROLLED AIRCRAFT. Stanley F. Schmidt and William C. Triplett. January 1955. 27p. diagrs., tab. (NACA TN 3387)

A method is developed for designing suitable nonlinear functions of error into a system to compensate for the undesirable effects of control-surface rate limiting on the response of an automatically controlled aircraft.

BRITISH REPORTS

N-34602*

Aeronautical Research Council (Gt. Brit.)
THE EFFICIENCY OF HIGH-SPEED WIND TUNNELS OF THE INDUCTION TYPE. A. E. Knowler and D. W. Holder. APPENDIX - THE EFFICIENCY OF INTERMITTENT OPERATION FROM COMPRESSED AIR STORAGE. D. W. Holder. 1954. iii, 59p. diagrs., photo., 6 tabs. (ARC R & M 2448. Formerly ARC 7563; 7672; 7756; 7812; 8024; 8138; 8394; 8668; 8669; 8670; 9490 and 9902)

An investigation has been made of the influence of various design features upon the efficiency of an induction-type tunnel with an annular injector slot. A model tunnel of circular cross-section was used, the working-section diameter being 2-1/4 inch. At subsonic working-section speeds it was found that efficiencies comparable with those of direct-action tunnels could be attained, but at supersonic speeds the efficiency began to fall rapidly. A comparison between the 2-1/4 inch and 12 inch tunnels is made.

N-34603*

Aeronautical Research Council (Gt. Brit.)
ASSESSMENT OF THE RELATIVE PERFORMANCE OF THE BY-PASS ENGINE AND THE ORTHODOX DOUBLE COMPOUND JET ENGINE. E. A. Bridle. 1954. 12p. diagrs. (ARC R & M 2862; ARC 11,740. Formerly NGTE Memo. M. 32)

The by-pass engine can be described as a form of ducted fan engine in which the fan boosts the main compressor. Two possible forms of by-pass engine are described, and their estimated performance is compared with that of the orthodox double compound jet engine under various flight conditions, the calculations being extended to include the case of thrust boosting by means of exhaust reheat. It is concluded that the by-pass engine can offer an appreciable gain in respect of fuel economy over the orthodox double compound jet engine even at 650 mph in the stratosphere, at the expense, however, of increased frontal area for a given thrust.

N-34604*

Aeronautical Research Council (Gt. Brit.)
FULL-SCALE MEASUREMENTS OF IMPACT LOADS ON A LARGE FLYING BOAT. PART 1. DESCRIPTION OF APPARATUS AND INSTRUMENT INSTALLATION. J. W. McIvor. 1954. 27p. photos., diagrs. (ARC CP 182)

The variations with time of the total force and the distribution of water pressures on the hull bottom of a flying boat are related to the horizontal velocity, vertical velocity and keel attitude relative to the water during impact. Methods are described for obtaining, in a form suitable for easy analysis of results, records of these variables, in order to verify impact theories. The equipment used included transducers for the conversion of physical quantities to electrical signals, multichannel electronic amplifiers, and mirror galvanometer recorders.

N-34605*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF INLET CONDITIONS ON THE FLOW IN ANNULAR DIFFUSERS. I. H. Johnston. 1954. 15p. diagrs. (ARC CP 178)

Tests have been carried out on annular diffusers having a common area ratio of 3.19 and varying in divergence angle from 6.5° to 15°. The performance of each diffuser has been measured for a variety of inlet velocity distributions and the effect of axially splitting the flow in the diffusers has been investigated. Diffuser efficiency is found to deteriorate as inlet conditions become nonuniform, this tendency increasing with diffuser angle. Splitting of the higher angle diffusers improves efficiency for nonuniform profiles, but these increases in efficiency are accompanied by pronounced static pressure gradients across the diffuser throat which in certain applications might prove undesirable.

N-34606*

Aeronautical Research Council (Gt. Brit.)
A METHOD OF COMPUTING SUBSONIC AND TRANSONIC PLANE FLOWS. C. S. Sinnott. 1954. 21p. diagrs., photos. (ARC CP 173)

A relaxation treatment of a simple but exact differential equation for compressible flow is presented. The method has advantages over other numerical treatments of the same problem and because of the simplicity of the basic differential equation should be particularly suitable for high-speed computing machines. The flow about a 10-percent-thick airfoil (RAE 104) at zero incidence is calculated for Mach numbers fo 0.70, 0.79, and 0.86. At M = 0.86 the existence, but not the position of a transonic shock wave is predicted by the relaxation technique. Satisfactory agreement with experiment is obtained.

N-34607*

Aeronautical Research Council (Gt. Brit.)
THE THEORETICAL INTERFERENCE VELOCITY ON THE AXIS OF A TWO-DIMENSIONAL WIND TUNNEL WITH SLOTTED WALLS. R. C. Tomlinson. 1954. 15p. diagrs., 2 tabs. (ARC CP 181)

A calculation is made of the interference velocity on the axis in the flow of an incompressible fluid past a line doublet in a two-dimensional slotted-wall tunnel, i.e. a rectangular tunnel whose shorter sides are slotted in the direction on the flow. Numerical solutions are obtained which show that if the width of (slot + slat) is one twelfth of the tunnel height (e.g. six slots in the shorter side of a 2 by 1 tunnel), the interference velocity is little different from the corresponding open-jet value - i.e. no slats - for all slot/slat ratios greater than 1/40. It appears likely that all cases which give conditions uniform across the center plane of the tunnel will also give an interference velocity which is close to the open jet figure.

N-34608*

Aeronautical Research Council (Gt. Brit.)
THE M. A. E. E. RECORDING ACCELEROMETER. D. M. Ridland and R. Parker. 1954. 20p. photos., diagrs. (ARC CP 177)

The M. A. E. E. recording accelerometer is basically the accelerometer unit of a desynn accelerometer, adapted to make a continuous and immediate presentation of accurate, calibrated accelerations on a half second time base. The recording medium is metallized paper, having a speed of half an inch per second, and the instrument can be operated continuously for 20 minutes on one loading. It can record with full scale deflections, from 1 to 10gg when the natural frequencies will be about 7 and 22 cps, respectively. The instrument is simple, it has been proved reliable and accurate and is most convenient in use.

N-34616*

Nat. Gas Turbine Establishment (Gt. Brit.)
THERMODYNAMIC PROPERTIES OF AIR AND COMBUSTION PRODUCTS OF HYDROCARBON FUELS. PART III. THE FLOW OF GASES OF VARYING SPECIFIC HEAT. D. Fielding, J. E. C. Topps and W. R. Thomson. June 1954. 43p. diagrs. (NGTE R. 160)

General methods of calculating gas flow have been investigated and it has been found possible to present data in graphical form which permits the frictionless flow properities of ideal gases of varying specific heat and any molecular weight to be calculated at velocities up to sonic with error not exceeding that inherent in the approximation to four significant figures. Charts are presented of a total head flow parameter against pressure ratio, pressure ratio against temperature ratio, and Mach number against temperature ratio, all with molar specific heat as a running parameter. The relations are also given for Mach numbers 1.0 to 3.0.

N-34617*

Nat. Gas Turbine Establishment (Gt. Brit.)
TESTS TO DETERMINE THE EFFECT OF THE EXHAUST CONE SUPPORT STRUT FAIRINGS ON THE PERFORMANCE OF A TURBO-JET ENGINE. W. Deacon. July 1954. 19p. diagrs. (NGTE Memo. M. 222)

Simple bench tests have been made to determine what effect the exhaust cone support strut fairings have on the performance of a turbojet engine. Pitot and yawmeter traverses were made just downstream of the turbine. The results show that some residual swirl is present in the turbine exhaust, and that the fairings effectively remove it. Removal of the strut fairings causes an increase in exhaust losses, mainly due to the increased swirl in the exhaust system, but also due to the exposure of unfaired support rods. The increased loss due to swirl is in accordance with that predicted from model tests. When the fairings are removed, removal of the bullet causes no further increase in exhaust losses.

N-34619*

Nat. Gas Turbine Establishment (Gt. Brit.)
SOME CALCULATIONS ON IDEAL COMBUSTION IN A PARALLEL DUCT. A. B. P. Beeton. July 1954. 25p. diagrs. (NGTE Memo. M. 221)

Taking one typical case representative of ram-jet combustion conditions, calculations were made of the integrated kinetic energy and throat specific impulse after loss-free combustion in a parallel duct. Various inlet flow velocities were considered, corresponding to downstream throat areas between 83-1/2 percent and 95-1/2 percent of the duct area. Comparing these results with those calculated for the same approach velocities on the usual basis of homogeneous flow, the latter are shown to involve a loss in specific impulse of at most half a second in 150. The corresponding kinetic energies were not calculated with sufficient accuracy to obtain more than the order of the loss, which appeared to be about half the energy in the approach flow.

N-34621*

Nat. Gas Turbine Establishment (Gt. Brit.)
THE EFFECT OF BURNER SHROUD AIR ON A FUEL SPRAY. H. Clare. July 1954. 25p. diagrs., photos. (NGTE Memo. M. 223)

The possibility of using shroud air as an atomization booster has been investigated. It was found to be effective only when the initial spray was coarse. Drop size analyses of sprays produced from swirl atomizers at low fuel pressures showed that at low shroud air pressure swirling air was the more effective. At higher air pressures of 20 in. water the effects of both swirled and unswirled air were similar. The difference between the swirled and unswirled air was most marked at a pressure of 2 in. head of water where the swirling air improved atomization, whilst unswirled air produced a still coarser spray. It is concluded that swirling shroud air could be used to advantage where both fuel and shroud air pressures were low, a condition which might be expected in an aircraft combustion chamber idling at altitude.

N-34623*

Nat. Gas Turbine Establishment (Gt. Brit.)
A CORRECTED SPEED TACHOSCOPE. R. Staniforth. May 1954. 15p. diagrs., photos. (NGTE Memo. M.217)

It is often desirable in testing aerodynamic compressors to take all readings at fixed corrected speeds rather than true speeds. This corrected speed is defined as the actual shaft speed divided by the square root of the ratio of the absolute air inlet temperature to the standard temperature (288° K.). With the instrument described, this is possible with high accuracy (error < 0.1 percent) without further complication than the setting of a dial to the observed air inlet temperature. The latter operation could be dispensed with and the correction obtained directly from a temperature sensitive device such as a thermistor or a resistance thermometer element.

N-34627*

Marine Aircraft Experimental Establishment (Gt. Brit.) SOME ASPECTS OF THE FLOW ROUND PLANING SEAPLANE HULLS OR FLOATS AND IMPROVEMENT IN STEP AND AFTERBODY DESIGN. K. M. Tomaszewski and A. G. Smith. September 1954. 13p. diagrs., photo. (MAEE F/TN/4; ARC 14,376; ARC S. 669. Formerly MAEE Tech. Memo 5)

A method of step and afterbody design is given and illustrated which is based on knowing the shape of the wake produced by the forebody and the interaction

between air and water flow under the afterbody. It is claimed that this is a logical approach which gives the designer a clear overall picture of the physical conditions existing during take-off and landing, enabling the optimum aero- and hydrodynamic performance to be quickly obtained. Application leads to large improvements in air and water drag and in water stability.

N-34628*

Royal Aircraft Establishment (Gt. Brit.)
CALIBRATION OF THE FLOW IN THE WORKING SECTION OF THE 3 FT. x 3 FT. TUNNEL, NATIONAL AERONAUTICAL ESTABLISHMENT. D. E. Morris. September 1954. 44p. diagrs. (RAE Tech. Note Aero 2336)

A number of calibrations, consisting of both pitot and static pressure measurements and also flow direction measurements, have been made of the flow in the working section of the 3-ft by 3-ft supersonic tunnel. In this report some selected examples are given to show the general nature of the flow distribution with the M = 1.4, 1.6, 1.8, and 2.0 nozzles and to demonstrate a number of interesting points in the measurements and in the characteristics of the flow.

N-34630*

Ministry of Supply (Gt. Brit.)
REPORT ON PROGRESS IN THE DEVELOPMENT OF AN ALLOYING THEORY OF TITANIUM. Dept. of Physical Metallurgy, Birmingham University. (Progress report 1951-1954 of the titanium research programme) November 1954. 28p. diagrs., photos. (MOS S & TM 13/54)

In this report an attempt has been made to summarize those properties of titanium and its alloys which would appear to have some significant relationship to the electronic structure of the metal and to put forward tentative suggestions for possible causes of the observed behavior of its alloys.

N-34631*

Ministry of Supply (Gt. Brit.)
DIFFUSION OF SOLUTE ELEMENTS IN TITANIUM. D. H. Tomlin and A. J. Mortlock. (Biannual progress report no. 1 for April-October 1954). November 1954. 6p. diagrs. (MOS S & TM 14/54)

The initial part of a general study of the diffusion of solute elements in titanium reported here has been aimed at experimentally determining the diffusion parameters associated with the movements of chromium in β-titanium. A new method is described which makes use of autoradiographic techniques, and which suggests that a number of diffusion coefficients corresponding to different temperatures may be determined using the same specimen.

MISCELLANEOUS

NACA Rept. 1152

Errata on "THEORY AND PROCEDURE FOR DETERMINING LOADS AND MOTIONS IN CHINE-IMMERSED HYDRODYNAMIC IMPACTS OF PRISMATIC BODIES." Emanuel Schnitzer. 1953.

NACA Rept. 1159

Errata on "IMPINGEMENT OF WATER DROPLETS IN WEDGES AND DOUBLE-WEDGE AIRFOILS AT SUPERSONIC SPEEDS." John S. Serafini. 1954.

N-33959*

Advisory Group for Aeronautical Research and Development. A SUMMARY OF THE TECHNIQUES OF VARIABLE MACH NUMBER SUPERSONIC WIND TUNNEL NOZZLE DESIGN. J. T. Kennedy and L. M. Webb. October 1954. 133p. diagrs., photos. (AGARDograph 3)

This report is a survey of the techniques of two-dimensional wind-tunnel nozzle design. A procedure for the aerodynamic design of flexible nozzles capable of continuous Mach number variation is developed in detail. The special structural, mechanical, calibration, and cost estimation problems involved in flexible nozzle construction are discussed.

N-35025*

Advisory Group for Aeronautical Research and Development. METHODS AND CRITERIA FOR THE SELECTION OF FLYING PERSONNEL. (Symposium held February 23-25, 1953, Paris) December 1954. 59p. (AGARDograph 2)

Original papers and summaries of the symposium covering three different aspects of the problem: (1) psychological and psychiatric methods of selection and assessment of flying personnel; (2) clinical selection criteria and methods; (3) physiological selection criteria and methods are presented.

DECLASSIFIED NACA REPORTS

NACA RM L7L12

MEASUREMENTS OF THE WING AND TAIL LOADS DURING THE ACCEPTANCE TESTS OF BELL XS-1 RESEARCH AIRPLANE. De E. Beeler and John P. Mayer. April 13, 1948. 25p. diagrs., photos., 2 tabs. (NACA RM L7L12) (Declassified from Confidential, 12/10/54)

During the acceptance tests of the XS-1 airplane, strain-gage measurements were made of wing and tail loads up to a Mach number of 0.80. The maximum lift and buffet boundaries were also determined. The loads encountered were well within the design loads and showed fairly good agreement with wind-tunnel and calculated data.

NACA RM L8A09

GENERAL HANDLING-QUALITIES RESULTS OBTAINED DURING ACCEPTANCE FLIGHT TESTS OF THE BELL XS-1 AIRPLANE. Walter C. Williams, Charles M. Forsyth and Beverly P. Brown. April 19, 1948. 72p. diagrs., photos., tab. (NACA RM L8A09) (Declassified from Confidential, 12/10/54)

Presents results obtained during acceptance tests of the Bell XS-1 airplane from minimum speed to a Mach number of 0.8. The longitudinal stability was positive but low for all conditions tested. The directional stability was exceptionally high, and the lateral stability was positive throughout the speed range tested. Aileron control was adequate. The stalling characteristics were considered satisfactory with stall warning in the form of buffeting. The large amount of friction in the control system, coupled with low control-operating forces, made exact control of the airplane difficult.

NACA RM L50J27

STABILITY AND CONTROL CHARACTERISTICS OF A 1/4-SCALE BELL X-5 AIRPLANE MODEL IN THE LANDING CONFIGURATION. Robert E. Becht. December 18, 1950. 38p. diagrs., photos. (NACA RM L50J27) (Declassified from Confidential, 10/29/54)

An investigation was conducted to determine the stability and control characteristics of a 1/4-scale model of a preliminary Bell X-5 airplane design in the landing configuration with and without dive brakes. Tests were made at wing sweep angles of 20° and 60°.

NACA RM L50K30

THE ORIGIN OF AERODYNAMIC INSTABILITY OF SUPERSONIC INLETS AT SUBCRITICAL CONDITIONS. Antonio Ferri and Louis M. Nucci. January 26, 1951. 111p. diagrs., photos., tab. (NACA RM L50K30) (Declassified from Confidential, 1/11/55)

The starting of "buzz" is explained as being caused by a separation on the inner surface of the cowling produced by a velocity discontinuity across a vortex sheet arising from a shock intersection. The explanation has been confirmed by tests of a number of inlet designs, and it has been shown that a useful range of stable flow regulation is attainable. Values of minimum stable entering volume flow for configurations of practical interest are presented for a range of Mach number from 1.90 to 2.70.

NACA RM L53E06a

SOME NOTES ON THE AERODYNAMIC LOADS ASSOCIATED WITH EXTERNAL-STORE INSTALLATIONS. H. Norman Silvers and Thomas C. O'Bryan. June 1953. 17p. diagrs. (NACA RM L53E06a) (Declassified from Confidential, 12/10/54)

The results of recent investigations of the aerodynamic loads associated with external stores are considered with a view toward indicating certain observations that may prove helpful in the design of future external store installations. Consideration was given to store-induced wing loads and to direct external store loads.

NACA RM L53G07

WIND-TUNNEL INVESTIGATION OF THE BEHAVIOR OF PARACHUTES IN CLOSE PROXIMITY TO ONE ANOTHER. Stanley H. Scher. August 1953. 12p. photos. (NACA RM L53G07) (Declassified from Confidential, 1/11/55)

An investigation made with small tethered parachutes in the Langley 20-foot free-spinning tunnel indicated that parachutes side by side had little effect on one another, but that when one parachute got into the wake above another parachute, the upper parachute sometimes collapsed on top of the lower parachute.

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Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1165

UNSTEADY OBLIQUE INTERACTION OF A SHOCK WAVE WITH A PLANE DISTURBANCE. Franklin K. Moore. 1954. ii, 21p. diagrs. (NACA Rept. 1165. Formerly TN 2879)

Analysis is made of the flow field produced by oblique impingement of weak plane disturbances of arbitrary profile on a plane normal shock. Three types of disturbance are considered: (a) Sound wave propagating in the gas at rest into which the shock moves. The sound wave refracts either as a simple isentropic sound wave or an attenuating isentropic pressure wave, depending on the angle between the shock and the incident sound wave. A stationary vorticity wave of constant pressure appears behind the shock. (b) Sound wave overtaking the shock from behind. The sound wave reflects as a sound wave, and a stationary vorticity wave is produced. (c) An incompressible vorticity wave stationary in the gas ahead of the shock. The incident wave refracts as a stationary vorticity wave, and either a sound wave or attenuating pressure wave is also produced. Computations are presented for the first two types of incident wave, over the range of incidence angles, for shock Mach numbers of 1, 1.5, and ∞.

NACA Rept. 1167

METHOD FOR CALCULATING THE ROLLING AND YAWING MOMENTS DUE TO ROLLING FOR UNSWEPT WINGS WITH OR WITHOUT FLAPS OR AILERONS BY USE OF NONLINEAR SECTION LIFT DATA. Albert P. Martina. 1954. ii, 16p. diagrs., 11 tabs. (NACA Rept. 1167. Formerly TN 2937)

The methods of NACA Reports 865 and 1090 have been applied to the calculation of the rolling- and yawing-moment coefficients due to rolling for unswept wings with or without flaps or ailerons. The methods allow the use of nonlinear section lift data together with lifting-line theory. Two calculated examples are presented in simplified computing forms in order to illustrate the procedures involved.

NACA Rept. 1168

SECONDARY FLOWS AND BOUNDARY-LAYER ACCUMULATIONS IN TURBINE NOZZLES. Harold E. Rohlik, Milton G. Kofskey, Hubert W. Allen and Howard Z. Herzig. 1954. ii, 32p. diagrs., photos., 3 tabs. (NACA Rept. 1168. Formerly TN 2871; TN 2909; TN 2989)

The results of detailed measurements of the high-speed flows in three turbine nozzle configurations are interpreted, with the aid of low-speed flow-visualization experiments, in order to establish the sources and patterns of the secondary flows there. The secondary-flow mechanism causes local accumulation of high-loss material by transporting boundary-layer fluids across the channels on the walls, as well as radially in the blade wakes and boundary layers. The size and location of these boundary-layer accumulations depend largely on the blade velocity profiles, not on the radial distribution of circulation along the blades.

NACA Rept. 1170

BEHAVIOR OF MATERIALS UNDER CONDITIONS OF THERMAL STRESS. S. S. Manson. 1954. ii, 34p. diagrs., photos., 6 tabs. (NACA Rept. 1170. Formerly TN 2933)

A review is presented of available information on the behavior of brittle and ductile materials under conditions of thermal stress and thermal shock. For brittle materials, simple formulas relating physical properties to thermal-shock resistance are derived and used to determine the relative significance of two indices currently in use for rating materials. The importance of simulating operating conditions in thermal-shock testing is deduced from the formula and is experimentally illustrated by showing that BeO could be both inferior or superior to Al_2O_3 in thermal shock depending on the testing conditions. For ductile materials, thermal-shock resistance depends upon the complex interrelation among several metallurgical variables which seriously affect strength and ductility. These variables are briefly discussed and illustrated from literature sources. The importance of simulating operating conditions in tests for rating ductile materials is especially to be emphasized because of the importance of testing conditions in metallurgy. A number of practical methods that have been used to minimize the deleterious effects of thermal stress and thermal shock are outlined.

NACA TN 3347

A WIND-TUNNEL TEST TECHNIQUE FOR MEASURING THE DYNAMIC ROTARY STABILITY DERIVATIVES INCLUDING THE CROSS DERIVATIVES AT HIGH MACH NUMBERS. Benjamin H. Beam. January 1955. 35p. diagrs., photos. (NACA TN 3347)

An experimental technique for measuring dynamic stability derivatives of a model airplane in a wind tunnel is described. A single-degree-of-freedom, feedback-controlled, forced-oscillation system was used to measure the stability derivatives which are important in estimating the lateral and longitudinal oscillatory motions of a rigid airplane. Some representative experimental data are included.

NACA TN 3350

THE LINEARIZED EQUATIONS OF MOTION UNDERLYING THE DYNAMIC STABILITY OF AIRCRAFT, SPINNING PROJECTILES, AND SYMMETRICAL MISSILES. A. C. Charters. January 1955. 102p. diagrs. (NACA TN 3350)

Linearized equations of motion are derived for aircraft with mirror symmetry and for spinning projectiles with both rotational and mirror symmetry. The customary set of dynamic stability derivatives is extended to include the aerodynamic effects of spin. The aircraft and projectile cases are treated alike and the consequences of symmetry and spin are shown by a comparison of the equations for the two cases. Dynamic stability conditions are derived. The equations for spinning projectiles are applied to the analysis of flight test data from the aerodynamics range.

NACA TN 3358

GUST-LOAD AND AIRSPEED DATA FROM ONE TYPE OF FOUR-ENGINE AIRPLANE ON FIVE ROUTES FROM 1947 TO 1954. Walter G. Walker. January 1955. 28p. diagrs., 4 tabs. (NACA TN 3358)

This paper presents the results of an analysis of approximately 100,000 hours of V-G data from one type of four-engine civil transport airplane to determine the magnitude and frequency of occurrence of the gust loads and gusts. The normal accelerations differed by approximately 15 percent and the derived gust velocities by about 18 percent for the five operations investigated. The gust loads of the present operations were less than the loads experienced by other four-engine civil transports previously investigated, but the differences are not significant. The present data indicated only small differences due to seasonal effects and different operational utilization.

NACA TN 3363

LOW-SPEED WIND-TUNNEL INVESTIGATION OF A TRIANGULAR SWEPTBACK AIR INLET IN THE ROOT OF A 45° SWEPTBACK WING. Arvid L. Keith, Jr. and Jack Schiff. January 1955. 65p. diagrs., photos., 5 tabs. (NACA TN 3363. Formerly RM L50I01)

Results of a low-speed study of a 45° sweptback wing-root air-inlet configuration believed suitable for transonic-speed airplanes are presented. The inlet-configuration lift and drag characteristics are compared with those of a basic model. Boundary-layer growth along the fuselage nose, inlet total-pressure recoveries, and static-pressure distributions over the inlet and wing surfaces are presented for wide ranges of inlet-velocity ratio and angle of attack.

NACA TN 3386

SOME CONSIDERATIONS ON TWO-DIMENSIONAL THIN AIRFOILS DEFORMING IN SUPERSONIC FLOW. Eugene Migotsky. January 1955. 36p. diagrs. (NACA TN 3386)

The aerodynamic characteristics of indicially cambered two-dimensional airfoils in supersonic flow are determined theoretically. The power required to sustain a general time-varying chordwise deformation is determined. Stability boundaries are presented for the harmonically oscillating parabolic mode. The thickness distribution of a beam having a parabolic fundamental bending mode, in vacuo, is determined.

NACA TN 3388

A FIBROUS-GLASS COMPACT AS A PERMEABLE MATERIAL FOR BOUNDARY-LAYER-CONTROL APPLICATIONS USING AREA SUCTION. Robert E. Dannenberg, James A. Weiberg and Bruno J. Gambucci. January 1955. 20p. diagrs., photos., 2 tabs. (NACA TN 3388)

The resistance to air flow of fibrous-glass compacts suitable for boundary-layer control was measured. The flow resistance is related to the thickness and density of the fibrous-glass compacts. Constant thickness compacts with specified permeability distributions were fabricated and tested.

BRITISH REPORTS

N-34689*

Nat. Gas Turbine Establishment (Gt. Brit.)
THE DEVELOPMENT OF AN ACCURATE SPEED MEASURING DEVICE (THE TACHRONOMETER). H. Shaw and W. E. Wilcox. May 1954. 12p. diagrs., photos. (NGTE Memo. M. 216)

An electrical system has been developed which will control a stopwatch to time a preselected number of revolutions of a shaft. Special attention has been given to the removal of sources of error, and to the provision for testing the operation of the instrument in situ. An accuracy of 0.2 percent can be obtained for mean speeds measured over a period of at least 50 seconds. The instrument is used in conjunction with an electric contact-maker driven through a reduction gear from the shaft of which the speed is to be measured.

N-34690*

Nat. Gas Turbine Establishment (Gt. Brit.)
ON RENDERING ENGINE EXHAUST GASES NON-EXPLOSIBLE. B. P. Mullins and J. M Hawkins. October 1954. 34p. diagrs. (NGTE Memo. M. 225)

A quantitative assessment of explosion hazards in combustion system exhaust gases has been made, and a criterion of nonexplosibility defined. Calculations have been made of: (1) the limiting quantities of induced air and injected water required to render exhaust gases of fuel burning rigs nonexplosible at all times; (2) quantities of air and water necessary to reduce the exhaust duct gas temperature to any desired level; (3) limits of explosibility in the static pressure range 0.1 to 1.0 atm when some fraction of the fuel supply is burned and the gas subsequently cooled to below 100° C; and (4) limiting safe fuel: air ratios at various initial mixture temperatures and pressures in the absence of injected water.

N-34691*

Royal Aircraft Establishment (Gt. Brit.)
AN IMPROVED PRESSURE TRANSDUCER EMPLOYING AN ELLIPTICAL TUBE AND STRAIN GAUGES. D. S. Dean. July 1954. 26p. diagrs., photos. (RAE Tech. Note RPD 106)

A pressure transducer is described which employs bonded wire strain gages to measure circumferential strain in a short elliptical tube. The transducer is designed for high sensitivity (double that possible with the usual circular tube type), robustness, accuracy, good temperature compensation and ability to withstand overloads. Graphs are included from which all the data may be obtained to enable transducers to be constructed for a wide variety of pressure ranges and to suit various electrical circuits. The transducer is covered by U.K. provisional patent Specification No. 21479/53.

N-34694*

Royal Aircraft Establishment (Gt. Brit.)
EVALUATING THE SUPERSONIC DRAG INTEGRAL USING FOURIER SERIES. N. A. Routledge. September 1954. 16p. (RAE Tech. Note MS 17)

The expression

$$\frac{1}{2\pi}\int_0^1\int_0^1 S''(x)\,S''(y)\,\log|x-y|^{-1}\,dx\,dy,$$

which is related to the drag of a body travelling at supersonic speeds, is evaluated for arbitrary functions $S(x)$ such that $S'(o) = S'(1) = 0$ by fitting Fourier Sine Series. Some general remarks are made on the utility of the method of approach that is adopted.

N-34721*

Aeronautical Research Council (Gt.Brit.)
A NOTE ON THE DEVELOPMENT OF SENSITIVE PRESSURE OPERATED WATER CONTACTS FOR USE ON SEAPLANES. R. Parker. 1954. 11p. diagrs., photos., tab. (ARC CP 176)

A pressure operated water contact has been developed, suitable for indicating the instants of take-off and touch-down for a seaplane hull. Flight tests have shown that the instrument is accurate in operation and sufficiently robust for normal flight test use

N-34772*

Aeronautical Research Council (Gt.Brit.)
A SURVEY OF SCALE EFFECTS ON THE HYDRODYNAMIC TESTING OF SEAPLANE MODELS. R. Parker. 1954. 29p. diagrs., photos., tab. (ARC CP 179)

A general survey is made of all the factors where true dynamic similarity cannot be achieved in model tests of seaplane hulls, and the likely effects on test results are discussed with reference to towing tank models and medium size research aircraft. In resistance tests the correction for Reynolds number effects requires more investigation. Pressure effects are likely to affect the breakaway of flow at small discontinuities such as extreme fairings with resultant errors in both stability and resistance test results. More accurate and systematic full scale data than at present is available is needed before methods of allowing for this can be satisfactorily developed.

N-34777*

Aeronautical Research Council (Gt. Brit.)
PUBLISHED REPORTS AND MEMORANDA FOR THE AERONAUTICAL RESEARCH COUNCIL. 1954. 7p. (ARC R & M 2650)

N-34778*

Aeronautical Research Council (Gt.Brit.)
OPTICAL CONSIDERATIONS AND LIMITATIONS OF THE SCHLIEREN METHOD. G. S. Speak and D. J. Walters. 1954. 25p. diagrs., 6 tabs. (ARC R & M 2859; 13,066. Formerly RAE Tech. Note IAP 968)

The elementary principles of the schlieren method are described, with reference to an ideal basic system. The experimental procedure in setting up the system is covered from the same aspect. It is concluded that the schlieren method may be used qualitatively at extremely high sensitivities with satisfactory results, but is not suitable for quantitative work where small pressure or density changes are involved. A secondary conclusion is that the twin-mirror system is in general the best for overall ease of interpretation of results, though local considerations may modify this choice.

N-35208*

Aeronautical Research Council (Gt.Brit.)
AUTHOR INDEX TO THE REPORTS AND MEMORANDA AND CURRENT PAPERS OF THE AERONAUTICAL RESEARCH COUNCIL. (1909-January 1954) 190p. (ARC R & M 2570)

MISCELLANEOUS

NACA Rept. 1165

Errata on "UNSTEADY OBLIQUE INTERACTION OF A SHOCK WAVE WITH A PLANE DISTURBANCE". Franklin K. Moore. 1954.

N-35053*

FIFTY YEARS OF BOUNDARY LAYER THEORY AND EXPERIMENT. Hugh L. Dryden. (Presented at meeting of Fluid Dynamics Div., Amer. Physical Soc., Hotel Chamberlin, Old Point Comfort, Va., Nov. 23, 1954). 17p.

This paper summarizes boundary-layer theory and experiment since Prandtl's boundary-layer theory was presented 50 years ago. It tells the story of the development of the new concept, its slow acceptance and growth, and its spread from group to group within the country of origin and its diffusion to other countries of the world.

UNPUBLISHED PAPERS

N-35089*

THE S. N. E. C. M. A. TRANSONIC WIND TUNNEL. (La Soufflerie Transsonique de la S. N. E. C. M. A.). O. Frenzl. November 1954. 30p. diagrs., photos. (Trans. from Docaero, no.23, Sept., 1953, p. 1-18)

The new S. N. E. C. M. A. wind tunnel is operated by a vapor ejector. After a discussion of its principle, the report describes the air reheater with gravel designed to prevent condensation, the antiturbulence grid, the test section with semiguided jet of 400 x 600 rectangular cross section, of 2.70 m in length, the control valves, the ejector, the diffuser, and the steam accumulator. The three-component wind-tunnel balance with six pressure cells, the schlieren apparatus, the Mach meter, and multiple pressure gage are briefly discussed, and the more particularly satisfactory results of the first tests are reported.

N-35126*

Cornell University, Graduate School of Aeronautical Engineering. ON THE GROWTH OF PLASTIC DEFORMATION IN A BAR SUBMITTED TO LONGITUDINAL IMPACT. C. Riparbelli. January 1953. 41p. diagrs. (Cornell University, Graduate School of Aeronautical Engineering)

The deformation of a semi-infinite bar submitted to end impact is computed step-by-step, each step corresponding to one element of a bar and to one time interval. At every step, two phases are considered: (a) propagation of the deformation wave as if it were elastic, (b) increment of deformation due to creep.

N-35237*

Cornell University, Graduate School of Aeronautical Engineering. DISTRIBUTION OF STRESS, STRAIN, VELOCITY IN A BAR OF NON-UNIFORM CROSS-SECTION UNDERGOING LONGITUDINAL IMPACT IN THE PLASTIC RANGE. Carlo Riparbelli. May 15, 1954. 77p. diagrs., photos. (Cornell University, Graduate School of Aeronautical Engineering)

A method for computing the distribution of stress, strain, and velocity in a bar of nonuniform cross section in the plastic domain is offered. This is based on the separate computation of two simultaneous phenomena, namely, propagation of elastic strain component, taking into account the taper effect, and plastic flow. The computation is performed step-by-step and the above said two phases are considered at each step. The distribution of plastic strain is thus predicted under the assumption of its being irreversible. Comparison is offered with distributions of plastic strain from experiments on copper bars of nonuniform cross section.

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National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1156

EXPERIMENTS TO DETERMINE NEIGHBORHOOD REACTIONS TO LIGHT AIRPLANES WITH AND WITHOUT EXTERNAL NOISE REDUCTION. Fred S. Elwell, Aeronautical Research Foundation. 1953. ii, 43p. diagrs., photos., 12 tabs. (NACA Rept. 1156. Formerly TN 2728)

Experiments to determine neighborhood reactions to the noise of light airplanes with and without noise-reduction equipment were conducted at a number of sites which might be convenient locations for landing strips within the metropolitan area of Boston, Mass. Two standard airplanes and two airplanes modified by reduction gears, four-bladed propellers, and engine exhaust silencers were used. Flights were made close to residential properties of varying income levels, population densities, and proximity to trade centers in order to determine whether the degree of noise reduction previously found to be aerodynamically and structurally practicable produced a significant reduction in neighborhood objections to such aircraft operations.

NACA Rept. 1157

ANALYTICAL DERIVATION AND EXPERIMENTAL EVALUATION OF SHORT-BEARING APPROXIMATION FOR FULL JOURNAL BEARINGS. George B. DuBois and Fred W. Ocvirk, Cornell Univ. 1953. ii, 32p. diagrs., photos., 4 tabs. (NACA Rept. 1157. Formerly TN 2808; TN 2809)

An approximate analytical solution including the effect of end leakage from the oil film of short plain bearings is presented because of the importance of endwise flow in sleeve bearings of the short lengths commonly used. The analytical approximation is supported by experimental data and includes the endwise flow and that part of the circumferential flow which is related to surface velocity and film thickness. Methods are also discussed for approximating a maximum bearing temperature for pressure-lubricated bearings and for evaluating the effect of deflection in misalinement on the eccentricity ratio at the ends of a bearing.

NACA Rept. 1166

RELATION BETWEEN ROUGHNESS OF INTERFACE AND ADHERENCE OF PORCELAIN ENAMEL TO STEEL. J. C. Richmond, D. G. Moore, H. B. Kirkpatrick and W. N. Harrison, National Bureau of Standards. 1954. ii, 9p. diagrs., photos., 7 tabs. (NACA Rept. 1166. Formerly TN 2934)

The relationship between adherence and roughness of interface between enamel and iron was studied. Porcelain-enamel ground coats were prepared and applied under conditions that gave various degrees of adherence. The variations were produced by (a) varying the amount of cobalt-oxide addition in the frit; (b) varying the type of metallic-oxide addition in the frit, keeping the amount constant at 0.8 weight percent; (c) varying the surface treatment of the metal before application of the enamel, by pickling, sandblasting, and polishing; and (d) varying the time of firing of the enamel containing 0.8 percent of cobalt oxide. A positive correlation was found between adherence and roughness of the interface.

NACA Rept. 1180

THEORETICAL STUDY OF THE TRANSONIC LIFT OF A DOUBLE-WEDGE PROFILE WITH DETACHED BOW WAVE. Walter G. Vincenti and Cleo B. Wagoner. (Portions of this work were reported at the eighth International Congress on Theoretical and Applied Mechanics, Istanbul, Turkey, August 20-28, 1952). 1954. ii, 24p. diagrs., 2 tabs. (NACA Rept. 1180. Formerly TN 2832)

Numerical calculations are described of the aerodynamic characteristics at small angle of attack of a thin, doubly symmetrical, double-wedge profile in the range of supersonic flight speed in which the bow wave is detached. The analysis is carried out within the framework of the transonic (nonlinear) small-disturbance theory. The following results are provided as functions of the transonic similarity parameter: (1) chordwise lift distribution, (2) lift-curve slope, and (3) position of center of lift.

NACA RM E53E29

IGNITION-DELAY DETERMINATIONS OF FURFURYL ALCOHOL AND MIXED BUTYL MERCAPTANS WITH VARIOUS WHITE FUMING NITRIC ACIDS USING MODIFIED OPEN-CUP AND SMALL-SCALE ROCKET ENGINE APPARATUS. Dezso J. Ladanyi, Riley O. Miller and Glen Hennings. February 1955. 17p. diagrs., photos., 4 tabs. (NACA RM E53E29)

Approximate linear relations were obtained when the logarithm of ignition delay was plotted against the reciprocal of absolute temperature for furfuryl alcohol and white fuming nitric acid (16 percent water) in the small-scale rocket engine (approximately 50 lb thrust) and for mixed butyl mercaptans and white fuming nitric acid (2 percent water) in the modified open-cup apparatus. Zero-temperature coefficients of ignition delay were obtained for furfuryl alcohol and white fuming nitric acid (2 percent water) in both apparatus for the temperature ranges investigated.

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NACA RM E54K10

SOME MEASUREMENTS OF BOILING BURN-OUT. Warren H. Lowdermilk and Walter F. Weiland. February 1955. 18p. diagrs., photo., 3 tabs. (NACA RM E54K10)

Measurements of boiling burnout heat flux for water flowing upward through an electrically heated tube were obtained for ranges of velocity from 0.1 to 19 feet per second; pressure from atmosphere to 2000 pounds per square inch; length-diameter ratios of 25, 37.5, and 50; and inlet subcooling from zero to 400° F. Unsteady flow was obtained for burnout conditions with a restriction located downstream of the point of burnout. A compressible fluid plenum chamber located between the restriction and the exit of the test section resulted in steady-flow burnout with a tenfold increase in the burnout heat flux.

NACA RM E54L10

MEASURED EFFECTIVE THERMAL CONDUCTIVITY OF URANIUM OXIDE POWDER IN VARIOUS GASES AND GAS MIXTURES. J. S. Boegli and R. G. Deissler. March 1955. 20p. diagrs., tab. (NACA RM E54L10)

This study was undertaken as part of a series of investigations to determine the effective conductivity of UO_2 powder with a density of 59.5 percent of the density of the solid UO_2 at temperatures between 200° and 1500° F. Experimental effective conductivities of the gas-powder mixtures were determined for helium, argon, and nitrogen gases, and mixtures of helium-argon and xenon-krypton gases. All tests were performed at a gas pressure above the breakaway pressure, where the thermal conductivity is independent of pressure. A method for determination of the relative thermal conductivity of the solid was devised from knowledge of the effective conductivity of the powder and the conductivity of the gases used in the two-phase system. This method was applied to the UO_2 used in this investigation.

NACA TM 1340

LIFT ON A BENT, FLAT PLATE. (Auftrieb einer geknickten ebenen Platte). F. Keune. February 1955. 15p. diagrs. (NACA TM 1340. Trans. from Bericht der Aerodynamischer Versuchsanstalt Göttingen. Luftfahrtforschung, Mar. 20, 1936, Annual Volume, p. 85-87)

The lift on a bent, flat plate is calculated exactly by the use of conformal mapping. Results are presented in terms permitting direct determination of the angle of zero lift, the lift coefficient, and the lift-curve slope for any flap-chord ratio, flap-deflection angle, and angle of attack.

NACA TM 1370

SOME MEASUREMENTS OF TIME AND SPACE CORRELATION IN WIND TUNNEL. (Quelques Mesures de Corrélation Dans le Temps et L'Espace en Soufflerie). A. Favre, J. Gaviglio and R. Dumas. February 1955. 21p. diagrs. (NACA TM 1370. Trans. from La Recherche Aéronautique, no. 32, Mar.-Apr., 1953, p. 21-28).

Results are presented of research obtained by means of an apparatus for measurement of time and space correlation and of a spectral analyser in the study of the longitudinal component of turbulence velocities in a wind tunnel downstream of a grid of meshes. Application to the case of a flat-plate boundary layer is illustrated. These researches were made at the Laboratoire de Mécanique de l'Atmosphère de l'I. M. F. M. for the O. N. E. R. A.

NACA TN 3281

INTERGRANULAR CORROSION OF HIGH-PURITY ALUMINUM IN HYDROCHLORIC ACID. I - EFFECTS OF HEAT TREATMENT, IRON CONTENT, AND ACID COMPOSITION. M. Metzger and J. Intrater, Columbia University. February 1955. 38p. photos., 8 tabs. (NACA TN 3281)

The intergranular corrosion of high-purity aluminum in hydrochloric acid was studied as a function of iron content, heat treatment, and acid composition under conditions where the rate of intergranular penetration was of the order of 1 millimeter per week. The behavior of specimens quenched to retain a single-phase structure indicated the rate of attack on the high-angle grain boundaries to be influenced by the segregation in these boundaries of iron and possibly other impurity atoms.

NACA TN 3322

AN ACCURATE AND RAPID METHOD FOR THE DESIGN OF SUPERSONIC NOZZLES. Ivan E. Beckwith and John A. Moore. February 1955. 57p. diagrs., 3 tabs. (NACA TN 3322)

A procedure is given for designing two-dimensional nozzles in which the streamline coordinates are computed directly from tabulated flow parameters and appropriate equations. The method of characteristics was used to obtain the first part of the flow which consists of a continuous expansion from a uniform sonic flow to a radial flow. The Foelsch equations are used for the transition from this radial flow to the final uniform flow. Information is presented which enables the designer to select and compute rapidly the wall contour for any nozzle or series of nozzles for a wide range of length-to-height ratio, Mach number, and wall angle at the inflection point.

NACA TN 3325

SIMILAR SOLUTIONS FOR THE COMPRESSIBLE LAMINAR BOUNDARY LAYER WITH HEAT TRANSFER AND PRESSURE GRADIENT. Clarence B. Cohen and Eli Reshotko. February 1955. 67p. diagrs., 2 tabs. (NACA TN 3325)

Stewartson's equations for the compressible laminar boundary layer with pressure gradient and heat transfer are solved for pressure gradients varying from that causing separation to the infinitely favorable gradient and for wall temperatures from absolute zero to twice the free-stream stagnation temperature. For the case of favorable pressure gradients with heated walls, it is shown that the velocity within a portion of the boundary layer must exceed the local external velocity. The variation of a Reynolds analogy parameter, which indicates the ratio of skin friction to heat transfer, is from zero to 7.4 for a surface of temperature twice the free-stream stagnation temperature and from zero to 2.8 for a surface held at absolute zero, where the value 2 applies to a flat plate.

NACA TN 3330

INGESTION OF FOREIGN OBJECTS INTO TURBINE ENGINES BY VORTICES. Lewis A. Rodert and Floyd B. Garrett. February 1955. 23p. diagrs., photos. (NACA TN 3330)

The ingestion of foreign objects by vortices formed between engine inlet and ground surface was investigated with a 5000-pound-thrust axial-flow jet engine. Pebbles, typical of objects that damage jet engines, were projected into the air by the vortices and were drawn into the engine by the high-velocity inlet-air stream. Vortex formation depended on engine speed, engine height, and surface wind. Pebbles lodged in surface cracks were more readily picked up than those exposed on a smooth surface. A motion-picture supplement may be obtained on loan from NACA Headquarters, Washington, D. C.

NACA TN 3339

EXPERIMENTS ON TURBULENT FLOW THROUGH CHANNELS HAVING POROUS ROUGH SURFACES WITH OR WITHOUT AIR INJECTION. E. R. G. Eckert, Anthony J. Diaguila and Patrick L. Donoughe. February 1955. 45p. diagrs., photos., tab. (NACA TN 3339)

Experiments were conducted to study the flow characteristics along porous rough surfaces with and without air injection for turbulent flow in a channel. Four degrees of roughness were studied with ratios of air-injection velocity to mainstream velocity from 0 to approximately 0.017. Velocity distributions along the rough porous surfaces and friction coefficients are presented.

NACA TN 3340

GENERALIZATION OF GAS-FLOW-INTERFEROMETRY THEORY AND INTERFEROGRAM EVALUATION EQUATIONS FOR ONE-DIMENSIONAL DENSITY FIELDS. Walton L. Howes and Donald R. Buchele. February 1955. 70p. diagrs., photos. (NACA TN 3340)

Generalized equations concerned with gas-flow interferometry are applied in developing interferogram evaluation equations for one-dimensional density fields. Theoretical limitations and systematic errors of the equations are investigated. Criteria for applicability and for avoiding apparent-ray-trace crossing are presented. The theory indicates that errors caused by an extended light source and test-section windows are negligible in practice. Analytical and experimental checks of the validity of the evaluation equations are presented. Theoretical results are compared with those of previous analyses.

NACA TN 3352

EXPERIMENTAL INVESTIGATION OF MISALINING COUPLES AND ECCENTRICITY AT ENDS OF MISALINED PLAIN BEARINGS. G. B. DuBois, F. W. Ocvirk and R. L. Wehe, Cornell University. February 1955. 81p. diagrs., photo., 3 tabs. (NACA TN 3352)

An experimental investigation was conducted to study the behavior of full journal bearings under steady load when acted on by a steady misalining couple. Displacements of the ends of the journal axis were measured with either an axial couple applied in the plane of the central load or a twisting couple in the plane normal to the central load. Oil-flow-rate and bearing-temperature measurements were also made to determine the effect of misalining couples on these quantities.

NACA TN 3355

PRELIMINARY INVESTIGATION OF A STICK SHAKER AS A LIFT-MARGIN INDICATOR. James P. Trant, Jr. February 1955. 19p. diagrs., photos. (NACA TN 3355)

Preliminary tests with simulator equipment were made to determine the ability of subjects to use frequency or amplitude of vibration of the pilot's control stick, or both, as an indicator for maintaining a desired lift margin below the stall. The results showed that the desired lift margin could probably be maintained, provided the allowable variation from the desired angle of attack or lift coefficient produced either changes in amplitude of vibration of about 100 percent or changes in frequency of 40 percent, or both.

NACA TN 3368

ANALYSIS OF BEHAVIOR OF SIMPLY SUPPORTED FLAT PLATES COMPRESSED BEYOND THE BUCKLING LOAD INTO THE PLASTIC RANGE. J. Mayers and Bernard Budiansky. February 1955. 44p. diagrs. (NACA TN 3368)

An analysis is presented of the postbuckling behavior of a simply supported square flat plate with straight edges compressed beyond the buckling load into the plastic range. The method of analysis involves the application of a variational principle of the deformation theory of plasticity in conjunction with computations carried out on a high-speed calculating machine. Numerical results are obtained for several plate proportions and for one material. The results indicate plate strengths greater than those that have been found experimentally on plates that do not satisfy straight-edge conditions.

NACA TN 3369

MINIMUM-DRAG BODIES OF REVOLUTION IN A NONUNIFORM SUPERSONIC FLOW FIELD. Conrad Rennemann, Jr. February 1955. 25p. diagrs. (NACA TN 3369)

A general expression for the cross-sectional-area distribution of the minimum-drag body of revolution of given volume and length in a nonuniform supersonic flow field is derived on the basis of linearized theory. This result is applied to the determination of the minimum-drag body of revolution of given volume and length located in the flow field of a parabolic body of revolution. The interference pressures from a main body acting on a satellite body have a negligible effect on the shape for minimum wave drag of the satellite body.

NACA TN 3371

ANALYSIS OF ACCELERATIONS, GUST VELOCITIES, AND AIRSPEEDS FROM OPERATIONS OF A TWIN-ENGINE TRANSPORT AIRPLANE ON A TRANSCONTINENTAL ROUTE FROM 1950 TO 1952. Thomas L. Coleman and Walter G. Walker. February 1955. 16p. diagrs., 3 tabs. (NACA TN 3371)

VGH time-history data obtained from one type of twin-engine transport airplane during operations from 1950 to 1952 on a transcontinental route are analyzed in order to determine the magnitude and frequency of occurrence of gust accelerations, gust velocities, and the associated airspeeds and altitudes. The present results compared favorably with results previously obtained for a similar type of twin-engine airplane during other operations. The present operations indicate a less severe acceleration history than that shown for the other airplane, apparently because of the lower operating airspeed in rough air.

NACA TN 3389

AXIALLY SYMMETRIC SHAPES WITH MINIMUM WAVE DRAG. Max. A. Heaslet and Franklyn B. Fuller. February 1955. 46p. diagrs. (NACA TN 3389)

Optimum bodies consisting of a basic cylinder with added peripheral volume are derived and presented in terms of the effective radius-length ratio. Variation of this parameter from 0 to ∞ encompasses the spectrum of results from slender to two-dimensional. A reciprocal theorem leads to simple interpretations of variational problems.

NACA TN 3396

ICING LIMIT AND WET-SURFACE TEMPERATURE VARIATION FOR TWO AIRFOIL SHAPES UNDER SIMULATED HIGH-SPEED FLIGHT CONDITIONS. Willard D. Coles. February 1955. 33p. diagrs., photos. (NACA TN 3396)

The variation of wet-surface temperature and the conditions that will result in ice-free surfaces for high-speed flight through clouds were investigated experimentally. The results are compared with calculated values obtained with an analytical method. The analytical results were generally conservative, giving wet-surface temperatures 2° to 4° F lower than the experiments and predicting the formation of ice at values of ambient-air temperature up to 12° F higher than the experiments. The location of analytically determined critical regions on the bodies for the initial formation of ice was experimentally substantiated.

NACA TN 3397

AN EVALUATION OF NON-NEWTONIAN FLOW IN PIPE LINES. Ruth N. Weltmann. February 1955. 40p. diagrs., tab. (NACA TN 3397)

An analysis is presented of a method for determining pressure losses due to the flow of non-Newtonian materials in pipe lines by using basic flow data obtained from measurements of flow curves, which are rate-of-shear - shearing-stress curves. The advantages of properly designed rotational viscometers over capillary viscometers for measuring these flow curves and interpreting them to obtain the basic flow parameters are discussed. Dimensionless parameters are calculated from these basic flow data and are used to construct a generalized friction diagram to describe the flow characteristics of Newtonian and non-Newtonian materials in pipe lines.

NACA TN 3398

A THERMAL EQUATION FOR FLAME QUENCHING. A. E. Potter, Jr. and A. L. Berlad. February 1955. 18p. diagrs., tab. (NACA TN 3398)

A thermal quenching equation is derived; the equation is essentially an extension of a previously proposed diffusional concept. By proper choice of the rate-controlling chemical reaction, the equation becomes suitable for use with rich as well as lean fuel-air mixtures. The equation was tested, using published quenching-distance data for propane-oxygen-nitrogen flames, which include the effect of oxygen-nitrogen ratio, equivalence ratio, pressure, and initial temperature.

NACA TN 3402

BOUNDARY LUBRICATION OF STEEL WITH FLUORINE- AND CHLORINE-SUBSTITUTED METHANE AND ETHANE GASES. S. F. Murray, Robert L. Johnson and Max A. Swikert. February 1955. 17p. photos., diagrs., 2 tabs. (NACA TN 3402)

Sliding-friction experiments were made with steel surfaces in atmospheres of halogenated gases. Under the conditions of this investigation, the most stable or fully fluorinated gases gave no surface protection. Several fluorinated compounds containing two or more chlorine atoms per molecule served as effective boundary lubricants (reduced friction and prevented excessive wear, surface welding, and metal transfer) in a manner comparable with a conventional liquid lubricant. Run-in procedure, bearing materials, and moisture availability appear to be critical in boundary lubrication by gaseous materials.

NACA TN 3405

TEMPERATURE-COMPOSITION LIMITS OF SPONTANEOUS EXPLOSION FOR NINE ALKYLSILANES WITH AIR AT ATMOSPHERIC PRESSURE. Rose L. Schalla and Glen E. McDonald. February 1955. 13p. diagrs. (NACA TN 3405)

To provide safe-handling information, the spontaneous explosion limits of nine alkylsilanes were determined as a function of temperature and fuel-air composition at a pressure of 1 atmosphere. Over a fuel concentration range of about 2 to 9 percent by volume, the fuels studied were nonexplosive below the following temperatures: tetramethylsilane $(CH_3)_4Si$, 450° C; trimethylsilane $(CH_3)_3SiH$, 300° C; diethylsilane $(C_2H_5)_2SiH_2$, 255° C; dimethylsilane $(CH_3)_2SiH_2$, 220° C; ethylsilane $(C_2H_5)SiH_3$, 215° C; isobutylsilane $(i\text{-}C_4H_9)SiH_3$, 200° C; n-butylsilane $(n\text{-}C_4H_9)SiH_3$, 185° C; methylsilane $(CH_3)SiH_3$, 125° C; and vinylsilane $H_2C = CH\text{-}SiH_3$, 90° C.

NACA TN 3409

CHAIN BREAKING AND BRANCHING IN THE ACTIVE-PARTICLE DIFFUSION CONCEPT OF QUENCHING. Frank E. Belles and A. L. Berlad. February 1955. 37p. diagrs., 3 tabs. (NACA TN 3409)

General quenching-distance equations that take into account gas-phase chain breaking and branching and

the effect of the wall efficiency for destruction of active particles are derived as extensions of the original simple theory of quenching by diffusion of active particles. The general characteristics of the equations are discussed. Quenching distance data from the literature for propane-oxygen-nitrogen mixtures are treated in a consistent manner. The effects of elevated initial mixture temperature are predicted and agree qualitatively with observed trends. It is found that the simple theory correlates all the data satisfactorily.

BRITISH REPORTS

N-34309*

Royal Aircraft Establishment (Gt. Brit.)
METHODS OF DETERMINATION AND OF FIXING BOUNDARY LAYER TRANSITION ON WIND TUNNEL MODELS AT SUPERSONIC SPEEDS. K. G. Winter, J. B. Scott-Wilson and F. V. Davies. September 1954. 27p. diagrs., photos. (RAE Tech. Note Aero 2341)

An account is given of methods used in supersonic wind tunnels for observation of boundary-layer phenomena, in particular of the sublimation and oil film techniques. Examples are given of the uses of these techniques. On the fixing of transition, a rough guide is given for the minimum size of wire required, with an example of the use of wires. The results of a brief experiment on the profile of an artificially promoted turbulent boundary layer are given.

N-34820*

Royal Aircraft Establishment (Gt. Brit.)
SOME NOTES ON A PROPOSAL TO USE A BLOWER TUNNEL FOR VISION IN RAIN TESTS ON AIRCRAFT WINDSCREENS. F. J. Bigg. September 1954. 16p. diagrs., 2 tabs. (RAE Tech. Note Mech. Eng. 187)

For research work on vision through aircraft windscreens in rain, it has been suggested many times that ground tests should be made using a blower tunnel with simulated rain. This note describes some tests and calculations, which have recently been made, from which it has become apparent that it is not possible to produce realistic rain conditions by this method. The possibility of using a large vertical wind tunnel has also been considered theoretically and it is concluded that this would also be impracticable.

N-34821*

Royal Aircraft Establishment (Gt. Brit.)
DEVELOPMENT OF AN AIR MASS-FLOW RATE METER. W. J. G. Cox. October 1954. 47p. diagrs., photos. (RAE Tech. Note Instn. 142)

The development of an air mass flow rate meter to cover a very wide range is described which, essentially an analogue computer, gives a two-sweep pointer direct presentation of air mass flow rate, independent of pressure, temperature, and velocity changes within the range of the instrument. The pointers are driven by a servo system which is error-actuated from the computing bridge network, secondary feedback being employed to maintain stability with a saturated angular output rate of approximately 33° per second. Specifications and performance figures are given for the individual transducer elements and the complete instrument, error estimations are made, and the servo stability is discussed.

N-34849*

Royal Aircraft Establishment (Gt. Brit.)
THEORETICAL LOAD DISTRIBUTIONS ON FIN-BODY-TAILPLANE ARRANGEMENTS IN A SIDE-WIND. J. Weber and A. C. Hawk. August 1954. 113p. diagrs., 6 tabs. (RAE Aero 2518)

A theory is developed for calculating the distributions of side force and lift on fin-fuselage-tailplane arrangements in a sidewind but with the tailplane set at zero angle of attack. The results can be extended to other arrangements and to compressible subcritical flow and are required for stability and stressing analysis. This paper is a continuation of a report in which the interference between fin and fuselage was considered. The addition of the tailplane brings changes in the load distribution as well as in the overall forces. The main functions needed for representative cases are given in tables and charts. Results for other geometrical arrangements can be obtained by interpolation.

N-34878*

Aeronautical Research Council (Gt. Brit.)
THE CRITICAL WHIRLING SPEEDS AND NATURAL VIBRATIONS OF A SHAFT CARRYING A SYMMETRICAL ROTOR. E. Downham. 1954. 13p. diagrs., photo. (ARC R & M 2854; ARC 13,917. Formerly RAE Structures 97)

The experiments described in this report are part of a program of model experiments designed to establish an accurate method for calculating the critical whirling speeds of complex systems. The critical whirling speeds and natural vibrations of a single shaft flexibly supported and carrying a flexible rotor of appreciable moment of inertia have been investigated and good agreement has been obtained between experimental and calculated results for the rotating system.

N-34879*

Aeronautical Research Council (Gt. Brit.)
THE INFLUENCE OF ROLLING MOMENTS ON SPIN RECOVERY AS OBSERVED IN MODEL-SPINNING TESTS. D. J. Harper. 1954. 13p. diagrs., tab. (ARC R & M 2831; ARC 13,538. Formerly RAE Aero 2365)

Several aspects of model-spinning test technique have been brought into prominence by full-scale developments. Correlation between model and full-scale recoveries has been poor in some cases, and it appears that full-scale recovery may depend on some other means in addition to the normal use of rudder and elevator. Analysis of data shows the effects of applied rolling moments and of aileron deflections on both spin and recovery to be closely related to the distribution of loading of the aircraft. The ordinary model-test result can be in error due to scale effects on rolling moments. This report collects the available model data on the effects of applied rolling moments, and also includes model data on the use of ailerons to assist recovery.

N-34880*

Aeronautical Research Council (Gt. Brit.)
THEORETICAL SUPERSONIC DRAG OF NON-LIFTING INFINITE-SPAN WINGS SWEPT BEHIND THE MACH LINES. T. Nonweiler. 1954. 22p. diagrs., 3 tabs. (ARC R & M 2795; ARC 13,896. Formerly RAE Tech. Note Aero 2073)

The wing section is assumed to be arbitrary but identical over the entire wing span. The drag is found according to the linear equations of supersonic flow by considering the flow due to a system of superposed source planes. The drag is found to be finite and the effect of the speed of flight independent of the section shape assumed. The variation of drag with the section shape is shown to be proportional to the integral over the chord of the product of the local wing thickness and the value of the excess pressure existing in incompressible flow at the same position. Methods of reducing drag by changing the section shape are considered.

N-34928*

Royal Aircraft Establishment (Gt. Brit.)
TRIALS OF 3 FT. DROGUE TARGET. D. R. Bettison and A. Eldridge. August 1954. 14p. diagrs., photo., 4 tabs. (RAE Tech. Note Mech. Eng. 185)

It was established by flight trials that the 1-ft 6-in. throat x 3-ft tail x 15-ft long drogue target manufactured in R. F. D. 3272/N nylon rip-stop is satisfactory for speeds up to 300 kts I. A. S. D. T. D. 778 material is inadequate for present requirements for all drogue sizes, and it recommended that it be replaced by a stronger material.

N-34929*

Royal Aircraft Establishment (Gt. Brit.)
SOLUTION OF AERO-ELASTIC PROBLEMS BY MEANS OF INFLUENCE COEFFICIENTS. D. Williams. November 1954. 12p. diagr. (RAE Structures 169)

It is shown that, on the basis of the data provided by two sets of influence coefficients for a wing (or other surface) - and "elastic" set giving deflections (and hence incidence angles) in terms of applied loads, and an aerodynamic set giving aerodynamic loads in terms of incidence angles - all "static" aeroelastic problems can easily and expeditiously be solved by the use of a digital computer. It is also suggested that the same method of approach may well be used for solving oscillatory aeroelastic problems such as flutter.

N-34930*

Nat. Gas Turbine Establishment (Gt. Brit.)
A NOTE ON THE COOLING OF TURBINE ROTOR BLADES BY WATER JETS. K. R. F. Kenworthy. October 1954. 6p. (NGTE Memo. M. 227)

Experimental work at N. G. T. E. on "spray" or "jet" cooling is reviewed and a performance estimate given in comparison with air cooling. It is shown that the gains realizable as a result of the higher maximum cycle temperature are much the same in the two cases. The detrimental effects of the water and, in aircraft applications, the weight of water to be carried lead to the conclusion that spray cooling is inferior to air cooling.

N-34931*

Royal Aircraft Establishment (Gt. Brit.)
THE SLIP BAND EXTRUSION EFFECT IN COLD ROLLED, SUPER PURITY ALUMINUM. C. A. Stubbington and P. J. E. Forsyth. October 1954. 7p. photos. (RAE Tech. Note Met. 205)

It has been found that by cold rolling pure aluminum to a suitable degree, a slip band extrusion effect can be produced by subsequent fatigue stressing. This effect has been shown to be due to local recrystallization producing soft regions along slip striations, and is analogous to the soft regions produced in aluminum -4 percent copper by accelerated overaging under the action of fatigue stresses.

N-34934*

Royal Aircraft Establishment (Gt. Brit.)
INTRODUCTORY NOTES TO THE PROBLEMS OF AERODYNAMIC HEATING. R. J. Monaghan. October 1954. 19p. diagrs. (RAE Tech. Note Aero 2346)

This note gives a simplified discussion of the aerodynamic heating problems encountered in high-speed flight, illustrates their magnitude, and considers some means of alleviation. Although the temperatures for zero heat transfer between airstream and aircraft increase rapidly with increase of flight speed, some alleviation can be obtained by choosing a surface finish which loses heat freely by radiation. In addition, small thicknesses of external insulation could be extremely effective in protecting the main structure and the amounts of heat which enter the interior of the aircraft need not be excessive.

N-34936*

Royal Aircraft Establishment (Gt. Brit.)
AN ELECTROLYTIC METHOD FOR THE DIRECT PRODUCTION OF MAGNESIUM LITHIUM ALLOYS FROM LITHIUM CHLORIDE. J. Smolinski, J. C. Hannam and A. L. Leach. October 1954. 19p. diagrs., photos., 9 tabs. (RAE Met. 80)

Magnesium lithium alloys were made directly at high current efficiency by electrolytic deposition of lithium on to a magnesium cathode from a molten 50 $LiCl$/50 KCl or 75 $LiCl$/25 $BaCl_2$ electrolyte at 560° to 630° C. The relation between sodium contamination in electrolyte and product has been determined. By careful selection of cell materials to avoid sodium contamination, alloys ductile in the aged condition could be made directly without need of refining.

N-34937*

Royal Aircraft Establishment (Gt. Brit.)
A RATE GYRO FOR USE IN AIRCRAFT DYNAMIC RESPONSE WORK. Keith Smith. October 1954. 13p. diagrs., photos. (RAE Tech. Note Aero 2327)

An instrument to measure angular rate under dynamic conditions, used in conjunction with a galvanometer recorder, has been developed from the existing standard instrumentation rate gyro (Type IT 2-1). With a range of ±8° per second, it has considerably improved dynamic response characteristics. Tests on an oscillating table indicate that the response is flat (±2 percent of static value) up to 8 cycles per

second for an amplitude of $\pm 6^{o}$ per second. Tests at a smaller amplitude were impractical but it is suspected that under these conditions the presence of nonlinear dynamic characteristics might cause a less satisfactory response.

N-34938*

Royal Aircraft Establishment (Gt. Brit.)
THE DETERMINATION OF MAGNESIUM OXIDE IN MAGNESIUM. H. J. Allsopp. October 1954. 10p. diagr., 6 tabs. (RAE Met. 79)

In the method described, magnesium metal is removed by sublimation in vacuum, the residue dissolved in acid, and the magnesium content determined volumetrically by disodium ethylene diamine tetra-acetate.

N-34939*

Royal Aircraft Establishment (Gt. Brit.)
GEOMETRICAL ANALYSIS OF SCHLIEREN PHOTOGRAPHS OF THE FLOW IN THE PLANE OF INCIDENCE OF INCLINED CONE-CYLINDERS AT SUPERSONIC SPEEDS. K. G. Winter. November 1954. 15p. diagrs., photo., tab. (RAE Tech. Note Aero 2345)

Measurements have been made of shock wave positions shown on schlieren photographs of the flow past inclined cone-cylinders. The resulting angles and distances have been correlated to give a general method of estimating the positions of the nose shock waves. The method is satisfactory at Mach numbers between 1.4 and 2.0 for cone-cylinders of semiangle less than 15°, at incidences up to 30°, and is of use in the design of models for supersonic wind tunnels.

N-34950*

Royal Aircraft Establishment (Gt. Brit.)
AN INTEGRATING AMPLIFIER FOR INSTRUMENTATION. E. T. de la Perrelle. September 1954. 18p. diagrs. (RAE Tech. Note Instn. 144)

The note discusses the use and design of amplifiers the output of which resembles, in essential features, the integrand with respect to time of the input. The relations between the gain and phase displacement versus frequency characteristics required to produce the desired result are shown to be a compromise, which is realizable in practice. A feedback integrator, which attenuates at frequencies below the lower limit of integration, is analyzed and discussed.

N-34951*

Royal Aircraft Establishment (Gt. Brit.)
ACCURACY AND SLIP TESTS PERFORMED ON A SINE AND COSINE BALL RESOLVER. B. Pounder. October 1954. 12p. diagrs., photo. (RAE Tech. Note IAP 1034)

A description is given of the methods used and the results obtained from the tests performed on a 1-inch ball resolver under development by IAP department. The following tests were performed: accuracy of resolution on no load; percentage slip of the output shafts for several applied torques and different angles; and the torque required to drive the input shaft for several values of the output load.

N-34953*

Royal Aircraft Establishment (Gt. Brit.)
NOTES ON THE INTERNATIONAL SYMPOSIUM ON MACROMOLECULAR CHEMISTRY HELD AT MILAN AND TURIN, 26TH SEPTEMBER - 2ND OCTOBER, 1954. W. W. Wright. November 1954. 19p. (RAE Tech. Note Chem. 1239)

General comments on a group of papers being followed by more detailed accounts of those papers appearing to the author to be of greater interest are given. A list of all the papers presented at this conference on macromolecular chemistry is given, and those available as preprints are marked.

N-34956*

Royal Aircraft Establishment (Gt. Brit.)
A GENERAL METHOD (DEPENDING ON THE AID OF A DIGITAL COMPUTER) FOR DERIVING THE STRUCTURAL INFLUENCE COEFFICIENTS OF AEROPLANE WINGS. D. Williams. November 1954. 32p. diagrs., tab. (RAE Structures 168)

A general method (requiring the aid of a digital computer) is described for deriving the influence coefficients of any type of wing, and hence for evaluating its strength and stiffness characteristics. The method allows for shear deflections, and hence implicitly takes account of effects like shear-lag and warping of wing cross-sections. A rapid method accurate enough to serve as a basis for dynamical calculations is first described, and secondly a more rigorous method on which to base final stressing of the structure.

N-34957*

Royal Aircraft Establishment (Gt. Brit.)
STUDIES OF FLAMES BURNING WITH CHLORINE TRIFLUORIDE. G. Skirrow, R. A. M. Straker and H. G. Wolfhard. September 1954. 19p. diagr., photos., tab. (RAE RPD 22)

Diffusion flames are described in which fuels such as hydrogen, carbon monoxide, carbon disulphide, water, ammonia, hydrocarbons, and organic halides are burnt with chlorine trifluoride. Chemical equilibrium is nearly established in the main reaction zone as in an oxygen diffusion flame but the chlorine trifluoride flames possess several unusual features. Carbon formation is very heavy with hydrocarbon fuels and it may even impair combustion. Radicals such as C_2 and CN have an unusually long lifetime and their presence in a high-temperature region enhances the luminosity of some of the flames. It is suggested that the persistence of these radicals may be due to the very rapid diffusion of hydrogen into the main reaction zone which effectively prevents the penetration of fluorine to the fuel side of the flame.

N-34959*

Royal Aircraft Establishment (Gt. Brit.)
THE CALCULATION OF THE PRESSURE DISTRIBUTION ON THICK WINGS OF SMALL ASPECT RATIO AT ZERO LIFT IN SUBSONIC FLOW. J. Weber. September 1954. 66p. diagrs., 4 tabs. (RAE Aero 2519)

The method of expressing the velocity increment over airfoils directly in terms of the section ordinates is extended to cover also straight and swept

wings of finite aspect ratio. The wings considered are untapered in plan form but may be tapered in thickness. The section can be of any given shape. Coefficients required in the calculation are tabulated for the center section of straight and sweptback wings of aspect ratios 0.5, 1, 2, and 4. The remaining calculations can be made very quickly. Since wings of very small aspect ratio can be treated also by the method of slender-body theory, the relations between linear theory, slender-body theory, and linearized slender-body theory are discussed.

N-34964*

Royal Aircraft Establishment (Gt.Brit.)
THE EFFECT OF ASPECT RATIO ON THE CHORDWISE LOAD DISTRIBUTION OF FLAT AND CAMBERED RECTANGULAR WINGS. J. Weber. October 1954. 40p. diagrs., 2 tabs. (RAE Aero 2525)

The report deals with the "first problem" of airfoil theory, that of determining the shape of the airfoil for a given load distribution. The downwash integral over wing and wake, which is involved in this calculation, is reduced to a very simple form which permits a rapid numerical evaluation for wings of rectangular plan form. This method has been used to check the accuracy of the results of various methods of calculation for small aspect ratio plane rectangular wings by inserting the calculated load distributions into the downwash equation and determining the airfoil shape which is then compared with the plane wing, for which the load distribution was calculated.

N-34965*

Royal Aircraft Establishment (Gt. Brit.)
THE PRESSURE DISTRIBUTION, (ACCORDING TO THE LINEAR THEORY), ON THE GROUND DUE TO A DELTA WING IN STEADY LEVEL SUPERSONIC FLIGHT. G. M. Roper. November 1954. 45p. diagrs. (RAE Tech. Note Aero 2332)

Effects of angle of attack and thickness are calculated separately, and the results are superimposed. Calculations are made for delta wings of single-wedge section and double-wedge section. The results are given in graphic form. The results can only be expected to give a very rough indication of the actual pressure distribution, since the fluid medium is assumed to be homogeneous, and no account is taken of shock waves. More recent work suggests that, in general, the pressures are overestimated. In particular, no significance should be attached to the very high pressures that occur in the very small region immediately behind the Mach wave from the trailing edge.

N-34966*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF LOW TEMPERATURES ON THE FATIGUE AND TENSILE PROPERTIES OF SOME LIGHT ALLOYS, NOTCHED AND UNNOTCHED. N. J. F. Gunn. October 1954. 40p. diagrs., photo., 20 tabs. (RAE Tech.Note Met.207)

Fatigue and tensile tests have been made on six light alloys at room and sub-zero temperatures, to ascertain the increase in properties at the low temperatures. The materials used were aluminum alloys D.T.D. 683, D.T.D. 363A, D.T.D. 364B (with two different heat treatments) magnesium alloy Z3Z, and a 12 percent magnesium lithium binary alloy. It was found that the fatigue and tensile properties did improve at the low temperatures, but the percentage increase was not very great.

N-34968*

Ministry of Supply (Gt. Brit.)
EXPERIENCE OF FATIGUE AT WEYBRIDGE. H. H. Gardner. (Part one of final report prepared by Vickers-Armstrong, Ltd., Weybridge). November 1954. 37p. diagrs., photo. (Ministry of Supply. S & TM 10/54)

During 1942-44 a number of fatigue failures occurred on Wellington aircraft in service. The majority of failures occurred in main spar booms on the tension flanges, resulting in all cases in the loss of the aircraft and the complete crew. This report outlines the causes of these failures and describes the steps which were taken to modify the design, together with the experimental evidence which led to the final form of modification adopted. It is decided that the detail design of the joint was responsible for high stress concentrations at the base of the serrations, and the material of the spar tubes due to the method of manufacture contained high initial tension stresses which increased the tension stresses at the serrations to serious proportions.

MISCELLANEOUS

NACA TN 3263

Errata on "LIFT AND MOMENT EQUATIONS FOR OSCILLATING AIRFOILS IN AN INFINITE UNSTAGGERED CASCADE." Alexander Mendelson and Robert W. Carroll. October 1954.

UNPUBLISHED PAPERS

N-35236*

Cornell University, Graduate School of Aeronautical Engineering. THE KINETIC ASPECT OF PLASTICITY. C. Riparbelli. February 1954. 68p. diagrs., photo. (Cornell University, Graduate School of Aeronautical Engineering)

The aim of the present paper is that of collecting some of the information available on plastic flow, with particular attention to plastic flow in copper and to its relation to the stress and strain, in order to explain some phenomena observed in the propagation of strain in a bar undergoing longitudinal impact and to eliminate an apparent contradiction between two groups of data.

C. Day

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CURRENT NACA REPORTS

NACA Rept. 1179

A NOTE ON SECONDARY FLOW IN ROTATING RADIAL CHANNELS. James J. Kramer and John D. Stanitz. 1954. ii, 12p. diagrs. (NACA Rept. 1179. Formerly TN 3013)

A general vector differential equation for the vorticity component parallel to a streamline is derived for steady, nonviscous and incompressible flow in a rotating system. This equation is then simplified by restricting it to rotating radial channels and by making further simplifying assumptions. This simplified equation is used to solve for the secondary vorticity, the vorticity component parallel to the streamline, in three special cases involving different streamtube geometries; the results are presented in a series of figures. The secondary vorticity is shown to decrease with decreased absolute angular velocity of the fluid, decreased inlet total-pressure gradient, decreased length of relative flow path, and increased relative velocity.

NACA RM E54D13

A DROP TEST FOR THE EVALUATION OF THE IMPACT STRENGTH OF CERMETS. B. Pinkel, G. C. Deutsch and N. H. Katz. March 1955. 8p. diagrs., photo. (NACA RM E54D13)

The development of brittle high-temperature materials has focused attention on the impact resistance of these materials. This report describes a device for measuring very small values of impact resistance both at norm and elevated temperatures. The device is believed to eliminate extraneous energies, such as the "toss energy" from the impact strength. The method of testing consists of dropping a hammer from increasing heights so that it strikes near the free end of a cantilever beam specimen. The energy of the hammer when the specimen fractures is the impact strength. Representative values of the impact strengths of several high-temperature materials are given.

NACA TM 1382

STEADY PROPERLY-BANKED TURNS OF TURBOJET-PROPELLED AIRPLANES. (La Virata Corretta Stazionaria Degli Aeroplani Azionati da Turboreattori). Angelo Miele. March 1955. 33p. diagrs., tab. (NACA TM 1382. Trans. from Rivista Aeronautica, v.27, no.1, 1951, p.23-35)

The problem of a jet propelled airplane in a steady turn is analyzed for the case of parabolic and non-parabolic aircraft polars. A general solution is obtained and the special cases of maximum banked turn, maximum angular velocity turn and minimum radius turn are then investigated. A brief comparison of the jet and reciprocating propelled airplane is made. Compressibility effects are considered.

NACA TN 3336

REVIEW OF EXPERIMENTAL INVESTIGATIONS OF LIQUID-METAL HEAT TRANSFER. Bernard Lubarsky and Samuel J. Kaufmann. March 1955. 115p. diagrs., tab. (NACA TN 3336)

Experimental data of various investigators of liquid-metal heat-transfer characteristics were reevaluated using as consistent assumptions and methods as possible and then compared with each other and with theoretical results. The reevaluated data for both local fully developed and average Nusselt numbers in the turbulent flow region were found still to have considerable spread, with the bulk of the data being lower than predicted by existing analysis. An equation based on empirical grounds which represents most of the fully developed heat-transfer data is $Nu = 0.625\ Pe^{0.4}$ where Nu represents the Nusselt number and Pe the Peclet number. The theoretical prediction of the heat transfer in the entrance region was found to give lower values, in most cases, than those found in the experimental work.

NACA TN 3338

A DYE-TRACER TECHNIQUE FOR EXPERIMENTALLY OBTAINING IMPINGEMENT CHARACTERISTICS OF ARBITRARY BODIES AND A METHOD FOR DETERMINING DROPLET SIZE DISTRIBUTION. Uwe H. von Glahn, Thomas F. Gelder and William H. Smyers, Jr. March 1955. 73p. diagrs., photos., tab. (NACA TN 3338)

A dye-tracer technique has been developed from which the droplet impingement characteristics of bodies can be determined by colorimetric analysis. The technique is applicable to various wind tunnels provided the humidity of the air stream can be maintained near saturation. A method is also presented whereby the droplet size distribution of the impinging cloud may be determined by relating the experimental impingement characteristics of a body to the theoretical trajectory results for the same body.

NACA TN 3359

AN INVESTIGATION OF DRAINS DISCHARGING LIQUID INTO SUBSONIC AND TRANSONIC STREAMS. Allen R. Vick and Frank V. Silhan. March 1955. 54p. diagrs., photos., tab. (NACA TN 3359)

Results of an investigation on the characteristics of drains discharging liquid into an airstream at Mach numbers from 0.5 to 1.3 are presented in the form of surface stain patterns, schlieren photographs of the flow, and drag measurements for drains of circular, elliptical, and airfoil cross-sectional shapes. Variables whose influence have been investigated include Mach number, liquid reservoir pressure, drain extension, angle of sweep, and end shape. Vent pressure data are presented as differentials between the free-stream and drain static pressure for various tube configurations.

NACA TN 3362

ESTIMATES OF PROBABILITY DISTRIBUTION OF ROOT-MEAN-SQUARE GUST VELOCITY OF ATMOSPHERIC TURBULENCE FROM OPERATIONAL GUST-LOAD DATA BY RANDOM-PROCESS THEORY. Harry Press, May T. Meadows and Ivan Hadlock. March 1955. 48p. diagrs., 4 tabs. (NACA TN 3362)

Relations are derived between the peak gust loads experienced in airplane operations and the probability distribution of root-mean-square gust velocity. These relations are applied in the analysis of operational data on peak gust accelerations to derive estimates of the probability distribution of root-mean-square gust velocity. The application of these results to gust load calculations for other airplane operations is also considered briefly.

NACA TN 3365

AN ANALYSIS OF ACCELERATIONS, AIRSPEEDS, AND GUST VELOCITIES FROM THREE COMMERCIAL OPERATIONS OF ONE TYPE OF MEDIUM-ALTITUDE TRANSPORT AIRPLANE. Thomas L. Coleman, Martin R. Copp, Walter G. Walker and Jerome N. Engel. March 1955. 31p. diagrs., 4 tabs. (NACA TN 3365)

Time-history data obtained by the NACA VGH recorder from one model of a four-engine civil transport airplane during operations on three routes are analyzed to determine the magnitude and frequency of occurrence of gust velocities, gust and maneuver accelerations, and the associated airspeeds. Variations of the gusts and gust accelerations with route and flight condition are indicated. Estimates of the overall gust and gust-load histories for extended operations on one route are obtained by supplementing the data from the NACA VHG recorder with available data from the NACA V-G recorder.

NACA TN 3374

TURBULENT-HEAT-TRANSFER MEASUREMENTS AT A MACH NUMBER OF 2.06. Maurice J. Brevoort and Bernard Rashis. March 1955. 20p. diagrs., tab. (NACA TN 3374)

An axially symmetric annular nozzle was used to obtain essentially flat-plate data on turbulent heat-transfer coefficients and temperature-recovery factors. The test results of this paper are for Mach number 2.06 and for a Reynolds number range of 1.7×10^6 to 8.8×10^7. The heat-transfer-coefficient results are in good agreement with theoretical analyses and the experimental results of the tests of V-2 rockets. The recovery factors are approximately 0.5 percent lower than data for a Mach number of 2.4.

NACA TN 3375

A THEORY FOR PREDICTING THE FLOW OF REAL GASES IN SHOCK TUBES WITH EXPERIMENTAL VERIFICATION. Robert L. Trimpi and Nathaniel B. Cohen. March 1955. 69p. diagrs., photo. (NACA TN 3375)

The nonlinear characteristic differential equations applicable to a quasi-one-dimensional unsteady channel flow with friction and heat transfer are linearized and integrated in functional form for the particular study of small perturbations from ideal shock-tube flows. If the equivalence of unsteady-flow and steady-flow boundary layers is assumed, the theory, evaluated with an equivalent steady-flow turbulent-boundary-layer skin-friction coefficient, predicts that the shock attenuates with distance and that average values of static pressure, velocity, density, and Mach number in the hot gas increase with time at a fixed position, while average sonic speed is simultaneously decreasing with time. Experimental measurements of the shock attenuation with distance and static-pressure variation with time at a fixed position for diaphragm pressure ratios from approximately 4 to 18 gave good agreement with the theoretical predictions.

NACA TN 3377

FLIGHT MEASUREMENTS OF THE VELOCITY DISTRIBUTION AND PERSISTENCE OF THE TRAILING VORTICES OF AN AIRPLANE. Christopher C. Kraft, Jr. March 1955. 32p. diagrs., photos., tab. (NACA TN 3377)

Measurements have been made in flight of the velocity distribution and persistence of the trailing vortices of a propeller-driven fighter-type airplane. The vortices were marked in the atmosphere with smoke and were penetrated by a jet airplane equipped with a high-frequency angle-of-attack vane and a sensitive total-pressure instrument. Photographs of the trailing-vortex filaments were also made.

NACA TN 3380

STUDY OF EFFECTS OF MICROSTRUCTURE AND ANISOTROPY ON FATIGUE OF 24S-T4 ALUMINUM ALLOY. H. A. Lipsitt, G. E. Dieter, G. T. Horne and R. F. Mehl, Carnegie Institute of Technology. March 1955. 41p. diagrs., photos., 4 tabs. (NACA TN 3380)

This report presents the results of an investigation of the statistics of the effects of variation in microstructure (extruded and extruded plus recrystallized) on the fatigue properties of 24S-T4 aluminum alloy notched specimens tested in both the longitudinal and transverse directions.

NACA TN 3390

SECOND-ORDER SUBSONIC AIRFOIL-SECTION THEORY AND ITS PRACTICAL APPLICATION. Milton D. Van Dyke. March 1955. 50p. diagrs., 5 tabs. (NACA TN 3390)

Several recent advances in subsonic compressible flow theory are combined into a unified second-order theory for two-dimensional airfoils. Solutions are given for a number of profiles, and are compared with the results of other theories and of experiment. A straightforward computing scheme is outlined for calculating the pressures on any airfoil at any angle of attack.

NACA TN 3391

FREE-FLIGHT MEASUREMENTS OF TURBULENT-BOUNDARY-LAYER SKIN FRICTION IN THE PRESENCE OF SEVERE AERODYNAMIC HEATING AT MACH NUMBERS FROM 2.8 TO 7.0. Simon C. Sommer and Barbara J. Short. March 1955. 47p. diagrs., photos., 2 tabs. (NACA TN 3391)

Measurements of average skin friction of the turbulent boundary layer have been made in free flight at high rates of heat transfer at high Mach numbers. The results are appreciably higher than zero-heat-transfer wind-tunnel data. The T' method for laminar boundary layers, slightly modified, is shown to agree with results of this and other investigations at widely different Mach numbers and heat-transfer conditions.

NACA TN 3399

A RAPID APPROXIMATE METHOD FOR THE DESIGN OF HUB SHROUD PROFILES OF CENTRIFUGAL IMPELLERS OF GIVEN BLADE SHAPE. Kenneth J. Smith and Joseph T. Hamrick. March 1955. 26p. diagrs., 3 tabs. (NACA TN 3399)

A rapid approximate method for the design of centrifugal compressors of given blade shape with compressible nonviscous flow characteristics has been developed using techniques based upon stream-filament theory. Axial symmetry is assumed, but meridional-plane forces derived from tangential pressure gradients are included. The method was applied to the design of an impeller in order to determine the approximate maximum meridional streamline spacing that could be used. Three numerical solutions for different streamline spacings were made using the same hub profile, blade shape, and prescribed velocity distribution along the hub. The shroud profiles obtained from the three solutions, which utilized 3, 5, and 9 streamtubes, were negligibly different. The approximate computing time required was 15 hours per streamtube.

NACA TN 3400

ANALYSIS OF ERRORS INTRODUCED BY SEVERAL METHODS OF WEIGHTING NONUNIFORM DUCT FLOWS. DeMarquis D. Wyatt. March 1955. 40p. diagrs. (NACA TN 3400)

Three typical duct flow profiles have been numerically analyzed to determine the errors introduced by commonly used averaging methods in the resultant uniform-flow properties. The analysis covers a range of subsonic duct Mach numbers, but is confined to flows having uniform static pressure and total temperature. An averaging method is developed which yields uniform properties that satisfy the integrated mass and momentum of the nonuniform flow. In contrast, it is shown that commonly used averaging methods introduce inherent errors which may markedly affect the validity of duct flow calculations.

NACA TN 3401

LAMINAR BOUNDARY LAYER BEHIND SHOCK ADVANCING INTO STATIONARY FLUID. Harold Mirels. March 1955. 25p. diagrs., 2 tabs. (NACA TN 3401)

A study was made of the laminar compressible boundary layer induced by a shock wave advancing into a stationary fluid bounded by a wall. For weak shock waves, the boundary layer is identical with that which occurs when an infinite wall is impulsively set into uniform motion (Rayleigh problem). A numerical solution was required for strong shocks. Velocity and temperature profiles, recovery factors, and skin-friction and heat-transfer coefficients are tabulated for a wide range of shock strengths.

NACA TN 3403

ANALYTICAL DETERMINATION OF EFFECT OF WATER INJECTION ON POWER OUTPUT OF TURBINE-PROPELLER ENGINE. Albert O. Ross and Merle C. Huppert. March 1955. 29p. diagrs. (NACA TN 3403. Formerly RM E9H17)

An analysis is presented to show the effect of evaporative cooling of the charge air during compression on the performance of a turbine-propeller engine incorporating a centrifugal compressor. Calculations were made with water as the cooling agent for compressor tip speeds of 1200, 1500, and 1800 feet per second. Results indicated that a power augmentation of 200 percent is possible at a compressor tip speed of 1800 feet per second if sufficient water is evaporated during compression to saturate the air at the compressor outlet.

NACA TN 3404

THE COMPRESSIBLE LAMINAR BOUNDARY LAYER WITH FLUID INJECTION. George M. Low. March 1955. 29p. diagrs., 3 tabs. (NACA TN 3404)

A solution of the equations of the compressible laminar boundary layer including the effects of transpiration cooling is presented. The analysis applied to the flow over an isothermal porous plate with a velocity of fluid injection proportional to the reciprocal of the square root of the distance from the leading edge. Several examples are calculated, and the stability of the boundary layer is investigated. It was found that, on a weight-of-coolant basis, transpiration cooling is more effective than other methods considered.

NACA TN 3407

INTERACTION OF A FREE FLAME FRONT WITH A TURBULENCE FIELD. Maurice Tucker. March 1955. 55p. diagrs., 2 tabs. (NACA TN 3407)

Theoretical values are obtained for the root-mean-square flame-generated turbulence velocities and the attenuating pressure fluctuations resulting from a linearized interaction of a constant-pressure combustion front with a field of isotropic turbulence. The anisotropic flame-generated turbulence is found to be of about the same intensity as the incident turbulence. A brief discussion of turbulent flame speed is given. Directly at the flame front the noise pressure levels characterizing the pressure fluctuations are fairly intense (59 to 81 decibels) even at moderate approach-flow turbulence intensities.

NACA TN 3408

ONE-DIMENSIONAL CALCULATION OF FLOW IN A ROTATING PASSAGE WITH EJECTION THROUGH A POROUS WALL. E. R. G. Eckert, John N. B. Livingood and Ernst I. Prasse. March 1955. 29p. diagrs., photo. (NACA TN 3408)

A method is developed for the determination of the local wall permeability necessary to obtain a prescribed local distribution of ejected gas or for the determination of the local distribution of ejected gas resulting from a given local wall permeability. Sample calculations are presented for two blind radial passages of a rotating transpiration-cooled turbine blade. The effects of passage area variation, passage inlet pressure, and passage inlet Mach number are investigated.

BRITISH REPORTS

N-36022*

Aeronautical Research Council (Gt. Brit.)
PUBLISHED REPORTS AND MEMORANDA OF THE AERONAUTICAL RESEARCH COUNCIL. 1954. 8p. (ARC R & M 2550)

N-36023*

Aeronautical Research Council (Gt. Brit.)
A WIND-TUNNEL INVESTIGATION OF ENTRY LOSS ON PROPELLER TURBINE INSTALLATIONS. PARTS I AND II. J. Seddon and A. Spence. 1954. 56p. diagrs., photos., 16 tabs. (ARC R & M 2894; ARC 11,602; ARC 11,883. Formerly RAE Aero 2252; RAE Aero 2281)

Part I describes tests on a series of models of annular entries, with and without propeller in the 5-foot tunnel, and tests on a set of large circular blade roots on a full-size nacelle in the 24-foot tunnel. Part II describes tests on models of a number of alternative ducted spinners for a typical engine, and for comparison, one annular entry similar to those tested in Part I. The work is confined to intakes for direct-flow engines with axial compressors. The conclusions on propeller losses can be applied to any form of annular intake.

N-36024*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF UNIFORMLY SPACED FLEXIBLE RIBS ON THE STRESSES DUE TO SELF-EQUILIBRATING SYSTEMS APPLIED TO LONG THIN-WALLED CYLINDERS. E. H. Mansfield and M. Fine. 1954. 43p. diagrs. (ARC R & M 2832; ARC 10,983. Formerly RAE Structures 6)

The effect of discrete, flexible ribs has been investigated and the results have been incorporated in a number of graphs which show the effect of rib-flexibility in a long thin-walled cylinder of arbitrary shape under end constraint. Some of the results of these investigations are of a negative character in that they show that for certain types of end conditions the effect of rib-flexibility is negligible. But rib-flexibility is of paramount importance when self-equilibrating shear-distorting forces are applied to a cylinder and this report makes the stress distribution in such a case readily determinable.

N-36025*

Aeronautical Research Council (Gt. Brit.)
AN ANALYSIS OF N. A. C. A. HELICOPTER REPORTS. R. N. Liptrot. 1954. 61p. diagrs., 5 tabs. (ARC CP 183)

Theory is compared with flight and model tests in order to obtain empirical correcting factors which will enable reliable performance estimates to be made for new helicopter designs. A survey of general theory is followed by an analysis of certain American reports. Correcting factors for effective blade drag for tip speed ratio, compressibility, and stalling of the retreating blade are derived. A method of calculating the retreating blade tip angle of attack for twisted blades is presented.

N-36026*

Aeronautical Research Council (Gt. Brit.)
LOAD DIFFUSION IN PLASTIC STRUCTURES. L. M. Tucker and R. B. Twiss. 1955. 79p. diagrs., photos., 14 tabs. (ARC CP 186)

This report describes theoretical and experimental investigations of the inherent advantages, in plastic structures, of resin bonded shear joints over comparable pin joints, and the most efficient material distribution for load diffusion. Theoretical analysis and graphical solutions are developed to obtain the ideal distribution of material for load diffusion; these have general applicability to structural design.

N-36073*

Royal Aircraft Establishment (Gt. Brit.)
HYDRAULIC FLUIDS, ETC.: THE DECREASE IN RATE OF FLOW ALONG TUBES OF A COLUMN OF LIQUID WHEN BROKEN BY AIR GAPS. G. F. N. Calderwood and E. W. J. Mardles. November 1954. 17p. diagrs., photos. (RAE Tech. Note Chem. 1242)

The loss of performance due to cavitation in a hydraulic system has been assessed by comparing observed times of flow with those calculated by means of the Poiseuille equation. Several air gaps of relatively small dimensions impart elastic and plastic resistance in addition to the normal viscous resistance so that the apparent viscosity may be several fold the bulk viscosity. An explanation of the increased resistance due to air gaps is attempted.

N-36075*

Royal Aircraft Establishment (Gt. Brit.)
USE OF RADIO-ACTIVE ISOTOPES FOR DETECTING FUEL CONTAMINATION OF AIRCRAFT STRUCTURES. B. F. A. Gatward, H. W. G. Wyeth and D. J. Nosworthy October 1954. 8p. diagr., tab. (RAE Tech. Note Mech. Eng. 191)

Previous methods of determining the areas of contamination of an aircraft structure from fuel spilt from the tanks in flight have not been satisfactory as their application has been difficult and the results obtained uncertain. This note describes a convenient method of tracing the spread of spilt fuel by using fuel treated with radio-active compounds. It records the results of an investigation in which the method was used successfully. It was found that the best results were obtained when the radio-activity of the fuel was approximately 300 microcuries per gallon.

N-36076*

Aeronautical Research Council (Gt. Brit.)
THE HOT-WIRE ANEMOMETER FOR TURBULENCE MEASUREMENTS. PART III. B. Wise and D. L. Schultz. March 24, 1954. 71p. diagrs. (ARC 16,679; FM 1527b; Oxford Univ., Engineering Lab. No. 69)

Further investigation of the operation of the hot-wire anemometer has shown that there are only two systems which are both statically stable and capable of improving the frequency response. A description is given of further experiments which have been made to verify the theory of operation of the wire, using both radio-frequency and direct current heating. An analysis of some feedback systems is given, and it is shown how these techniques may be used in the measurement of turbulence at high air speeds.

N-36077*

Aeronautical Research Council (Gt. Brit.)
NEUTRAL HOLES IN LATERALLY LOADED PLATES HAVING SMALL DEFLECTIONS. R. Hicks. April 26, 1954. 43p. diagrs., photos. (ARC 16,768; Strut 1707)

Reinforced holes which do not alter the stress distribution in a plate are said to be neutral. In this discussion it is shown that a circular neutral hole can be cut in a laterally loaded plate providing there is a choice for the cross-sectional dimensions of the reinforcement. General expressions are derived which enable the cross-sectional dimensions of the reinforcement to be obtained from the expression for the deflection surface of a similarly loaded plate which has no hole. For some particular load systems considered, expressions are found for the cross-sectional dimensions of rings reinforcing circular neutral holes in plates whose boundaries are circular, rectangular, triangular, and elliptical. These expressions are used to solve typical numerical examples and it is found for all the cases considered that the cross-sectional dimensions of the ring are always practical.

N-36080*

Aeronautical Research Council (Gt. Brit.)
THE PLANE STRESS DISTRIBUTION IN A PLATE CONTAINING A REINFORCED ELLIPTICAL HOLE. R. Hicks. April 26, 1954. 11p. diagrs. (ARC 16,769; Strut 1708)

The investigation deals with a reinforced elliptical hole in a rectangular plate having unequal applied principal stresses. It is shown that providing the ratio of the major and minor axes of the ellipse is suitably chosen, reinforcements of practical dimensions can be designed to give small stress concentrations.

N-36081*

Aeronautical Research Council (Gt. Brit.)
VISCOUS EFFECTS ON PITOT TUBES AT LOW SPEEDS. F. A. MacMillan. June 15, 1954. 8p. diagrs., 2 tabs. (ARC 16,866; FM 2081)

Measurements were made of the pressure in a blunt-nosed pitot tube in an air stream at Reynolds numbers of 15 to 1,000. The results are expressed in terms of a pressure coefficient. This pressure coefficient becomes greater than 1 at low Reynolds numbers, the increase being about 1-1/2 percent at a Reynolds number of 50 (based on external tube radius). No decrease of the coefficient below 1 was found at any Reynolds number. When the values of the coefficient are plotted against Reynolds numbers based on internal tube radius, it is found that the curves are in closer agreement than when the external radius is used.

N-36092*

Aeronautical Research Council (Gt. Brit.)
THE FLEXURAL AXIS OF THIN-WALLED SECTIONS THAT HAVE NO PLANE OF SYMMETRY. D. Williams and B. V. S. C. Rae. 1955. 6p. diagrs. (ARC R&M 2939; ARC 6871. Formerly RAE SME 3248)

A method of finding the flexural axis of unsymmetrical thin-walled sections is described that not only obviates the necessity for first finding the principal axes of inertia, but also simplifies the whole procedure.

N-36093*

Aeronautical Research Council (Gt. Brit.)
EXPERIMENTS IN THE COMPRESSED AIR TUNNEL ON SWEPTBACK WINGS INCLUDING TWO DELTA WINGS. R. Jones, C. J. W. Miles and P. S. Pusey. 1954. 26p. diagrs., 6 tabs. (ARC R & M 2871. Formerly ARC 11,354; Perf. 415)

Date are given relating to C_L, C_D, and C_m at high values of Reynolds number on wings of triangular planform, and at angles of attack from 0° to above the stall. Increasing the radius of the leading edge did not yield an improved $C_{L\ max}$ vs. R curve. Although the induced drag coefficient on the modified delta wing is somewhat less than on the original wing, the minimum-drag coefficient is greater.

N-36094*

Aeronautical Research Council (Gt. Brit.)
PRESSURE PLOTTING AND BALANCE MEASUREMENTS IN THE HIGH SPEED WIND TUNNEL ON A HALF-MODEL OF A 90-DEG-APEX DELTA WING WITH FUSELAGE. A. C. S. Pindar and J. R. Collingbourne. 1954. 59p. diagrs., 5 tabs. (ARC R & M 2844; ARC 12,804. Formerly RAE Aero 2335)

Tests were made on a delta wing that had a taper ratio of 0.143 and a wing section of RAE 102, symmetrical, 10 percent thickness/chord at 35 percent chord. The tests were conducted at a Reynolds number of 1.8×10^6 and Mach numbers up to 0.93. These tests were designed to provide data on the surface pressures over a delta wing at high subsonic speeds. For comparison, balance measurements were also arranged. The pressure distributions were the most accurate and reliable of the results given.

N-36128*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF COMPRESSIBILITY ON ELEVATOR FLUTTER. D. E. Williams. 1954. 9p. diagrs. (ARC CP 185)

The effect of compressibility on elevator flutter is investigated by using two-dimensional control surface derivatives for Mach numbers of 0 and 0.7. It is shown that compressibility may have a considerable effect when the stick is fixed, but that the effect is small when the stick is free.

N-36129*

Aeronautical Research Council (Gt. Brit.)
APPROXIMATE WALL CORRECTIONS FOR AN OSCILLATING SWEPT WING IN A WIND TUNNEL OF CLOSED CIRCULAR SECTION. W. E. A. Acum and H. C. Garner. 1955. 23p. diagrs., tabs. (ARC CP 184)

The oscillatory interference upwash for a circular tunnel is derived from the corresponding steady upwash. Corrections to measured derivatives of a slowly pitching wing are calculated by Multhopp's lifting surface theory. A satisfactory approximate method using interference parameters for a small wing is given, and an extension to rectangular tunnels is suggested.

N-36203*

Forest Products Research Lab. (Gt. Brit.)
THE KNIFE-TEST METHOD OF ASSESSING BOND QUALITY IN PLYWOOD. R. A. G. Knight and L. S. Doman. December 1954. 17p. diagrs., photos., 4 tabs. (Forest Products Research Lab. AMP 26/1; PRP 13/1)

This report describes the procedure of knife-testing and the origin of the "Master Scale" by means of which bond quality can be given by numerical assessment. Questions are answered about the test such as the influence of species and the "force factor," and the strengths and weaknesses of the test are pointed out. An analysis is made of the knife-test data for variation.

MISCELLANEOUS

NACA TN 3409

Errata on "CHAIN BREAKING AND BRANCHING IN THE ACTIVE-PARTICLE DIFFUSION CONCEPT OF QUENCHING." Frank E. Belles and A. L. Berlad. February 1955.

DECLASSIFIED NACA REPORTS

NACA RM A50H24

FLIGHT CALIBRATION OF FOUR AIRSPEED SYSTEMS ON A SWEPT-WING AIRPLANE AT MACH NUMBERS UP TO 1.04 BY THE NACA RADAR-PHOTOTHEODOLITE METHOD. Jim Rogers Thompson, Richard S. Bray and George E. Cooper. October 27, 1950. 41p. diagrs., photos., tab. (NACA RM A50H24) (Declassified from Confidential, 3/11/55)

The characteristics of four different airspeed systems installed in a swept-wing airplane have been investigated in flight up to 1.04 Mach number by the NACA radar-phototheodolite method of airspeed calibration. The variations of static-pressure defect per unit indicated impact pressure with Mach number and a limited amount of information on the effect of airplane normal-force coefficient are presented for each system. The results are compared with available theory and wind-tunnel tests of the isolated heads.

NACA RM E50F29

SURVEY OF LESS-INFLAMMABLE HYDRAULIC FLUIDS FOR AIRCRAFT. Wray V. Drake and I. L. Drell. September 7, 1950. 64p. 14 tabs. (NACA RM E50F29) (Declassified from Confidential, 3/11/55)

A survey of current information on civil and military development of less-inflammable hydraulic fluids for aircraft is presented. Types of less-inflammable fluid reported include: glycol derivative, water base, silicone, ester, and halogenated compound. Specification requirements, physical and chemical properties, hydraulic-system test results, and advantages and disadvantages of various hydraulic fluids are discussed. For completely satisfactory service, some modification of currently available fluids or of present hydraulic-system parts still appears necessary.

NACA RM E53C12

THE DESIGN OF BRITTLE-MATERIAL BLADE ROOTS BASED ON THEORY AND RUPTURE TESTS OF PLASTIC MODELS. Andre J. Meyer, Jr., Albert Kaufman and William C. Caywood. April 6, 1953. 45p. diagrs., photos., tab. (NACA RM E53C12) (Declassified from Confidential, 3/11/55)

Theoretical design charts based on Neuber's equations for symmetrically located notches are presented for estimating the approximate rupture strengths of blade roots made from brittle materials. The limit of applicability of the theoretical charts is shown as determined by rupture tests of plastic models. The optimum proportions among overall root width, neck width, notch radius, and notch depth are determined from the design charts. Eighteen different root designs were investigated, their relative strengths were evaluated analytically and experimentally and the results were compared. A dovetail root having the optimum proportions as established by this investigation was the strongest root evaluated.

National Advisory Committee for Aeronautics

Research Abstracts

NO. 81 APRIL 20, 1955

CURRENT NACA REPORTS

NACA TM 1371

APPARATUS FOR MEASUREMENTS OF TIME AND SPACE CORRELATION. (Appareil de Mesures de la Correlation Dans le Temps et L'Espace). A. Favre, J. Gaviglio and R. Dumas. (Presented at eighth International Congress for Theoretical and Applied Mechanics, Istanbul, Aug., 1952) April 1955. 20p. diagrs., photos. (NACA TM 1371. Trans. from La Rechèrche Aéronautique, no. 31, Jan.-Feb., 1953, p. 37-44).

A brief review is made of improvements to an experimental apparatus for time and space correlation designed for study of turbulence. Included is a description of the control of the measurements and a few particular applications.

NACA TM 1387

THEORY OF REVERSIBLE AND NONREVERSIBLE CRACKS IN SOLIDS. (Teoriya obratimykh i neobratimykh treshchin v tverdykh telakh). Y. I. Frenkel. April 1955. 14p. diagrs. (NACA TM 1387. Trans. from Zhurnal Tekhnicheskoi Fiziki, v. 22, no. 11, Nov., 1952, p. 1857-1866)

The Griffith crack theory is reviewed and certain shortcomings of this theory are discussed. A new description for the shape of a crack is given which takes into account the atomic structure of material. Through consideration of the total energy of the system and the shape of the crack, expressions for crack behavior are derived which are considered to remedy the defects of the Griffith theory.

NACA TN 3216

COOPERATIVE INVESTIGATION OF RELATIONSHIP BETWEEN STATIC AND FATIGUE PROPERTIES OF WROUGHT N-155 ALLOY AT ELEVATED TEMPERATURES. NACA Subcommittee on Heat-Resisting Materials. April 1955. 92p. diagrs., photos., 13 tabs. (NACA TN 3216)

Extensive data are given relating properties of N-155 alloy under static, combined static and dynamic, and completely reversed dynamic stress conditions. Time periods for fracture ranged from 50 to 500 hours at room temperature, 1,000°, 1,200°, 1,350°, and 1,500° F. The work was on a cooperative basis to help clarify the principles governing load-carrying ability of heat-resistant alloys at temperatures and conditions where both creep and fatigue can occur simultaneously. In view of the uncertainty in interpreting results of various types of fatigue tests, duplicate data were obtained from as many types of fatigue testing machines as could be arranged.

NACA TN 3270

EFFECT OF DISSOCIATION ON THERMODYNAMIC PROPERTIES OF PURE DIATOMIC GASES. Harold W. Woolley, National Bureau of Standards. April 1955. 19p. diagrs., tab. (NACA TN 3270)

A graphical method is described by which the enthalpy, entropy, and compressibility factor for the equilibrium mixture of atoms and diatomic molecules for pure gaseous elements may be obtained and shown for any dissociating element for which the necessary data exist. Results are given for hydrogen, oxygen, and nitrogen. The effect of dissociation on the heat capacity is discussed briefly.

NACA TN 3282

INTERGRANULAR CORROSION OF HIGH-PURITY ALUMINUM IN HYDROCHLORIC ACID. II - GRAIN-BOUNDARY SEGREGATION OF IMPURITY ATOMS. M. Metzger and J. Intrater, Columbia University. April 1955. 33p. diagrs., 4 tabs. (NACA TN 3282)

The variation in the rate of intergranular corrosion of single-phase high-purity aluminum in 20 percent hydrochloric acid as a function of iron content and final-annealing temperature is attributed to the segregation to atomic sites in the grain-boundary region of iron and possibly other impurity atoms. The experimental results are analyzed by reference to a distribution function, obtained by statistical mechanical methods, which gives the equilibrium fraction of certain sites in the boundary which are occupied by solute atoms in terms of the interaction energy for the segregation of the solute atoms at these sites.

NACA TN 3326

THE COMPRESSIBLE LAMINAR BOUNDARY LAYER WITH HEAT TRANSFER AND ARBITRARY PRESSURE GRADIENT. Clarence B. Cohen and Eli Reshotko. April 1955. 43p. diagrs., 2 tabs. (NACA TN 3326)

An approximate method for the calculation of the compressible laminar boundary layer with heat transfer and arbitrary pressure gradient, based on Thwaites' correlation concept, is presented. With the definition of dimensionless shear and heat-transfer parameters and an assumed correlation of these parameters in terms of a momentum parameter, a complete system of relations for calculating skin-friction and heat-transfer results. Knowledge of velocity or temperature profiles is not necessary in using this calculation method. When the method is applied to a convergent-divergent, axially symmetric rocket nozzle, it shows that high rates of

heat transfer are obtained at the initial stagnation point and at the throat of the nozzle. Also indicated are negative displacement thicknesses in the convergent portion of the nozzle; these occur because of the high density within the lower portions of the cooled boundary layer.

NACA TN 3351

PLASTIC DEFORMATION OF ALUMINUM SINGLE CRYSTALS AT ELEVATED TEMPERATURES. R. D. Johnson, A. P. Young and A. D. Schwope, Battelle Memorial Institute. April 1955. 76p. diagrs., photos., 3 tabs. (NACA TN 3351)

A study was made of plastic deformation of aluminum single crystals over a wide range of temperatures. Results are presented of constant-stress creep tests, constant-load-rate tests, and constant-load creep tests. The effect of crystal orientation on the operative slip system was determined. The effect of small amounts of prestraining was studied and two high-resolution X-ray techniques were used to detect and follow the strain. Light and electron microscopy were used to study the complex nature of slip bands and kink bands on specimens deformed at elevated temperatures.

NACA TN 3370

A SIMPLIFIED METHOD FOR CALCULATING AEROELASTIC EFFECTS ON THE ROLL OF AIRCRAFT. John M. Hedgepeth, Paul G. Waner, Jr. and Robert J. Kell. March 1955. 26p. diagrs., 4 tabs. (NACA TN 3370)

An approximate linearized lifting-surface theory is used in conjunction with structural influence coefficients to formulate a method for analyzing the aeroelastic behavior in roll of an aircraft. Rolling effectiveness and aileron-reversal speed are computed by the use of a Galerkin-type procedure. Results obtained for two example configurations by using this method are compared with the results obtained by using the more refined method of NACA TN 3067.

NACA TN 3373

THEORETICAL CALCULATIONS OF THE PRESSURES, FORCES, AND MOMENTS DUE TO VARIOUS LATERAL MOTIONS ACTING ON THIN ISOLATED VERTICAL TAILS WITH SUPERSONIC LEADING AND TRAILING EDGES. Kenneth Margolis. March 1955. 43p. diagrs., 10 tabs. (NACA TN 3373)

Expressions based on linearized thin-airfoil theory for supersonic speeds are derived for the velocity potentials and pressure distributions due to various lateral motions for a family of thin isolated vertical tails with arbitrary sweepback and taper ratio. Motions treated are steady rolling, steady yawing, constant sideslip, and constant lateral acceleration. For the particular cases of half-delta and rectangular vertical tails, forces and moments expressed in the form of stability derivatives are also derived and presented in simple charts. All results are, in general, applicable at those supersonic speeds for which both the tail leading and trailing edges are supersonic. End-plate effects for several of the derivatives are also considered.

NACA TN 3376

THE EFFECT OF CONTROL STIFFNESS AND FORWARD SPEED ON THE FLUTTER OF A 1/10-SCALE DYNAMIC MODEL OF A TWO-BLADE JET-DRIVEN HELICOPTER ROTOR. George W. Brooks and Maurice A. Sylvester. April 1955. 38p. diagrs., photo., 3 tabs. (NACA TN 3376)

Some tests have been made with a 1/10-scale dynamic model of a two-blade jet-drive helicopter to study the effects of blade-pitch-control stiffness and tip-speed ratio on the rotor blade flutter characteristics. The results showed that the flutter speed of the model blades was increased as the blade-pitch-control stiffness was increased and indicated that the structural blade modes of primary importance with respect to flutter were the first torsion mode and the flapping mode. The rotor speed at flutter was reduced slightly as the tip-speed ratio was increased from hovering to forward flight.

NACA TN 3383

INVESTIGATION OF THE TURBULENT BOUNDARY LAYER ON A YAWED FLAT PLATE. Harry Ashkenas and Frederick R. Riddell, Cornell University. April 1955. 57p. diagrs., photos. (NACA TN 3383)

Experiments carried out on three flat plates yawed 0°, 30°, and 45° with artificially fixed transition in a low-speed, low-turbulence tunnel are described. The effects of yaw on the velocity profile and on the direction of flow near the plate are found to be small. The boundary-layer displacement thickness on a yawed plate is found to grow in the streamwise direction at a rate slightly greater than it does on the unyawed plate; this is in contrast with the laminar case where the "independence principle" discovered by Prandtl and others leads to a substantially reduced rate of growth on yawed plates.

NACA TN 3392

TWO MINIATURE TEMPERATURE RECORDERS FOR FLIGHT USE. John V. Foster. April 1955. 13p. diagrs., photos. (NACA TN 3392)

Descriptions are given for two types of temperature recorders suitable for use with thermocouples on fighter-type aircraft. One is an electromechanical self-balancing potentiometer type; the other uses electronic feedback to achieve fast balance.

NACA TN 3393

AN EXPERIMENTAL INVESTIGATION OF THE BASE PRESSURE CHARACTERISTICS OF NONLIFTING BODIES OF REVOLUTION AT MACH NUMBERS FROM 2.73 TO 4.98. John O. Reller, Jr. and Frank M. Hamaker. March 1955. 45p. diagrs., photos. (NACA TN 3393. Formerly RM A52E20)

Base pressure characteristics of related nonlifting bodies of revolution were investigated at free-stream Mach numbers from 2.73 to 4.98 and Reynolds numbers from 0.6×10^6 to 8.8×10^6. The basic body shape was a 10-caliber tangent ogive with a cylindrical afterbody. The variation of base pressure coefficient with free-stream Mach number and

Reynolds number was determined for laminar-, transitional-, and turbulent-boundary-layer flow. Some effects of body fineness ratio, nose-profile shape, and afterbody shape (boattail) were also included in the investigation.

NACA TN 3420

HYDRODYNAMIC TARES AND INTERFERENCE EFFECTS FOR A 12-PERCENT-THICK SURFACE-PIERCING STRUT AND AN ASPECT-RATIO-0.25 LIFTING SURFACE. John A. Ramsen and Victor L. Vaughan, Jr. April 1955. 20p. diagrs. (NACA TN 3420)

Results are presented from an investigation of the hydrodynamic tares and interferences acting on an NACA 66_1-012 airfoil-section surface-piercing strut and an aspect-ratio-0.25 modified-flat-plate rectangular lifting surface. The interference of the strut on the lifting surface was negligible except at very shallow depths, where it increased the lift and pitching moment slightly. Strut-tare effects were appreciable only on drag, where section-drag coefficients showed good agreement with data from previous tank and wind-tunnel tests. The surface-intersection drag coefficients were constant above the critical wave speed and showed fairly good agreement with wave-drag theory below the critical speed.

NACA TN 3426

AN EXPERIMENTAL STUDY OF ORIFICE COEFFICIENTS, INTERNAL STRUT PRESSURES, AND LOADS ON A SMALL OLEO-PNEUMATIC SHOCK STRUT. James H. Walls. April 1955. 23p. diagrs., photos. (NACA TN 3426)

Measurements of shock-strut internal pressures, telescoping velocity, and strut stroke were made during drop tests of a small oleo-pneumatic landing gear to determine the characteristics of the orifice and to show the relationships between internal strut pressures and the overall loads developed by the strut. The variation of the orifice coefficient with telescoping velocity and strut stroke is presented. Strut forces determined from internal-pressure measurements are compared with forces measured by an external dynamometer. Strut forces calculated from measured telescoping velocity and stroke time histories are evaluated, a constant orifice coefficient and isothermal air compression being assumed.

NACA TN 3428

GROUND-SIMULATOR STUDY OF THE EFFECTS OF STICK FORCE AND DISPLACEMENT ON TRACKING PERFORMANCE. Stanley Faber. April 1955. 21p. diagrs., photos. (NACA TN 3428)

Tests were performed on a ground simulator with one degree of freedom, pitch, to determine the desired magnitude of the control-stick forces and displacements in relation to the performance of a tracking task. The dynamics of the simulated airplane were typical of those of current fighters operating at low altitudes and at subsonic speeds and having an undamped natural frequency of 1/2 cycle per second and a damping ratio of approximately 0.8.

NACA TN 3429

STATIC STABILITY OF FUSELAGES HAVING A RELATIVELY FLAT CROSS SECTION. William R. Bates. March 1955. 29p. diagrs., tab. (NACA TN 3429. Formerly RM L9I06a)

The subject investigation contains results of force tests and flow surveys made in the Langley free-flight tunnel to determine the static stability characteristics of several fuselages having a relatively flat cross section and a high fineness ratio.

NACA TN 3430

ON SLENDER DELTA WINGS WITH LEADING-EDGE SEPARATION. Clinton E. Brown and William H. Michael, Jr. April 1955. 27p. diagrs. (NACA TN 3430)

The slender-body approximation of linearized compressible flow is applied to the problem of a delta wing in which flow separation occurs at the leading edges. The vortex sheets found in the real flow are approximated by concentrated vortices with feeding lattices, and an adaptation of Kelvin's theorem is applied to simulate the force-free nature of the vortex sheet. Computed pressure distributions and span loadings are presented, and the theoretical lift results are compared with the results of simple force tests made at a Mach number of 1.9.

NACA TN 3431

AN ANALYSIS OF THE STABILITY AND ULTIMATE COMPRESSIVE STRENGTH OF SHORT SHEET-STRINGER PANELS WITH SPECIAL REFERENCE TO THE INFLUENCE OF RIVETED CONNECTION BETWEEN SHEET AND STRINGER. Joseph W. Semonian and James P. Peterson. March 1955. 49p. diagrs., tab. (NACA TN 3431)

A method of strength analysis of short sheet-stringer panels subjected to compression is presented which takes into account the effect that the riveted attachments between the plate and the stiffeners have on the strength of panels. An analysis of experimental data shows that panel strength is highly influenced by rivet pitch, diameter, and location and that the degree of influence for a given riveting depends on the panel configuration and panel material.

NACA TN 3432

CIRCUMFERENTIAL DISTRIBUTION OF PROPELLER-SLIPSTREAM TOTAL-PRESSURE RISE AT ONE RADIAL STATION OF A TWIN-ENGINE TRANSPORT AIRPLANE. A. W. Vogeley and H. A. Hart. April 1955. 24p. diagrs., photos. (NACA TN 3432)

Flight tests on a twin-engine transport airplane have been made to determine the effects of fuselage-nacelle interference on the circumferential distribution of the rise in total pressure behind the propellers. The effects of this flow interference on the operation of a simple propeller-thrust indicator, which samples the total-pressure rise at two diametrically opposed points in the slipstream (to counteract the effects of variations in angles of pitch and yaw), have been investigated.

NACA TN 3434

A STUDY OF NORMAL ACCELERATIONS AND OPERATING CONDITIONS EXPERIENCED BY HELICOPTERS IN COMMERCIAL AND MILITARY OPERATIONS. Marlin E. Hazen. April 1955. 34p. diagrs., photos., 5 tabs. (NACA TN 3434)

An analysis is presented of the normal accelerations and operating conditions encountered by two different airmail helicopters and a military pilot-training helicopter. Tables and graphs are used to illustrate the effect of operating conditions on acceleration levels, and a summary of all NACA helicopter VGH data analyzed to date is included.

NACA TN 3446

EFFECT OF AMMONIA ADDITION ON LIMITS OF FLAME PROPAGATION FOR ISOOCTANE-AIR MIXTURES AT REDUCED PRESSURES AND ELEVATED TEMPERATURES. Cleveland O'Neal, Jr. April 1955. 32p. diagrs., 3 tabs. (NACA TN 3446)

Limits were determined for isooctane, ammonia, and mixtures of these two fuels with air at pressures up to 400 mm Hg and temperatures from 60° to 400° C. In the ternary mixtures, NH_3-air weight ratios were 0.020 and 0.039. For all mixtures, the flammable region (rich minus lean limit equivalence ratio) broadened as the temperature was raised. The flammable region of isooctane was roughly three times that of ammonia. However, small additions of ammonia to isooctane broadened the flammable range up to an NH_3-air ratio of about 0.02; further additions narrowed the range. Added ammonia was completely consumed in lean mixtures; in rich mixtures about half of the ammonia was unburned.

NACA TN 3447

ANALYTIC DETERMINATION OF THE DISCHARGE COEFFICIENTS OF FLOW NOZZLES. Frederick S. Simmons. April 1955. 15p. diagrs. (NACA TN 3447)

An analytic expression for the discharge coefficient of flow nozzles is obtained by integration of an approximation for the velocity profile through the cross section of the nozzle. This expression shows the discharge coefficient to be a function of the Reynolds number and the geometry of the nozzle and agrees well with published experimental data for Reynolds numbers between 10^4 and 10^6.

NACA TN 3496

FLIGHT TESTING BY RADIO REMOTE CONTROL - FLIGHT EVALUATION OF A BEEP-CONTROL SYSTEM. Howard L. Turner, John S. White and Rudolph D. Van Dyke, Jr. March 1955. 55p. diagrs., photos., tab. (NACA TN 3496. Formerly RM A52A29)

A comparison between manual control and remote control showed that a beep-type, radio-remote-control system was, in general, a satisfactory means of control for conducting standard handling-quality flight tests. The dynamic characteristics of the airplane-autopilot combination and the selection of the proper parameter adjustments are discussed.

BRITISH REPORTS

N-36289*

Aeronautical Research Council (Gt. Brit.)
DIFFUSION OF ANTISYMMETRICAL LOADS INTO, AND BENDING UNDER, TRANSVERSE LOADS OF PARALLEL STIFFENED PANELS. J. H. Argyris. 1954. 52p. diagrs. (ARC R & M 2822. Formerly ARC 9662; Strut 1037)

The purpose of this paper is to present the general theory of diffusion of antisymmetrical concentrated end loads and edge loads into parallel stiffened panels, including the theory of bending of a parallel stiffened panel under arbitrary transverse loads. By combining the results of this paper with the results on diffusion of symmetrical loads given in R & M 1969 and R & M 2038 or in Appendix I to this paper, it is possible to analyze the diffusion in a parallel panel under any arbitrary load or edge stress distribution.

N-36290*

Aeronautical Research Council (Gt. Brit.)
THE DETERMINATION OF THE PRESSURE DISTRIBUTION OVER AN AEROFOIL SURFACE BY MEANS OF AN ELECTRICAL POTENTIAL ANALYSER. S. C. Redshaw. 1954. 40p. diagrs., photos., tabs. (ARC R & M 2915; ARC 15,733. Formerly Boulton Paul Aircraft Ltd. Tech. Rept. 101)

The potential flow, both with and without circulation around several thin wings has been studied by means of a three-dimensional potential analyzer. It is shown that, by using the normal assumptions made in the exercise of the linear perturbation theory, it is possible to obtain the pressure distribution for small angles of attack, as well as the slope of the lift-incidence curve, easily and rapidly. Experiments are also described in which it was attempted to remove the effect of boundary restraint in a manner analogous to that used in a flexible walled wind tunnel.

N-36381*

Royal Aircraft Establishment (Gt. Brit.)
BOUNDARY LAYER MEASUREMENTS ON 10° AND 20° CONES AT M = 2.45 AND ZERO HEAT TRANSFER. E. V. Davies and J. R. Cooke. November 1954. 62p. diagrs., photos., 2 tabs. (RAE Tech. Note Aero 2314)

Transition from laminar to turbulent flow occurred between 4 and 6 in. from the tip of the 10° cone at Reynolds number between 10^6 and 1.4×10^6; the layer on the 20° cone was laminar over its entire length of 6 in. (Reynolds number = 1.4×10^6). Results agree well with the flat plate solution of Monaghan transformed by the theoretical cone-flat plate relations of Hantzsche and Wendt, and Mangler. The data for the turbulent boundary layer were obtained from the 10° cone and comparison with flat plate data indicates that the cone-flat plate relation is within 6 percent of an empirical relation analogous to the $\sqrt{3}$ laminar boundary layer factor.

N-36382*

Royal Aircraft Establishment (Gt. Brit.)
A FLIGHT INVESTIGATION OF THE WAKE BEHIND A METEOR AIRCRAFT, WITH SOME THEORETICAL ANALYSIS. D. R. Andrews. December 1954. 38p. diagrs., photos., tab. (RAE Tech. Note Aero 2283)

The jet velocity falls to a negligible value by 200-300 feet behind the jet exit. Major disturbances behind an aircraft are due to the trailing vortices and these decay only slowly. Tests with a Vampire flying in the wake show that the strength of these vortices has fallen to about half its initial value by 8000 feet behind the aircraft. Theory and flight tests show that the rolling moment imposed on a tracking aircraft constitutes the most severe disturbance from these vortices, and in some cases this rolling moment can be large enough to overpower the aileron control of the tracking aircraft.

N-36383*

Royal Aircraft Establishment (Gt. Brit.)
CURRENT INTERRUPTION OF D.C. CIRCUITS IN AIR AT LOW PRESSURES, WITH SPECIAL REFERENCE TO THE ARC CHARACTERISTIC BETWEEN SILVER ELECTRODES. A. H. M. Arnold and L. H. Ford. July 1954. 34p. diagrs., 11 tabs. (RAE EL. 1485)

Measurements have been made of the voltage and current in d-c arcs over a range of air pressures using silver, copper, and tungsten electrodes. The investigation has shown that although the arc characteristic at low pressures is less favorable for breaking large currents than it is at atmospheric pressure, comparable switch performance may usually be obtained either by an increase of gap length, or by an increase in the number of series breaks. Simple empirical relationships for the arc characteristics based on the experimental data obtained are given for silver and tungsten electrodes: tests on the interrupting capacity of switches gave results which were in reasonable agreement with predictions made from these empirical formulas.

N-36385*

Royal Aircraft Establishment (Gt. Brit.)
SOME EXPERIMENTS ON RATES OF QUENCHING. F. J. Bradshaw and S. Pearson. October 1954. 11p. diagrs. (RAE Tech. Note Met. 203)

Experiments are described on the quenching rates of 6.4 mm diameter cylindrical specimens in water at various temperatures. Similar work is described using cylinders and wires (1.2 to 0.3 mm) quenched in liquids held at temperatures below 0° C. Appropriate mean values of surface heat transfer coefficients are deduced.

N-36386*

Royal Aircraft Establishment (Gt. Brit.)
28 S.W.G. TITANIUM SHEETING FOR FIREPROOF BULKHEADS. J. T. Ballett. September 1954. 7p. photos., 2 tabs. (RAE Tech. Note Met. 202)

Tensile and bend tests were made on 28 S.W.G (0.015 in.) Ti 75A titanium sheet in the annealed condition and also after exposure in a furnace at 1000° C for 5 minutes. Exposure tests were also carried out using two different types of torch flames. The results showed that the heating to 1000° C increased the tensile strength of the material by about 20 percent to 49 tons/sq in., with an accompanying reduction in elongation from 28 percent to 4 percent.

UNPUBLISHED PAPERS

N-35767*

SELECTIVITY IN THE FORMATION OF FATIGUE CRACKS DURING THE WORKING OF STEEL IN A CORROSIVE MEDIUM; AND ADSORPTIVE BEGINNING OF THE CORROSIVE FATIGUE OF METALS. (Pro Vibirnist' v Utvorenni Trishchin Vtomi pri Roboti Stali u Koroziynomu Seredovishchi, and Adsorbtsiinii Pochatok Koroziinoi Vtomi Metaliv). G. V. Karpenko. 11p. diagrs., photos. (Trans. from Akademiia Nauk URSR, Kiev, Dopovidi, no. 2, 1951, p. 112-119)

In part I, steel was tested under reversed torsion in air and aerated water. Transcrystalline cracks perpendicular to the maximum tensile stress were observed. All cracks were found to be normal to the surface. In part II, the effects of an actively corrosive media as well as a superficially corrosive one were considered.

N-35826*

Univ. of Calif., Berkeley. Institute of Engineering Research. A MACH 3.106 TWO-DIMENSIONAL ADJUSTABLE NOZZLE FOR LOW DENSITY FLOW (NO. 10 NOZZLE). L. Talbot. February 18, 1954. (iii), 29p. diagrs., photos., 3 tabs. (Univ. of Calif., Berkeley. Institute of Engineering Research. HE-150-120)

Following the results of tests conducted in a small wind tunnel, a Mach 3.106 adjustable throat two-dimensional nozzle was designed for the No. 3 Wind Tunnel of the Low Pressures Project. The nozzle measured 11.05 in. from throat to exit and, including boundary-layer corrections, had exit dimensions of 3.899 in. x 4.116 in. Test section Mach numbers from 2.50 to 6.53 were produced by varying the nozzle throat height. The uniform flow region decreased with increased Mach number; at the highest Mach number the nozzle was completely filled with boundary layer.

N-35827*

Polytechnic Institute of Brooklyn. THE NON-LINEAR DEFLECTION OF INFINITE STRIP PLATES. F. S. Shaw, F. Pohle and N. Perrone. June 1953. 16p. diagrs., tab. (Polytechnic Institute of Brooklyn. PIBAL 225)

By expressing the von Kármán plate theory entirely in terms of displacements, there result three simultaneous nonlinear governing equations. These are not readily soluble. If, however, the plate is taken to be an infinite strip, and the loading to vary on in the finite direction, solutions can be obtained for a variety of loading cases. This restricted class of problems is discussed here, and the solution for the case of uniform loading is considered in all detail.

N-35828*

Polytechnic Institute of Brooklyn. THE NONLINEAR DEFLECTION OF AN INFINITE STRIP MEMBRANE. N. Perrone, F. Pohle and F. S. Shaw. April 1953. 13p. diagr. (Polytechnic Institute of Brooklyn. PIBAL Rept. 219)

The problem of the nonlinear deflection of a membrane having the shape of an infinite strip is considered. By setting up the problem in terms of displacement components, it is shown that it is possible to obtain exact, simple, closed form solutions for a variety of loading cases which are subject to the restriction that variation is in the finite direction only.

N-35829*

Univ. of Okla. Research Institute. FLAME STABILIZATION RESULTING FROM CYCLONIC FLOW IN MIXTURES OF NATURAL GAS AND AIR. Lyle F. Albright and Lloyd G. Alexander. (Final rept. for period June 4, 1952 to June 30, 1954). viii, 108p. diagrs., photos., 26 tabs. (Univ. of Okla. Research Institute)

The application of cyclonic flow to the combustion of natural gas-air mixtures in emergent cyclonic free jets, ducts, and diverging sections has been investigated. The investigation consists of quantitative measurements to determine the characteristics and stability limits of the flames obtained. In addition, directional impact and static pressure tube measurements were made in the flow fields of emergent cyclonic free jets, so that the explanation to flame stabilization due to cyclonic motion could be conclusively established.

N-35830*

Brown Univ., Providence, R.I. Div. of Applied Mathematics. REMARKS ON TRANSFORMS AND BOUNDARY VALUE PROBLEMS. P. Germain. June 1954. 34p. (Brown Univ., Providence, R.I. Div. of Applied Mathematics)

An attempt is made to show the relations between transforms and simple boundary value problems. Some general formulas show in fact that the Fourier integral theorem, the Fourier Dini integral theorem and many of the consequences which can be derived from them may easily be generalized. The same formulas can be applied as well to elliptic as to hyperbolic problems. It does not seem to be possible to obtain correspondingly simple results for the case of problems related to an equation of mixed type. As an application of the approach, the interpretation of a result, called a generalized Hankel Transform, was made precise. The method and the results may be extended to the case of finite transforms.

N-35831*

Brown Univ., Providence, R.I. Div. of Applied Mathematics. AN EXPRESSION FOR THE GREEN'S FUNCTION FOR A PARTICULAR TRICOMI PROBLEM. P. Germain. June 1954. 34p. diagrs. (Brown Univ., Providence, R.I. Div. of Applied Mathematics)

The Tricomi equation is written with new independent variables; this new form allows one to write the Green's function for a special Tricomi problem in the form of a Mellin Transform. The analysis is greatly simplified by the use of a technique previously used by R. Bader and the author. Corresponding formulas for the doublet are given. These results are given in a form which can be used for numerical computation. Using the same method, a generalized Tricomi problem is discussed. The results may be used in order to simplify the existence proof for a solution of a Tricomi problem for the Tricomi equation.

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Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1169

MATRIX METHODS FOR DETERMINING THE LONGITUDINAL-STABILITY DERIVATIVES OF AN AIRPLANE FROM TRANSIENT FLIGHT DATA. James J. Donegan. 1954. ii, 20p. diagrs., 6 tabs. (NACA Rept. 1169. Formerly TN 2902)

Three methods are presented for calculating the longitudinal stability derivatives from transient flight data. Several examples using flight data are given to illustrate the method. The results indicate the scatter which is typical of this type of analysis.

NACA TN 3349

APPLICATION OF THE GENERALIZED SHOCK-EXPANSION METHOD TO INCLINED BODIES OF REVOLUTION TRAVELING AT HIGH SUPERSONIC AIRSPEEDS. Raymond C. Savin. April 1955. 71p. diagrs., photos., tab. (NACA TN 3349)

The generalized shock-expansion method is applied to obtain solutions to the flow field about pointed bodies of revolution at high supersonic airspeeds and small angles of attack. Simple explicit expressions are obtained for the surface Mach numbers and surface pressures in the special case of slender bodies. In the case of inclined cones, algebraic solutions are obtained defining the entire flow field. Experimental pressure-distribution data for cones and ogives at Mach numbers from 3 to 5 are included.

NACA TN 3372

FLIGHT MEASUREMENTS OF BASE PRESSURE ON BODIES OF REVOLUTION WITH AND WITHOUT SIMULATED ROCKET CHAMBERS. Robert F. Peck. April 1955. 18p. diagrs., photo. (NACA TN 3372. Formerly RM L50I28a)

Base pressures were measured on fin-stabilized bodies of revolution with and without rocket chambers and with and without a converging afterbody. At Mach numbers between 0.7 and 1.2, the results show that the presence of a "cold" rocket chamber increased the pressure (less suction) over the center portion of the bases. The effects of rocket chambers on pressures near the edge of the bases were not as consistent throughout the Mach number range nor as appreciable at most speeds as were the effects on pressures measured on the center line.

NACA TN 3406

A SELF-EXCITED, ALTERNATING-CURRENT, CONSTANT-TEMPERATURE HOT-WIRE ANEMOMETER. Charles E. Shepard. April 1955. 29p. diagrs., photos. (NACA TN 3406)

The hot-wire anemometer described herein was used to study turbojet-engine compressor rotating stall and surge. The system was capable of measuring flow over a frequency range of zero to 500 cycles per second. A self-sustaining, 8 kilocycle-per-second oscillation was used to heat the wire in a constant-temperature system. The relatively rugged, large-diameter wire allowed the use of the anemometer during the full-scale performance testing of compressors and turbojet engines. The commercial audio-frequency amplifier used reduced the cost and the time required to build the anemometer.

NACA TN 3410

VARIATION OF LOCAL LIQUID-WATER CONCENTRATION ABOUT AN ELLIPSOID OF FINENESS RATIO 10 MOVING IN A DROPLET FIELD. Rinaldo J. Brun and Robert G. Dorsch. April 1955. 51p. diagrs., photo., tab. (NACA TN 3410)

Trajectories of water droplets about an ellipsoid of revolution with a fineness ratio of 10 (10 percent thick) in flight through a droplet field were computed with the aid of a differential analyzer. Analyses of these trajectories indicate that the local concentration of liquid water at various points about an ellipsoid varies considerably and under some conditions may be several times the free-stream concentration. Curves of the local concentration factor as a function of spatial position were obtained and are presented in terms of dimensionless parameters that describe flight and atmospheric conditions.

NACA TN 3423

METHOD OF CONTROLLING STIFFNESS PROPERTIES OF A SOLID-CONSTRUCTION MODEL WING. Norman S. Land and Frank T. Abbott, Jr. April 1955. 21p. diagrs., photos., tab. (NACA TN 3423)

A simple method is presented for controlling the bending and torsional stiffnesses of a solid-construction model wing. The method consists of weakening the wing by drilling holes through the wing normal to the chord plane. Aerodynamic continuity is maintained by filling the holes with a relatively soft material. The important parameters controlling the stiffnesses are the amount of material removed by drilling the ratio of hole diameter to wing thickness, and the plan-form pattern of the holes. Data are given which may be used for predicting the stiffness of a model wing weakened in this manner.

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NACA TN 3435

A STATISTICAL STUDY OF WING LIFT AT GROUND CONTACT FOR FOUR TRANSPORT AIRPLANES. Dean C. Lindquist. April 1955. 18p. diagrs., tab. (NACA TN 3435)

A brief statistical study of the value of the wing-lift factor K_L at the instant of ground contact during landing is presented for four transport airplanes. Frequency distributions and probability distributions of the wing-lift factor were determined from acceleration measurements on VGH records of 2,049 landings in routine airline operations. The results indicate that the mean value of K_L is very nearly 1, that in 95 percent of all the landings the lift factor did not vary from the mean value by more than ± 0.1, and that the probability of obtaining a value of K_L as low as 0.8 or as high as 1.2 is approximately 1 in 10,000.

NACA TN 3437

PRELIMINARY INVESTIGATION OF A SUBMERGED AIR SCOOP UTILIZING BOUNDARY-LAYER SUCTION TO OBTAIN INCREASED PRESSURE RECOVERY. Mark R. Nichols and P. Kenneth Pierpont. April 1955. 72p. diagrs., photos., 2 tabs. (NACA TN 3437. Formerly RM L50A13)

This paper presents results of low-speed tests of a submerged inlet consisting essentially of a conventional scoop located in a dimple in the fuselage surface. Boundary-layer-control systems investigated are shown to provide important increases in performance. It appears that the flow instability frequently encountered in the case of twin internally coupled inlets will be avoided for design high-speed inlet-velocity ratios as low as 0.5.

NACA TN 3445

DESIGN AND PERFORMANCE OF THROTTLE-TYPE FUEL CONTROLS FOR ENGINE DYNAMIC STUDIES. Edward W. Otto, Harold Gold and Kirby W. Hiller. April 1955. 39p. diagrs., photo. (NACA TN 3445)

The results of an analytical and experimental investigation of the steady-state and dynamic characteristics of three types of throttle-controlled fuel systems are presented. The investigation covers the effect of output pressure on the controlled flow and the dynamic response of output flow to throttle movement. Results show that linearized analysis provides an adequate description of the dynamic response. The best system tested showed a usable frequency response to 300 cycles per second.

NACA TN 3498

EXPLORATORY INVESTIGATION OF AN AIRFOIL WITH AREA SUCTION APPLIED TO A POROUS, ROUND TRAILING EDGE FITTED WITH A LIFT-CONTROL VANE. Robert E. Dannenberg and James A. Weiberg. April 1955. 55p. diagrs., photos., 2 tabs. (NACA TN 3498)

A two-dimensional wind-tunnel investigation has been made of an NACA 65_1-012 airfoil modified with a porous, round trailing edge fitted with a small vane. Area suction was applied and the vane was used to fix the rear stagnation point. The effects of variations of the chordwise extent of suction and of the vane geometry were investigated with the aim of attaining high maximum lift with low suction quantity.

BRITISH REPORTS

N-36530*

Royal Aircraft Establishment (Gt. Brit.)
AN INVESTIGATION OF THE TEMPERATURE GRADIENTS ARISING FROM KEROSENE FIRES ON WATER. Jean Birchall, M. D. Knowles and J. A. Campbell. November 1954. 11p. diagrs., photos. (RAE Tech. Note Mech. Eng. 192)

When kerosene is burning on the surface of still water for short periods, the upper layer of water will reach boiling point, but there is a negligible temperature change at depths greater than 1 inch. Temperature gradients of the order of 600° C per inch, measured in the vertical plane, occur immediately above the water level, and of 100° C per inch, immediately below. Clearly defined effects are produced on metal specimens partially submerged in the water.

N-36531*

Royal Aircraft Establishment (Gt. Brit.)
A COUNTER CHRONOMETER FOR THE CALIBRATION OF PULSE INTERVALS IN MICROSECONDS. H. W. P. Knapp. November 1954. 23p. diagrs., photo. (RAE Tech. Note GW 346)

An electronic chronometer for the measurement of pulse intervals from 20 microseconds to 1.7 milliseconds is described with particular reference to the calibration of a pulse position system. The accuracy is 1 microsecond for a single count and about 0.25 microsecond for a run of 10 successive counts.

N-36533*

Royal Aircraft Establishment (Gt. Brit.)
PRESSURE LAG IN PIPES WITH SPECIAL REFERENCE TO AIRCRAFT SPEED AND HEIGHT MEASUREMENTS. Keith Smith. November 1954. 33p. diagrs., photos. (RAE Aero 2507)

A new method of applying lag corrections in flight is presented. It is based on the results of ground tests employing simulated steady dives and is shown to be more accurate than the method of Charnley using the response to a step input. The errors involved in measurement of lag in a pull-out are considered theoretically and are shown to be just appreciable in certain cases. Instrument lag is also briefly touched upon. A routine procedure for lag correction in flight is given.

N-36534*

Royal Aircraft Establishment (Gt. Brit.)
INTERIM NOTE ON THE DESIGN AND DEVELOPMENT OF A LABORATORY APPARATUS TO STUDY THE HIGH SPEED IMPACT BETWEEN A LIQUID DROP AND A SURFACE. D. C. Jenkins. December 1954. 25p. diagrs., photos. (RAE Tech. Note Mech. Eng. 193)

An apparatus is described which can be used for the study of the high-speed impact between a liquid drop and a surface. The apparatus has been used at speeds up to 800 ft/sec. Further development is described which will add to the scope of the apparatus.

N-36535*

Royal Aircraft Establishment (Gt. Brit.)
HOT HARDNESS TESTS ON SOME TITANIUM ALLOYS. D. M. Leggett and D. A. Sutcliffe. October 1954. 18p. diagrs., photos., 4 tabs. (RAE Tech. Note Met. 206)

The construction of a hot hardness tester is described. Details are given of the method of carrying out tests. The results of tests on some experimental and commercial titanium alloys are given, together with results of tests on stainless steel and Nimonic 95.

N-36536*

Royal Aircraft Establishment (Gt. Brit.)
THE DETERMINATION OF COEFFICIENTS OF HEAT TRANSFER TO A ROCKET MOTOR NOZZLE BY A TRANSIENT METHOD: PART II. W. S. Long. December 1954. 19p. diagrs., 2 tabs. (RAE Tech. Note RPD 114)

The measurements of heat transfer described in this note were made using a solid copper nozzle with an internal profile symmetrical about the throat. By this means it was possible to determine values at the throat of the nozzle and in the subsonic and supersonic regions of gas flow. The rate of heat transfer across the gas boundary layer was measured by determining the quantity of heat conducted into the nozzle by the transient measurement of temperatures at various points within it during the running time of the motor. The main purpose of the five firings described was to check the reproducibility of temperature measurements before embarking upon a comprehensive program. The reproducibility was found to be good.

N-36540*

Ministry of Supply (Gt. Brit.)
A REVIEW OF THE PROBLEM OF ABATING THE NOISE FROM AIRCRAFT. December 1954. 5p. (Ministry of Supply. NC 150)

The problem of abating noise from aircraft has been reviewed, with particular emphasis on the reduction of noise in the vicinity of airports. This review states briefly the salient facts concerning the noises from different sources and the possibilities of reducing them. The general conclusion is that, so far as present knowledge goes, no drastic reduction of noise can be achieved without introducing very great economic penalties.

N-36541*

Royal Aircraft Establishment (Gt. Brit.)
THE USE OF RESIN-GLASS LAMINATES FOR BATTERY CONTAINERS. M. M. Cornford and E. Haythornthwaite. November 1954. 16p., 7 tabs. (RAE Tech. Note Chem. 1241)

A study has been made of the factors affecting the resistance of glass fabric-resin fabrications to battery acid with a view to their use in battery containers. Polyester resins can be obtained which are resistant to the attack of the electrolyte. Low alkali glass is seriously attacked by battery acid and the use of high alkali glass in this application is recommended. Increased resistance of polyester resin glass fabric laminates to attack by battery acid is obtained if a finish is applied to the glass surface to obtain the strongest possible resin to glass bond on lamination.

N-36542*

Ministry of Supply (Gt. Brit.)
RESEARCH ON MOULDED DURESTOS AIRCRAFT STRUCTURES. FINAL REPORT - JUNE 1954. 161p. diagrs., photos., 53 tabs. (Ministry of Supply. S & TM 15/54)

The problem in this investigation was to establish a method of design and manufacture for certain type wing structures in the plastic material Durestos. The main objectives were to achieve efficiency on a strength-weight basis and a high rate of production at a cost far less than that normally associated with aircraft manufacture. It has been established that the first object can be met. In regard to the second object, further work on two different lines relating to workshop technology would need developing before mass production could be undertaken without risk of delays; the first relates to moulding tool manufacture while the second relates to "flock injection moulding" of the wing stiffening structure, for example, rib and spanwise internal flanges.

MISCELLANEOUS

N-35833

Advisory Group for Aeronautical Research and Development. PAPERS PRESENTED AT THE FIFTH MEETING OF THE WIND TUNNEL AND MODEL TESTING PANEL: MEASUREMENT OF AERODYNAMIC FORCES ON OSCILLATING AEROFOILS. A. I. van de Vooren, Nationaal Luchtvaartlaboratorium. A REVIEW OF THE TECHNIQUES OF MEASURING OSCILLATORY AERODYNAMIC FORCES AND MOMENTS ON MODELS OSCILLATING IN WIND TUNNELS IN USE ON THE CONTINENT. Jacques Valensi, Universite d'Aix-Marseille; APPENDIX: SYNTHETICAL METHODS FOR STUDY OF DYNAMIC FLIGHT PROPERTIES. E. Billion, ONERA. METHODS AND RESULTS OF NON-STATIONARY AIRFOIL THEORY. R. Timman, Nationaal Luchtvaartlaboratorium. TECHNIQUES OF MODEL TESTING IN FREE FLIGHT. Joseph A. Shortal, National Advisory Committee for Aero-

nautics. JET-ENGINE-DRIVEN WIND TUNNELS. F. B. Greatrex, Rolls-Royce, Ltd. SOME ASPECTS OF SUPERSONIC WIND TUNNELS OPERATING TECHNIQUES. John R. Markham, Massachusetts Institute of Technology. DEVELOPMENT OF INTERMITTENT WIND TUNNEL TECHNIQUE. J. Lukasiewicz, National Aeronautical Establishment, Canada. THE DESIGN OF LARGE HIGH-SPEED WIND TUNNELS. Ralph F. Huntsberger and John F. Parsons, National Advisory Committee for Aeronautics. NOTES ON THE DESIGN AND CONSTRUCTION OF THE WELDED STEEL STRUCTURE FOR THE 8 FT x 8 FT HIGH SPEED WIND TUNNEL AT THE NATIONAL AERONAUTICAL ESTABLISHMENT, BEDFORD. W. Wadkin and T. Barnes, British Ministry of Works. DESIGN AND CONSTRUCTION ASPECTS OF HIGH POWER WIND TUNNEL DRIVE SYSTEMS AND LARGE DIAMETER WIND TUNNEL COMPRESSORS. James Clark, Lovelace Foundation for Medical Education and Research. (Presented at Scheveningen Netherlands Conference, May 3-7, 1954) 192p. diagrs., photos. (Advisory Group for Aeronautical Research and Development. AG15/P6)

DECLASSIFIED NACA REPORTS

NACA RM E51C27

CRITERIONS FOR PREDICTION AND CONTROL OF RAM-JET FLOW PULSATIONS. William H. Sterbentz and John C. Evvard. May 16, 1951. 63p. diagrs., photos. (NACA RM E51C27) (Declassified from Confidential, 4/14/55)

Results of a theoretical and experimental study of ram-jet diffuser flow pulsing, commonly referred to as a "buzz condition," with and without combustion are presented. The theoretical approach to the problem is a simplified treatment of the ram jet likened to act as a Helmholtz resonator. The theoretical resonance criterions reasonably predicted the occurrence of diffuser-flow pulsations.

NACA RM E51D19

EXPERIMENTAL INVESTIGATION OF TYPICAL CONSTANT- AND VARIABLE-AREA EXHAUST NOZZLES AND EFFECTS ON AXIAL-FLOW TURBOJET-ENGINE PERFORMANCE. Lewis E. Wallner and John T. Wintler. July 1951. 43p. diagrs., photos. (NACA RM E51D19) (Declassified from Confidential, 4/14/55)

A study of the performance of constant- and variable-area exhaust nozzles and their effects on turbojet engines has been made from data obtained in the NACA Lewis altitude wind tunnel. The aspects covered include exhaust-nozzle velocity and flow coefficients at pressure ratios up to 3.6, a comparison of full- and small-scale nozzle data, and influence of exhaust nozzles on engine specific fuel consumption, thrust control, and afterburner performance.

NACA RM E52D30

INVESTIGATION OF POWER EXTRACTION CHARACTERISTICS AND BRAKING REQUIREMENTS OF A WINDMILLING TURBOJET ENGINE. Curtis L. Walker and David B. Fenn. July 1952. 31p. diagrs., tab. (NACA RM E52D30) (Declassified from Confidential, 4/14/55)

An investigation was conducted in an altitude chamber at the NACA Lewis Laboratory to determine the power extraction and braking characteristics of a windmilling single-spool axial-flow turbojet engine of the 5000-pound thrust class over a range of altitudes from 5000 to 50,000 feet and flight Mach numbers from 0.2 to 1.0. The constant applied torque required to stop the rotation of a windmilling engine in 0.2 minute at a simulated altitude of 40,000 feet was found to be 99 foot-pounds at a flight Mach number of 0.2 and 620 foot-pounds at a flight Mach number of 1.0. The torque required to stop the engine in 0.2 minute at a flight Mach number of 0.4 decreased from 290 foot-pounds as altitude was increased from 5000 to 50,000 feet.

NACA RM E52I24

AMPLITUDE OF SUPERSONIC DIFFUSER FLOW PULSATIONS. William H. Sterbentz and Joseph Davids. December 1952. 23p. diagrs. (NACA RM E52I24) (Declassified from Confidential, 4/14/55)

A theoretical method for evaluating the stability characteristics and the amplitude and frequency of pulsation of ram-jet engines without heat addition is presented. Theory and experiment show that the pulsation amplitude of a high-mass-flow ratio diffuser having no cone surface flow separation increases with decreasing mass flow. The theoretical trends for changes in amplitude, frequency, and mean-pressure recovery with changes in plenum-chamber volume were experimentally confirmed. For perforated, convergent-divergent-type diffusers, theory and experiment show the existence of a stability hysteresis loop on the pressure-recovery mass-flow-ratio curve.

NACA RM L52A18

AN ANALYSIS OF BUZZING IN SUPERSONIC RAM JETS BY A MODIFIED ONE-DIMENSIONAL NON-STATIONARY WAVE THEORY. Robert L. Trimpi. March 1952. 72p. diagrs., photos. (NACA RM L52A18) (Declassified from Confidential, 4/14/55)

Experimental instantaneous pressure records of simulated ram-jet models without heat addition showed that they buzzed in a manner governed internally by quasi-one-dimensional (plane-wave) theory, a manner which is not compatible with the laws of the Helmholtz (spherical-wave) theory. A theory applicable to the buzzing problem was obtained through modification of the one-dimensional, unsteady-flow theory. Theoretical computations of the pressure-time curves agreed closely with the experimental records. A possible simulation of the buzzing in ram jets with combustion by the test of a cold-flow model in which a contraction in area replaces the combustion chamber is also discussed.

NACA RM L52B14

FLIGHT MEASUREMENTS OF THE LATERAL STABILITY AND CONTROL CHARACTERISTICS OF A HIGH-SPEED FIGHTER AIRPLANE. H. L. Crane, A. R. Beckhardt and C. E. Matheny. September 1952. 50p. diagrs., tab. (NACA RM L52B14) (Declassified from Confidential, 4/14/55)

Results are presented of measurements made of controls-free lateral oscillations, sideslips, rudder kicks, and aileron rolls at 10,000 at Mach numbers up to 0.815 and 30,000 feet at Mach numbers up to 0.84. The variations of the static derivatives obtainable from the sideslip data with Mach number are presented. Discussion of the controls-free lateral oscillations and of the tendency toward rudder snaking is included.

NACA RM L52D08

PRELIMINARY STUDY OF SOME FACTORS WHICH AFFECT THE STALL-FLUTTER CHARACTERISTICS OF THIN WINGS. A. Gerald Rainey. July 1952. 33p. diagrs., photo., tab. (NACA RM L52D08) (Declassified from Confidential, 4/14/55)

The results of an exploratory, analytical, and experimental study of some of the factors which might be of importance in the stall flutter of thin wings are presented. The factors considered were Mach number, Reynolds number, density, aspect ratio, sweepback, structural damping, location of torsion nodal line, and concentrated weights.

NACA RM L52D10

PRELIMINARY EXPERIMENTAL INVESTIGATION OF THE FLIGHT OF A PERSON SUPPORTED BY A JET THRUST DEVICE ATTACHED TO HIS FEET. C. H. Zimmerman, Paul R. Hill and T. L. Kennedy. January 1953. 31p. diagrs., photos., 2 tabs. (NACA RM L52D10) (Declassified from Confidential, 4/11/55)

An investigation has been made of the stability and controllability in space of an arrangement comprising a man standing on a small platform which is rigidly connected to a jet nozzle having its thrust opposed to the pull of gravity. A man can stand stably on a jet-supported platform with little or no practice. Factors which would be thought to be disturbing, such as gyroscopic couples, off-center weights, inertia of the platform, and unsteady wind velocity, had no objectionable effects. A high degree of maneuverability in translational flight within the confines of a limited space was demonstrated.

NACA RM L53G28

A THEORY FOR STABILITY AND BUZZ PULSATION AMPLITUDE IN RAM JETS AND AN EXPERIMENTAL INVESTIGATION INCLUDING SCALE EFFECTS. Robert L. Trimpi. October 1953. 75p. diagrs., photos., 3 tabs. (NACA RM L53G28) (Declassified from Confidential, 4/14/55)

From a theory developed on a quasi-one-dimensional-flow basis, it is found that the stability of the ram jet is dependent upon the instantaneous values of mass flow and total pressure recovery of the supersonic diffuser and immediate neighboring subsonic diffuser. Conditions for stable and unstable flow are presented. The theory developed in the paper is in agreement with the experimental data of the papers of both Sterbentz and Evvard and Ferri and Nucci. A simple theory for predicting the approximate amplitude of small pressure pulsation in terms of mass-flow decrement from minimum-stable mass flow is developed and found to agree with experiments. Cold-flow tests at a Mach number of 1.94 of ram-jet models having scale factors of 3.15:1 and Reynolds number ratios of 4.75:1 with several supersonic diffuser configurations showed only small variations in performance between geometrically similar models. The conditions at which buzz originated were nearly the same for the same supersonic diffuser (cowling-position angle) configurations in both large and small diameter models (both Reynolds numbers). There was no appreciable variation in stability limits of any of the models when the combustion-chamber length was increased by a factor of three. The unsteady-flow performance and wave patterns were also similar when considered on a reduced-frequency basis depending on the relative lengths of the model. The velocity profile in the combustion chamber at both Reynolds numbers was appreciably influenced by an angle of attack of $1/2^{\circ}$.

NACA RM L54B12a

FLIGHT TESTS OF A MAN STANDING ON A PLATFORM SUPPORTED BY A TEETERING ROTOR. Paul R. Hill and T. L. Kennedy. March 1954. 26p. diagrs., photos. (NACA RM L54B12a) (Declassified from Confidential, 4/11/55)

Following the lead given by successful flight tests of a man standing on a jet-supported platform, flight tests were made of a man standing on a teetering-rotor-supported platform. The rotor was 7 feet in diameter as was driven by compressed-air jets at the tips supplied to the machine by air hoses. Hovering and limited translational flights from 1- to 7-foot elevations were made both indoors and outdoors. The stability and controllability of the machine and flyer combination were satisfactory.

NACA RM L54G14a

A PRELIMINARY FLIGHT INVESTIGATION OF AN OIL-FLOW TECHNIQUE FOR AIR-FLOW VISUALIZATION. Harold I. Johnson and Robert G. Mungall. October 1954. 33p. diagrs., photos. (NACA RM L54G14a) (Declassified from Confidential, 4/14/55)

Preliminary experiments were made to evaluate a simple oil-flow technique for use in flight research. Photographs of oil flow on the wing of a swept-wing airplane in transonic flight and oil patterns remaining on the wing after flight at transonic speeds are presented. Also included are comparable shadowgraph and tuft pictures. The technique shows considerable promise, particularly for future transonic- and supersonic-flight research.

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CURRENT NACA REPORTS

NACA Rept. 1173

ON TRAVELING WAVES IN BEAMS. Robert W. Leonard and Bernard Budiansky. 1954. iii, 27p. diagrs. (NACA Rept. 1173. Formerly TN 2874)

The basic equations of Timoshenko for the motion of vibrating nonuniform beams, which allow for effects of transverse shear deformation and rotary inertia, are presented in several forms; the propagation of sharp disturbances is discussed. Numerical traveling-wave solutions are obtained for some elementary problems of finite uniform beams for which the propagation velocities of shear and bending discontinuities are equal. Comparisons are made with modal solutions and, in some cases, with exact closed solutions.

NACA Rept. 1177

COMPARISON OF PERFORMANCE OF EXPERIMENTAL AND CONVENTIONAL CAGE DESIGNS AND MATERIALS FOR 75-MILLIMETER-BORE CYLINDRICAL ROLLER BEARINGS AT HIGH SPEEDS. William J. Anderson, E. Fred Macks and Zolton N. Nemeth. 1954. ii, 15p. diagrs., 6 tabs. (NACA Rept. 1177. Formerly TN 3001; TN 3002)

Studies are reported of four experimental bearings with outer-race-riding cages and inner-race-guided rollers operated at lower temperatures and to higher DN values (product of bearing bore in mm and shaft speed in rpm) than conventional inner- and outer-race-riding cage-type bearings. The experimental cages were designed to allow maximum cooling with minimum oil entrapment. In an investigation of four outer-race-riding cage-type bearings (two with bronze and two with nodular iron cages), heavy wear was found to accompany cage slip. Cage slip and, consequently, wear were found higher with nodular iron than with bronze at high speeds.

NACA Rept. 1185

THE CALCULATION OF PRESSURE ON SLENDER AIRPLANES IN SUBSONIC AND SUPERSONIC FLOW. Max. A. Heaslet and Harvard Lomax. 1954. ii. 11p. diagrs. (NACA Rept. 1185. Formerly TN 2900)

Under the assumption that a wing, body, or wing-body combination is slender or flying at near sonic velocity, expressions are given which permit the calculation of pressure in the immediate vicinity of the configuration. The disturbance field, in both subsonic and supersonic flight, is shown to consist of two-dimensional disturbance fields extending laterally and a longitudinal field that depends on the streamwise growth of cross-sectional area. A discussion is also given of couplings, between lifting and thickness effects, that necessarily arise as a result of the quadratic dependence of pressure on the induced velocity components.

NACA Rept. 1186

FORMATION AND COMBUSTION OF SMOKE IN LAMINAR FLAMES. Rose L. Schalla, Thomas P. Clark and Glen E. McDonald. 1954. ii, 21p. diagrs., photos. (NACA Rept. 1186. Formerly RM E51E15; RM E52G24; RM E52I22; RM E52I26; RM E53E05; RM E53J12; RM E54E03)

The nature and formation of smoke and its combustion were investigated. Factors affecting smoke formation were studied in both diffusion flames and premixed Bunsen flames. The variables investigated were (1) fuel type, (2) external air-flow rate, (3) oxygen-enrichment of external air, (4) substitution of argon for nitrogen in external oxidant, (5) fuel temperature or primary mixture temperature, and (6) pressure. The ability of a flame to burn smoke admitted from an exterior source was also studied. A critical survey was made of the literature pertaining to the mechanism of smoke formation.

NACA TN 3295

EFFECT OF PRESSURE ON THERMAL CONDUCTANCE OF CONTACT JOINTS. Martin E. Barzelay, Kin Nee Tong and George F. Holloway, Syracuse University. May 1955. 52p. diagrs., 2 tabs. (NACA TN 3295)

As an extension of previous experimental work further tests were conducted to determine the factors influencing the thermal conductance across the interface formed between stationary plane surfaces of 75S-T6 aluminum alloy and AISI Type 416 stainless-steel blocks. The types of joints investigated included bare metal-to-metal contact, contact surfaces separated by a good conductor (brass shim stock), and contact surfaces separated by a thin sheet of insulation (asbestos).

NACA TN 3297

EFFECT OF OXYGEN CONTENT OF FURNACE ATMOSPHERE ON ADHERENCE OF VITREOUS COATINGS TO IRON. A. G. Eubanks and D. G. Moore, National Bureau of Standards. May 1955. 17p. diagrs., photos., 2 tabs. (NACA TN 3297)

A series of vitreous coatings of the same basic composition, but with cobalt-oxide contents varying from 0 to 6.4 percent by weight, was fired on ingot iron in atmospheres consisting of various oxygen-nitrogen mixtures. The effect of the oxygen content of the atmosphere on adherence was determined by sub-

jecting each specimen to the American Society for Testing Materials adherence test, and the effect on interface roughness was estimated from examination of metallographic sections.

NACA TN 3381

HEAT-LOSS CHARACTERISTICS OF HOT-WIRE ANEMOMETERS AT VARIOUS DENSITIES IN TRANSONIC AND SUPERSONIC FLOW. W. G. Spangenberg, National Bureau of Standards. May 1955. 82p. diagrs., photos., 14 tabs. (NACA TN 3381)

An experimental investigation was made of the heat-loss characteristics of heated fine wires suitable for use as anemometers in turbulence research. Speeds ranged from low subsonic to Mach number 1.9. Density and temperature loading were varied over wide limits, and wire diameters ranged from 0.00005 to 0.0015 inch. The effects of each of the several variables on the heat-loss characteristics of both normally oriented and swept wires were measured.

NACA TN 3385

THEORY OF THE JET SYPHON. B. Szczeniowski, University of Montreal. May 1955. 49p. diagrs., 3 tabs. (NACA TN 3385)

A new approach to the theory of the mixing of two currents in an injector is presented, dealing with an incompressible ideal fluid. The theory shows new potentialities in an appropriate shaping of the form of the walls of the mixing zone so as to improve the jet-syphon efficiency beyond that heretofore predicted theoretically. Some examples of ways to improve jet-syphon efficiency are indicated.

NACA TN 3418

THE ZERO-LIFT WAVE DRAG OF A PARTICULAR FAMILY OF UNSWEPT, TAPERED WINGS WITH LINEARLY VARYING THICKNESS RATIO. Arthur Henderson, Jr. and Julia M. Goodwin. May 1955. 28p. diagrs. (NACA TN 3418)

On the basis of linear theory, the zero-lift wave drag of a particular family of unswept, tapered wings with linearly varying thickness ratio and symmetrical parabolic-arc sections has been calculated. By comparing the drag for these wings with that for a corresponding constant-thickness-ratio wing with rhombic sections, it is found that the variable-thickness-ratio wings can be used to advantage with no serious structural penalties if the wings are assumed to have the same given root thickness ratio or the same internal volume.

NACA TN 3436

AN INVESTIGATION OF SEVERAL NACA 1-SERIES NOSE INLETS WITH AND WITHOUT PROTRUDING CENTRAL BODIES AT HIGH-SUBSONIC MACH NUMBERS AND AT A MACH NUMBER OF 1.2. Robert E. Pendley and Harold L. Robinson. May 1955. 51p. diagrs., photos. (NACA TN 3436. Formerly RM L9L23a)

Measurements of pressure distribution, drag, and internal-flow pressure loss are presented for three NACA 1-series nose inlets, two of which were fitted with protruded central bodies. Test Mach number and inlet-velocity ratio ranged from 0.4 to 1.2 and from 0 to 1.34, respectively. The nose-inlet pressure drag at a Mach number of 1.2 and the central-body effects on subcritical drag, the supercritical drag rise, and the inlet total-pressure loss are discussed.

NACA TN 3450

PRELIMINARY INVESTIGATION OF PROPERTIES OF HIGH-TEMPERATURE BRAZED JOINTS PROCESSED IN VACUUM OR IN MOLTEN SALT. C. A. Gyorgak and A. C. Francisco. May 1955. 29p. diagrs., photos., 7 tabs. (NACA TN 3450)

An investigation was conducted to determine the effect of the variables temperature, time at temperature, and nickel addition to the braze alloy on the shear strength of high-temperature-alloy brazed joints processed in vacuum or in molten salt. Both brazing methods produced shear strengths greater than those of joints processed in dry hydrogen. Vacuum brazing was superior to salt-bath brazing, average shear strengths being on the order of 63,000 and 48,000 psi, respectively.

NACA TN 3451

ANALYSIS OF FULLY DEVELOPED TURBULENT HEAT TRANSFER AND FLOW IN AN ANNULUS WITH VARIOUS ECCENTRICITIES. Robert G. Deissler and Maynard F. Taylor. May 1955. 42p. diagrs. (NACA TN 3451)

A previous analysis for turbulent heat transfer and flow in tubes was generalized and applied to an annulus with various eccentricities. Expressions for eddy diffusivity which were varified for flow and heat transfer in tubes were assumed to apply in general along lines normal to a wall. Velocity distributions, wall shear-stress distributions, and friction factors, as well as wall heat-transfer distributions, wall temperature distributions, and average heat-transfer coefficients, were calculated for an annulus having a radius ratio of 3.5 at various eccentricities.

NACA TN 3452

INVESTIGATION OF JET-ENGINE NOISE REDUCTION BY SCREENS LOCATED TRANSVERSELY ACROSS THE JET. Edmund E. Callaghan and Willard D. Coles. May 1955. 27p. diagrs., photos., tab. (NACA TN 3452)

An investigation of screens located transversely across a jet as a noise-reduction device was conducted on a full-scale turbojet engine. The screens lowered the sound pressure levels rearward and increased them in front resulting in a nearly circular, nondirectional sound field. The sound power level was lowered by as much as 7.5 db by the proper screen choice and location, and, in addition, the maximum sound pressure level was decreased approximately 12 db over that of the engine alone.

NACA TN 3453

LONGITUDINAL TURBULENT SPECTRUM SURVEY OF BOUNDARY LAYERS IN ADVERSE PRESSURE GRADIENTS. Virgil A. Sandborn and Raymond J. Slogar. May 1955. 40p. diagrs., tab. (NACA TN 3453)

Results of measurements of the longitudinal velocity-component spectra at various positions through the boundary layer for four stations in increasing adverse pressure gradients are presented in tabular form. A comparison is presented between longitudinal turbulence spectra in zero pressure gradient and in moderate adverse pressure gradients (reasonably far from separation). The effect of pressure gradient was found to be small. The measured spectra are also compared with the predicted variations derived from the hypothesis of statistical equilibrium. Longitudinal-turbulence scales and microscales evaluated from spectrum measurements are given.

BRITISH REPORTS

N-36607*

Royal Aircraft Establishment (Gt. Brit.)
A STUDY OF THE LONGITUDINAL RESPONSE OF AIRCRAFT TO TURBULENT AIR. J. K. Zbrozek. January 1955. 31p. diagrs., tab. (RAE Aero 2530)

A method of calculating the aircraft dynamic behavior in turbulent air is presented. It is suggested that the assessment of the aircraft dynamic stability should include the study of aircraft behavior in turbulent air in addition to the present practice of evaluating the dynamic characteristics for perfectly smooth conditions. The dynamic behavior of aircraft in continuous turbulence is examined theoretically, investigating the influence of the following parameters: static margin (changing c.g. position), damping in pitch, lift slope, wing loading, and aircraft size. The theory outlined in the present paper provides the information required in gunnery and bombing problems and should be useful in the studies of automatic stabilization and gun- and bomb-sight design. Some results regarding gust loads in continuous turbulence are also obtained, which may have application in studies of the fatigue life of aircraft structures.

N-36608*

Royal Aircraft Establishment (Gt. Brit.)
TROPICAL EXPOSURE TESTS ON WOOD ASSEMBLY ADHESIVES AT T. T. E., NIGERIA. A. Baker and M. G. D. Hockney. January 1955. 11p. 3 tabs. (RAE Tech. Note Chem. 1244)

Tropical trials of assembly adhesives by the boxed test-piece technique have been proceeding for 3 years. Specimens have been withdrawn for strength testing, in comparison with temperate controls, at suitable periods. The results are discussed in the light of contemporary F. P. R. L sponsored trials of plywood and wood assembly adhesives.

N-36609*

Nat. Gas Turbine Establishment (Gt. Brit.)
CALCULATED WEAK LIMIT FLAME TEMPERATURES OF HYDROCARBON-AIR-DILUENT MIXTURES. B. P. Mullins and J. M. Marley. March 1955. 20p. diagrs., 7 tabs. (NGTE Memo. M. 235)

Weak limit flame temperatures (T_L) have been calculated for hydrocarbon-air-diluent systems using the known experimental values of the ternary compositions at the weak limit of inflammability. The effectiveness of five gaseous diluents in causing T_L to increase lies in the ascending order: argon, nitrogen, water vapor, carbon dioxide, and carbon tetrachloride.

N-36611*

Royal Aircraft Establishment (Gt. Brit.)
THE LOAD DISTRIBUTION AT SONIC SPEED OVER A FAMILY OF LINEARLY TWISTED WINGS WITH STRAIGHT-EDGED PLANFORMS. D. G. Randall. January 1955. 42p. diagrs., 3 tabs. (RAE Aero 2531)

The method for the calculation of the load distribution over a wing at sonic speed described by K. W. Mangler, which is based on linearized potential flow, is applied to a family of linearly twisted wings with straight-edged plan forms. The results obtained are plotted against the following three parameters: A the aspect ratio, $1 - \lambda/1 + \lambda$, where λ is the taper ratio, and A tan Λ 1/2, where Λ 1/2 is the sweepback angle of the half-chord line. The results obtained in previous work for the same family of plan forms at incidence are plotted against the same parameters. In addition a particular wing is studied in detail; chordwise pressure distributions, spanwise loading, etc. are presented for the plane wing at incidence and the twisted wing at zero incidence.

N-36616*

Aeronautical Research Council (Gt. Brit.)
THE INTERACTION BETWEEN SHOCK WAVES AND BOUNDARY LAYERS. D. W. Holder, H. H. P Pearcey and G. E. Gadd. WITH A NOTE ON THE EFFECTS OF THE INTERACTION ON THE PERFORMANCE OF SUPERSONIC INTAKES. J. Seddon. 1955. 101p. diagrs., photos., 2 tabs. (ARC CP 180)

The interaction between shock waves and boundary layers has important effects in many problems of high-speed flow. This paper has been written as a guide to the literature on the subject, and as a critical review of the present state of knowledge concerning both the underlying physical processes and the practical applications. Part I of the paper describes experiments on comparatively simple types of flow designed to provide fundamental information and to assist in the development of the theory. Many of the features found in the fundamental experiments appear also in practical applications and these are considered in Parts II and III. Some notes on the further work that is required are given in Part IV.

N-36617*

Aeronautical Research Council (Gt. Brit.)
REPORT OF THE DEFINITIONS PANEL ON THE DEFINITIONS OF THE THRUST OF A JET ENGINE AND OF THE INTERNAL DRAG OF A DUCTED BODY. 1955. 28p. diagrs. (ARC CP 190)

The problems which occur in defining the thrust of a jet engine and the internal drag of a ducted body are considered, and formal definitions and names are given for the concepts considered to be of importance.

N-36618*

Aeronautical Research Council (Gt. Brit.)
SHADOWGRAPHS OF MODEL PROJECTILES FIRED AT HIGH MACH NUMBERS AND NEAR M = 1 IN THE N. P. L. BALLISTIC RANGE. W. F. Cope. 1955. 49p. diagrs., photos. (ARC CP 189)

Shadowgraphs of 20 mm projectiles fired at Mach numbers above 3 are shown and the important features are discussed. Shadowgraphs of three rounds which passed through M = 1 are also shown. In all three cases the drag coefficient was determined, and for one, all of the aerodynamic coefficients were found. The effect of the retardation is discussed and it is concluded that the effect is probably small enough to be negligible except perhaps on the drag. These rounds were stable. The unstable region for a projectile is at a lower Mach number (about 0.75). To illustrate this, the analysis of some earlier rounds is included.

N-36619*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE FLOW NEAR THE TAIL OF A TWO-DIMENSIONAL AEROFOIL MOVING AT A FREE-STREAM MACH NUMBER CLOSE TO UNITY. D. W. Holder. 1955. 11p. diagrs., photos. (ARC CP 188)

A qualitative argument, which is supported by experimental evidence, suggests that the local Mach number downstream of the trailing-edge shock waves is approximately independent of free-stream Mach number, airfoil geometry, and angle of attack. Thus, there is a unique relationship between the flow deflection angle at the trailing edge and the local Mach number just upstream of the trailing-edge shock waves. This relationship is determined from wind-tunnel experiments on RAE series airfoils and may be used to give rapid estimates of the local Mach number at the trailing-edge of an airfoil in terms of the trailing-edge angle, angle of attack, and control angle. The characteristics of straight-sided controls are considered for an example.

N-36621*

Aeronautical Research Council (Gt. Brit.)
INTEGRATION OF THE BOUNDARY LAYER EQUATIONS FOR A PLANE IN COMPRESSIBLE FLOW BY THE METHOD OF STEEPEST DESCENT. D. Meksyn. July 31, 1954. 11p. tab. (ARC 16,961; FM 2098)

In a former paper the author found the asymptotic integrals of the equations of motion for the flow past a semi-infinite plane for supersonic speed, for the case when the coefficients of viscosity and conductivity depend on or are independent of temperature, and has shown that the results obtained are in close agreement with those found by numerical integration. The integration was carried out for the case of no heat transfer and for a particular value of Prandtl number $\sigma = 0.733$. The aim of the present paper is to extend the integration of the equations to the general case of heat transfer and arbitrary σ (close to unity).

N-36622*

Aeronautical Research Council (Gt. Brit.)
SURFACE NOISE FROM A PLANE TURBULENT BOUNDARY LAYER. O. M. Phillips. August 4, 1954. 15p. diagr. (ARC 16,963; FM 2099)

A study is made of the properties of the viscous sublayer in a turbulent flow past a solid boundary, from which the surface noise produced by the distribution of fluctuating stresses on a plane boundary can be estimated. The intensity of the surface noise per unit area is compared with the expression given by Lighthill for the aerodynamic quadrupole noise of a turbulent boundary layer. It appears that for Mach numbers less than about unity, the dipole radiation from the surface is more efficient than the quadrupole radiation from the turbulent boundary layer itself.

N-36625*

Aeronautical Research Council (Gt. Brit.)
THE DISTRIBUTION OF PRESSURE ON AN AEROFOIL, IN A STREAM WITH A SPANWISE VELOCITY GRADIENT. W. A. Mair. July 13, 1954. 16p. diagrs., 3 tabs. (ARC 16,937; FM 2093)

Pressure measurements were made at one section of an airfoil of constant chord spanning a wind tunnel. A flat plate was mounted in the tunnel upstream of the airfoil so that the wake from the plate produced a spanwise velocity gradient at the airfoil. By traversing the plate across the tunnel, the position of the wake could be altered relative to the pressure holes in the airfoil so that the complete pressure distribution over the airfoil in the neighborhood of the wake could be found. The results showed that, because of the secondary flow produced by the interaction between the airfoil and the wake, the variation of the pressure across the wake for a given chordwise position was very small, except close to the leading edge. The lift coefficient was nearly constant across the wake. The form drag coefficient was considerably reduced in the wake.

N-36626*

Aeronautical Research Council (Gt. Brit.)
ON THE EFFECT OF WING BENDING ON THE ACCELERATION DUE TO LANDING IMPACT. A. R. Collar. June 1954. 6p. diagrs. (ARC 16,960; S. 729)

Some previously recorded measurements of the normal accelerations due to landing of a seaplane at varying vertical velocities are compared with accelerations theoretically predicted. While good

agreement is obtained on the magnitude of the peak acceleration, this peak occurs in all cases about twice as long after impact as is predicted by theory. Various explanations have been considered, including that of wing bending; however, this had been discarded. The present author believes that the flexibility of the structure might cushion the impact. Since all the vertical momentum must be destroyed, whether the wings are flexible or not, it is to be expected that the peak acceleration will be about the same, but it will occur later if the wings flex than if they are rigid. A simple mathematical model is discussed.

N-36638*

Ministry of Supply (Gt. Brit.)
EXPERIENCE OF FATIGUE AT WEYBRIDGE. Part 2: - AN INVESTIGATION INTO THE FATIGUE STRENGTH OF ALUMINIUM ALLOY TO SPECIFICATION. D. T. D. 364. (Part 2 of final report prepared by Vickers-Armstrong, Ltd., Weybridge) March 1955. iii, 31p. diagrs., 15 tabs. (Ministry of Supply. S & TM 2/55)

This report presents the results of a series of direct stress fatigue tests on aluminum alloy D. T. D. 364 (2014). The work described in this report shows clearly the difficulty of establishing for a given material allowable fatigue stresses on simple specimens. It is considered that much more work is necessary on other light alloy specifications, and that more work should be undertaken to establish precisely the calibration of fatigue testing machines.

N-36639*

Royal Aircraft Establishment (Gt. Brit.)
SOME PROPELLER NOISE CALCULATIONS SHOWING THE EFFECT OF THICKNESS AND PLANFORM. K. V. Diprose. January 1955. 16p. diagrs., 4 tabs. (RAE Tech. Note MS 19)

Sound pressures have been calculated for a propeller designed for a high-speed airplane (Mach 0.77). The contribution to the noise due to the blade thickness was much larger than expected; reasons are given for doubting the validity of the formulas used, and ways of improving them suggested. Tapering the plan form, to move the main sources of noise further inboard to regions of lower Mach number was found to produce only small relief in the calculated noise.

N-36641*

Royal Aircraft Establishment (Gt. Brit.)
WIND TUNNEL OBSERVATIONS OF BOUNDARY LAYER TRANSITION ON TWO SWEPTBACK WINGS AT A MACH NUMBER OF 1.61. J. B. Scott-Wilson and D. S. Capps. December 1954. 12p. diagrs., photos. (RAE Tech. Note Aero 2347)

Visual observations of transition were made on two sweptback wings at a Mach number of 1.61. Laminar boundary-layer instability which resulted in the formation of streamwise vortices, was found on these wings. At zero incidence the Reynolds number, based on the mean chord of the wing, at which this instability occurred, 1.9×10^6, was very much lower than the critical value predicted by low-speed theory. At incidence the laminar boundary layer on the wing was found to be more stable on the upper surface, but less stable on the lower surface than at zero incidence.

N-36642*

Royal Aircraft Establishment (Gt. Brit.)
THE MECHANISM OF FATIGUE FAILURE IN SOME BINARY AND TERNARY ALUMINIUM ALLOYS. P. J. E. Forsyth and C. A. Stubbington. December 1954. 27p. diagrs., photos., tab. (RAE Met. 81)

The fatigue process in a number of aluminum alloys was found to be one of depletion of solute atoms in localized regions under the action of cyclic stresses. This depletion or overageing provided soft spots in the structure in which most of the subsequent plastic deformation was concentrated. Depending on temperature, these depleted zones were trans or intercrystalline, and the subsequent fatigue crack followed these paths. A crack once started, might, by virtue of the heavy stress concentration, produce its own depleted zone ahead of the root, and could thus progress without particular reference to existing soft spots.

MISCELLANEOUS

NACA TN 3152

Errata on "TRANSVERSE OSCILLATIONS IN A CYLINDRICAL COMBUSTION CHAMBER." Franklin K. Moore and Stephen H. Maslen. October 1954.

N-37041

Advisory Group for Aeronautical Research and Development. PROCEEDINGS OF THE THIRD AGARD GENERAL ASSEMBLY, SEPTEMBER 7 AND 10, 1953: ROLE OF RESEARCH AND DEVELOPMENT IN AVIATION DURING THE LAST TEN YEARS. Harry Garner, Ministry of Supply. SOME TASKS FOR AGARD. O. H. Wansbrough-Jones, Ministry of Supply. THE REVIEW OF ICING RESEARCH. (Problemes poses par le givrage des avions). Edmond A. Brun, National Council of Scientific Research. THOUGHTS ON FUTURE NOISE SUPPRESSION RESEARCH. E. J. Richards, University of Southampton. THE STRUCTURAL EFFECTS OF AERODYNAMIC HEATING. N. J. Hoff, Polytechnic Institute of Brooklyn; APPENDIX I: THERMAL CONDITIONS ASSOCIATED WITH AIRCRAFT IN FLIGHT. Martin Bloom, Polytechnic Institute of Brooklyn; APPENDIX II: SIMULATION OF AERODYNAMIC HEATING IN STRUCTURAL TESTING. Joseph Kempner, Polytechnic Institute of Brooklyn. FOUNDATIONS OF OPERATIONAL RESEARCH. Theodore von Karman. OPERATIONAL RESEARCH. B. G. Dickins, Air Ministry. AEROMEDICAL INTERESTS - LOOKING FORWARD. Otis O. Benson, Jr., USAF. EXAMPLES OF NATO

N-37041

EXCHANGE OF SCIENTIFIC PERSONNEL. M. Brull, University of Michigan. A TOUR OF WESTERN EUROPE: APRIL, 1953. Edited by L. H. G. Sterne. (Presented at London AGARD Conference, September 3-11, 1953). 115p. diagrs., photos. (Advisory Group for Aeronautical Research and Development. AG6/P3)

N-37086*

Advisory Group for Aeronautical Research and Development. SPONTANEOUS IGNITION OF LIQUID FUELS. B. P. Mullins. 1955. xi, 117p. diagrs. (AGARDograph 4)

This book is a survey and review of the present status of knowledge in that area of the combustion field concerned with spontaneous ignition. The test methods used to obtain spontaneous ignition temperature are described in detail and spontaneous ignition temperature data are presented for 433 substances. Additional information is given on general theoretical considerations, fuel additives, and applications of spontaneous ignition data.

(May be purchased from Butterworth's Publications, Ltd., 88 Kingsway, London, W. C. 2, England at $2.75.)

N-37087*

Advisory Group for Aeronautical Research and Development. ANTHROPOMETRY AND HUMAN ENGINEERING: BODY MEASUREMENTS IN RELATION TO WORK SPACES IN AIRCRAFT. G. M. Morant. STATISTICS OF ELEMENTARY MEDICAL BIOMETRY RELATIVE TO PILOTS OF THE FRENCH AIR FORCE. (STATISTIQUES DE BIOMETRIE MEDICALE ELEMENTAIRE RELATIVES AU PERSONNEL NAVIGANT DE L'ARMEE DE L'AIR FRANCAISE). E. Ducros. SHELDON TYPES AND SUCCESS IN FLIGHT PERFORMANCE. Johs. Dossing. ADAPTING THE AEROPLANE TO THE PILOT. W. K. Stewart. INSTRUMENT DIALS, INSTRUMENT ARRANGEMENT AND COCKPIT DESIGN. Walter F. Grether. A METHODOLOGY FOR INSTRUMENT DISPLAY DESIGN. George W. Hoover. FACTORS AFFECTING THE VALIDITY AND UTILITY OF AEROMEDICAL RESEARCH DATA. Robert B. Payne. THE ESTABLISHMENT OF A LONGITUDINAL STUDY OF THE MEDICAL AND PSYCHOLOGICAL ASPECTS OF THE U. S. NAVAL AVIATOR. Ashton Graybiel. SOMATOTYPING. P. M. Van Wulfften Palthe. HUMAN FACTORS IN AIRCRAFT DESIGN. Morley Gray Whillans. (Symposium held May 3-4, 1954, Scheveningen, Netherlands). 1955. 123p. diagrs., photos., tabs. (AGARDograph 5)

(May be purchased from Butterworth's Publications, Ltd., 88 Kingsway, London, W. C. 2, England at $3.00.)

DECLASSIFIED NACA REPORTS

NACA RM A51E16

A FLIGHT STUDY OF REQUIREMENTS FOR SATISFACTORY LATERAL OSCILLATORY CHARACTERISTICS OF FIGHTER AIRCRAFT. Charles J. Liddell, Jr., Brent Y. Creer and Rudolph D. Van Dyke, Jr. July 1951. 39p. diagrs., photo., 2 tabs. (NACA RM A51E16) (Declassified from Confidential, 5/10/55)

A conventional, propeller-driven fighter, fitted with servo devices for varying in flight the dihedral effect, the static directional stability, and the directional damping was used in a pilot-opinion survey to determine the lateral-oscillatory characteristics which go to make up satisfactory lateral flying qualities. In addition, the lateral aperiodic motions encountered during the investigation and their relations to the pilots' opinions are discussed.

NACA RM E52E16

EXPERIMENTAL INVESTIGATION OF AIR-FLOW UNIFORMITY AND PRESSURE LEVEL ON WIRE CLOTH FOR TRANSPIRATION-COOLING APPLICATIONS. Patrick L. Donoughe and Roy A. McKinnon. July 1952. 28p. diagrs., photos., tab. (NACA RM E52E16) (Declassified from Confidential, 5/10/55)

An experimental investigation was conducted to obtain information on air-flow uniformity and pressure-level effects for various meshes of stainless-steel corduroy wire cloth, and permeability and strength data for a 20- by 20-mesh stainless-steel wire cloth. It was found that close control of the wire cloth thickness yielded sufficiently uniform air flow and that available methods may be used to predict the effect of pressure level. Permeability and strengths of the 20- by 20-mesh wire cloth were similar to those already available from other meshes. The reduced tensile strength of the 20- by 20-mesh wire cloth in the direction of the primary stresses is one and a half to three times as great as the strength of the best porous sintered materials presently available.

NACA RM L52E07

AN INVESTIGATION OF THE LOW-SPEED LONGITUDINAL STABILITY CHARACTERISTICS OF A SWEPT-WING AIRPLANE MODEL WITH TWO MODIFICATIONS TO THE WING-ROOT PLAN FORM. William B. Kemp, Jr. July 1952. 17p. diagrs., tab. (NACA RM L52E07) (Declassified from Confidential, 5/10/55)

An investigation has been conducted in the Langley 300-mph 7- by 10-foot tunnel to determine the effects of two wing-root leading-edge plan-form modifications on the low-speed longitudinal stability characteristics of a complete airplane model having a 50.7° sweptback wing.

NACA RM L53E11

EFFECTS OF RATE OF FLAP DEFLECTION ON FLAP HINGE MOMENT AND WING LIFT THROUGH THE MACH NUMBER RANGE FROM 0.32 TO 0.87. Thomas R. Turner. June 1953. 29p. diagrs., photos. (NACA RM L53E11) (Declassified from Confidential, 5/10/55)

An investigation at Mach numbers from 0.32 to 0.87 has been made to determine the effect of rate of flap deflection on flap hinge moment and wing lift. Rate of flap deflection varied from 0° to 1.17^{o} per chord length of travel. The Reynolds number varied from approximately 1.0 to 2.3 x 10^{6}. The wing had an aspect ratio of 4, a taper ratio of 0.6, and zero sweep of the 75-percent-chord line. The wing was fitted with a full-span 25-percent-chord plain flap.

NACA RM L53E15

SOME OBSERVATIONS ON STALL FLUTTER AND BUFFETING. A. Gerald Rainey. June 1953. 11p. diagrs. (NACA RM L53E15) (Declassified from Confidential, 5/10/55)

An attempt is made to describe the phenomenological differences between stall flutter and buffeting. Some experimental results are presented concerning both the boundaries at which these phenomena occur and the stresses involved.

National Advisory Committee for Aeronautics

Research Abstracts

NO.84 JUNE 9, 1955

CURRENT NACA REPORTS

NACA Rept. 1182

COMPARISON OF EFFECTIVENESS OF CONVECTION-, TRANSPIRATION-, AND FILM-COOLING METHODS WITH AIR AS COOLANT. E. R. G. Eckert and John N. B. Livingood. 1954. ii, 17p. diagrs. (NACA Rept. 1182. Formerly TN 3010)

Material necessary for a comparison of the cooling requirements of film and transpiration cooling with conventional convection cooling is presented. Both laminar and turbulent flow, with and without radiation, are considered for a flat plate. The superiority of transpiration cooling is clearly shown for both laminar and turbulent flow.

NACA RM L55D15a

SOME OBSERVATIONS ON LOSS OF STATIC STRENGTH DUE TO FATIGUE CRACKS. Walter Illg and Herbert F. Hardrath. May 1955. 8p. diagrs. (NACA RM L55D15a)

Static tensile tests were performed on simple notched specimens containing fatigue cracks. Four types of aluminum alloys were investigated: 2024-T3 (formerly 24S-T3) and 7075-T6 (formerly 75S-T6) in sheet form, and 2024-T4 (formerly 24S-T4) and 7075-T6 (formerly 75S-T6) in extruded form. The cracked specimens were tested statically under four conditions: unmodified and with reduced eccentricity of loading by three methods. Results of static tests on C-46 wings containing fatigue cracks are also reported.

NACA RM L55D15b

PRELIMINARY INVESTIGATION OF THE FAILURE OF PRESSURIZED STIFFENED CYLINDERS. Norris F. Dow and Roger W. Peters. May 1955. 14p. diagrs., photos., tab. (NACA RM L55D15b)

Tests were made of stiffened cylinders of 2024 aluminum alloy under internal pressure and cyclic torsion. Both gradual and explosive types of failures occurred. The type of failure depended upon the hoop stress and structural configuration, particularly on the ratio of area in rings to associated skin area.

NACA TM 1379

A METHOD OF QUADRATURE FOR CALCULATION OF THE LAMINAR AND TURBULENT BOUNDARY LAYER IN CASE OF PLANE AND ROTATIONALLY SYMMETRICAL FLOW. (Ein Quadraturverfahren zur Berechnung der laminaren und turbulenten Reibungsschicht bei ebener und rotationssymmetrischer Strömung). E. Truckenbrodt. May 1955. 40p. diagrs. (NACA TM 1379. Trans. from Ingenieur-Archiv, v. 20, no. 4, 1952, p. 16-228).

For calculation of the characteristic parameters of the boundary layer (momentum-loss thickness and form parameter for the velocity profile), two quadrature formulas are given which are valid for the laminar as well as for the turbulent state of flow. These formulas cover both the two-dimensional and the rotationally symmetrical case. The calculation of the momentum-loss thickness is carried out by a simple integration of the energy theorem. The equation for the form parameter is obtained by coupling of the momentum theorem with the energy theorem. Knowledge of the derivatives of the velocity distribution and of the radius of the body along the length x is not necessary.

NACA TN 3296

SEPARATION, STABILITY, AND OTHER PROPERTIES OF COMPRESSIBLE LAMINAR BOUNDARY LAYER WITH PRESSURE GRADIENT AND HEAT TRANSFER. Morris Morduchow and Richard G. Grape, Polytechnic Institute of Brooklyn. May 1955. 45p. diagrs., 6 tabs. (NACA TN 3296)

A theoretical study is made of the effect of pressure gradient, wall temperature, and Mach number on laminar boundary-layer characteristics and, in particular, on the skin-friction and heat-transfer coefficients, on the separation point in an adverse pressure gradient, on the wall temperature required for complete stabilization of the laminar boundary layer, and on the minimum critical Reynolds number for laminar stability. A simple and accurate method of locating the separation point in a compressible flow with heat transfer is developed.

NACA TN 3314

A TECHNIQUE UTILIZING ROCKET-PROPELLED TEST VEHICLES FOR THE MEASUREMENT OF THE DAMPING IN ROLL OF STING-MOUNTED MODELS AND SOME INITIAL RESULTS FOR DELTA AND UNSWEPT TAPERED WINGS. William M. Bland, Jr. and Carl A. Sandahl. May 1955. 25p. diagrs., photos., tab. (NACA TN 3314. Formerly RM L50D24)

* AVAILABLE ON LOAN ONLY.
ADDRESS REQUESTS FOR DOCUMENTS TO NACA, 1512 H ST., NW., WASHINGTON 25, D. C., CITING CODE NUMBER ABOVE EACH TITLE, THE REPORT TITLE AND AUTHOR.

A free-flight test technique with which the damping in roll of sting-mounted models can be measured over the high subsonic, transonic, and supersonic speed range with rocket-propelled test vehicles is described. Initial results for delta and unswept tapered wings are presented and compared with theory.

NACA TN 3367

A DYNAMIC-MODEL STUDY OF THE EFFECT OF ADDED WEIGHTS AND OTHER STRUCTURAL VARIATIONS ON THE BLADE BENDING STRAINS OF AN EXPERIMENTAL TWO-BLADE JET-DRIVEN HELICOPTER IN HOVERING AND FORWARD FLIGHT. John Locke McCarty and George W. Brooks. May 1955. i. 47p. diagrs., photo., 6 tabs. (NACA TN 3367)

An experimental investigation of the rotor system of a 1/10-scale dynamic model of an experimental two-blade jet-driven helicopter to determine the effect of various changes in the design configuration on the blade bending strains has been conducted. These changes included the addition of different amounts of concentrated weight to the blades at various radial and chordwise locations and variations in the design counterweight locations, as well as changes in the blade-pitch-control stiffness. The blade bending strains could be materially reduced by adding concentrated weights to the blades in such a manner as to minimize resonance conditions or to induce favorable coupling of blade bending and torsion deformations.

NACA TN 3394

LOW-SPEED INVESTIGATION OF THE EFFECTS OF ANGLE OF ATTACK ON THE PRESSURE RECOVERY OF A CIRCULAR NOSE INLET WITH SEVERAL LIP SHAPES. James R. Blackaby. May 1955. 30p. diagrs., photo. (NACA TN 3394)

An investigation was made at a free-stream Mach number of 0.237 of the effects of lip bluntness and profile on the total-pressure recovery of a circular nose inlet in a ducted body of revolution at angles of attack up to 25°. A sharp inlet lip having a wedge angle of $7\text{-}1/2^{\circ}$ was tested in addition to two circular-arc lips and two lips with elliptical profiles, all of which were formed within the $7\text{-}1/2^{\circ}$ angle of the sharp lip.

NACA TN 3395

ON THE CALCULATION OF THE 1·P OSCILLATING AERODYNAMIC LOADS ON SINGLE-ROTATION PROPELLERS IN PITCH ON TRACTOR AIRPLANES. Vernon L. Rogallo and Paul F. Yaggy. May 1955. 28p. diagrs., photo. (NACA TN 3395)

A procedure for calculating the 1·P oscillating aerodynamic thrust loads on single-rotation, tractor propellers in pitch at zero yaw is developed and is evaluated. Application of the procedure requires knowledge of only the upflow angles at the horizontal center line of the propeller disk. The applicability of the procedure to various airplane configurations is discussed.

NACA TN 3417

MEASUREMENTS OF FREE-SPACE OSCILLATING PRESSURES NEAR A PROPELLER AT FLIGHT MACH NUMBERS TO 0.72. Arthur W. Vogeley and Max C. Kurbjun. May 1955. 24p. diagrs., photos., tab. (NACA TN 3417)

Limited measurements have been made of the free-space oscillatory pressures near the tips of a propeller at flight Mach numbers up to 0.72. Measurements were made at a single radial station and at three axial positions (ahead of, in the plane of, and behind the propeller disk). Comparisons, showing the effects of forward Mach number on oscillating pressures, are made with the Garrick-Watkins theory (NACA TN 3018).

NACA TN 3424

AERODYNAMIC CHARACTERISTICS OF SEVERAL 6-PERCENT-THICK AIRFOILS AT ANGLES OF ATTACK FROM 0° TO 20° AT HIGH SUBSONIC SPEEDS. Bernard N. Daley and Douglas R. Lord. May 1955. 57p. diagrs., photos. (NACA TN 3424. Formerly RM L9E19)

Aerodynamic characteristics obtained from two-dimensional tests of eight 6-percent-thick symmetrical airfoils of the supersonic and subsonic type are presented at angles of attack from 0° to 20° and at Mach numbers from 0.3 to about 0.9. Results indicate generally improved characteristics for the circular-arc and wedge-type airfoils when the maximum thickness was located forward. The variations with Mach number of the lift, drag, and pitching-moment coefficients are generally similar for those supersonic- and subsonic-type airfoils tested.

NACA TN 3425

SOME CALCULATIONS OF THE LATERAL RESPONSE OF TWO AIRPLANES TO ATMOSPHERIC TURBULENCE WITH RELATION TO THE LATERAL SNAKING PROBLEM. John D. Bird. May 1955. 24p. diagrs., 2 tabs. (NACA TN 3425. Formerly RM L50F26a)

Results of calculations of the lateral response to representative time histories of atmospheric turbulence for two airplanes having widely different dynamic properties indicate that, under the proper conditions, atmospheric turbulence can initiate and maintain a lateral hunting oscillation of an airplane, and that this oscillation can be fairly regular in both amplitude and frequency. This effect is more pronounced for lightly damped airplanes.

NACA TN 3427

THEORETICAL INVESTIGATION OF A PROPORTIONAL-PLUS-FLICKER AUTOMATIC PILOT. Ernest C. Seaberg. May 1955. 53p. diagrs., photo., tab. (NACA TN 3427. Formerly RM L50I19)

An analysis has been made of the stability of a supersonic canard airframe and a proportional-plus-flicker autopilot. Essentially, this autopilot maintains a zero reference about which the output is proportional to the input and a flicker response overrides this proportional response at a fixed angle of gimbal displacement on either side of the zero gyroscope reference. The analysis consists of an investigation of the calculated transient responses based on the variation of the autopilot and aerodynamic parameters. The calculations are based on the assumption that the proportional part of the system either contains a perfect autopilot or is the actual autopilot frequency response approximated by mathematical transfer function.

NACA TN 3433

TOTAL LIFT AND PITCHING MOMENT ON THIN ARROWHEAD WINGS OSCILLATING IN SUPERSONIC POTENTIAL FLOW. H. J. Cunningham. May 1955. 43p. diagrs., 4 tabs. (NACA TN 3433)

Total lift and moment coefficients are given for thin arrowhead wings oscillating in pitch and vertical translation which extend to the fifth power and to the third power of the frequency for the subsonic- and supersonic-leading-edge cases, respectively. These expressions are sufficiently accurate to make them potentially useful in flutter applications.

NACA TN 3438

ON THE KERNEL FUNCTION OF THE INTEGRAL EQUATION RELATING LIFT AND DOWNWASH DISTRIBUTIONS OF OSCILLATING WINGS IN SUPERSONIC FLOW. Charles E. Watkins and Julian H. Berman. May 1955. 43p. (NACA TN 3438)

A suitable form of doublet potential that serves as a basis for deriving the kernel function for supersonic flow, corresponding to the kernel function for subsonic flow presented in NACA TN 3131, is derived by using a cutoff or unit function. A treatment similar to that made for the subsonic kernel is made for the kernel function for supersonic flow. The singularities are isolated and discussed, and the kernel function is shown to lead to correct results for two-dimensional flow, and to reduce properly to the sonic case.

NACA TN 3439

ANALYSIS OF EAR FORMATION IN DEEP-DRAWN CUPS. Arthur J. McEvily, Jr. May 1955. 7p. diagrs. (NACA TN 3439)

A review of the literature on deep drawing and on anisotropy of metals indicates that no direct correlation has been established between the number and location of the ears on deep-drawn cups and the preferred crystallographic orientation of the blank material. In the present paper, a method for predicting earing behavior is proposed which is based on the plastic properties of single crystals and a knowledge of the preferred orientation of the blank material. The proposed method of prediction is in satisfactory agreement with reported experimental results.

NACA TN 3440

HOVERING FLIGHT TESTS OF A FOUR-ENGINE-TRANSPORT VERTICAL TAKE-OFF AIRPLANE MODEL UTILIZING A LARGE FLAP AND EXTENSIBLE VANES FOR REDIRECTING THE PROPELLER SLIPSTREAM. Louis P. Tosti and Edwin E. Davenport. May 1955. 26p. diagrs., photos., tab. (NACA TN 3440)

An investigation of the take-off, landing, and hovering flight characteristics of a four-engine-transport, vertical take-off airplane has been conducted with a remotely controlled free-flight model. The model had four propellers distributed along the wing with thrust axes parallel to the fuselage axis. In order to produce direct lift for hovering flight the propeller slipstream was deflected downward about 70° by a full-span 65-percent-chord flap deflected 90° and eight extensible vanes arranged above the wing in a cascade relation.

NACA TN 3441

AN NACA VANE-TYPE ANGLE-OF-ATTACK INDICATOR FOR USE AT SUBSONIC AND SUPERSONIC SPEEDS. Jesse L. Mitchell and Robert F. Peck. May 1955. 8p. diagrs., photo. (NACA TN 3441. Formerly RM L9F28a)

A description is presented of a vane-type angle-of-attack indicator developed by the NACA for use at supersonic and subsonic speeds. A brief history of the development and a wind-tunnel calibration are given together with a discussion of the corrections to be applied to the indicated readings.

NACA TN 3442

A PRELIMINARY INVESTIGATION OF AERODYNAMIC CHARACTERISTICS OF SMALL INCLINED AIR OUTLETS AT TRANSONIC MACH NUMBERS. Paul E. Dewey. May 1955. 21p. diagrs., photos. (NACA TN 3442. Formerly RM L53C10)

The aerodynamic characteristics of several outlets with inclined or curved axes discharging air into a transonic stream have been investigated. The data presented herein show the discharge coefficient of such outlets and the static-pressure distribution in the vicinity of the outlets for several values of stream Mach number and discharge flow parameter. Tuft observations, showing the vortex formation caused by the outlet discharge from a perpendicular and an inclined outlet, are also presented.

NACA TN 3444

FRICTION, WEAR, AND SURFACE DAMAGE OF METALS AS AFFECTED BY SOLID SURFACE FILMS. Edmond E. Bisson, Robert L. Johnson, Max A. Swikert and Douglas Godfrey. May 1955. 60p. diagrs., photos., tab. (NACA TN 3444)

A summation is presented of NACA results obtained from friction and wear investigations from 1946 to 1954. The results are consistent with theoretical predictions that solid surface films of low shear strength can serve to reduce both friction and surface damage. Metallic oxides can have very marked effects. Wear studies show that the ability of materials to form surface films is an important factor in wear. Solid lubricants (MoS_2 and graphite) are beneficial under severe operating conditions, including temperatures approaching 1000° F; both materials are, however, subject to oxidation at these temperatures.

NACA TN 3454

EFFECT OF A DISCONTINUITY ON TURBULENT BOUNDARY-LAYER-THICKNESS PARAMETERS WITH APPLICATION TO SHOCK-INDUCED SEPARATION. Eli Reshotko and Maurice Tucker. May 1955. 21p. diagrs. (NACA TN 3454)

The problem of shock-induced turbulent boundary-layer separation was analyzed by an approximate method. This method is based on a moment-of-momentum equation and calculates the change of boundary-layer-thickness parameters and form factor caused by a discontinuity where effects of friction can be neglected. The form of the result suggests that the Mach number ratio across the shock is a characteristic parameter for defining shock-induced separation. The method is also used to estimate the effects of mass transfer on the boundary-layer-thickness parameters for zero pressure gradient.

BRITISH REPORTS

N-36843*

Royal Aircraft Establishment (Gt. Brit.)
THE USE OF QUARTZ IN THE MANUFACTURE OF SMALL DIAMETER PITOT TUBES. J. R. Cooke. December 1954. 15p. diagrs., photos., tab. (RAE Tech. Note Aero 2325)

This note describes the method of manufacture of small quartz-tipped pitot tubes (down to 0.005 in. outside tip diameter) which have been used successfully for boundary-layer measurements on small models in a supersonic wind tunnel. Tests have been made (a) of the effects of taper and end finish on the accuracy of measurement and (b) of the effect of the inside diameter of the tip (for a standard taper) on response rate. For a given inside tip diameter, the tapered quartz tubes gave a faster response rate than the stainless steel hypodermic tubes previously used.

N-36849*

Aeronautical Research Council (Gt. Brit.)
TESTS RELATED TO THE EFFECT OF PROFILE SHAPE AND CAMBER-LINE ON COMPRESSOR CASCADE PERFORMANCE. S. J. Andrews. 1955. 23p. diagrs. (ARC R & M 2743; ARC 13,207. Formerly NGTE R. 60)

Three shapes were chosen for comparison with the airfoil. They were the flat plate with rounded leading and trailing edges, a flat plate with sharpened leading and trailing edges, and an approximately biconvex shape. A representative cascade shape was chosen and four cascades with the four sections mounted on circular-arc camber lines were made up. In addition, two cascades were made up on parabolic arcs. The main conclusions are that the approximately biconvex profile is superior to the airfoil at Mach numbers above 0.75, and that the circular arc camber line is, on the whole, superior to the parabolic arc. The "plate" blades with blunt leading and trailing edges are poor in performance, but the "plate with sharpened edges" is reasonably good.

N-36850*

Aeronautical Research Council (Gt. Brit.)
AERODYNAMIC FORCES ON RECTANGULAR WINGS OSCILLATING IN A SUPERSONIC AIR STREAM. W. E. A. Acum. 1954. 28p. diagrs., 2 tabs. (ARC R & M 2763. Formerly ARC 13,286; FM 1465; 0.879; S & C 2418)

In this report linearized theory is used and numerical solutions are derived by the method of "relaxation." The problem reduces to one of finding a series of conical flow solutions. Moment coefficients for a range of Mach numbers and various frequency parameter values were calculated. For a range of Mach numbers in two-dimensional flow, the aerodynamic damping for pitching oscillation can be negative for certain positions of the axis of pitch oscillation, and this implies instability. The results of this report show that aspect ratio has a stabilizing effect for axes less than about 0.7 of the chord downstream of the leading edge, but has the opposite effect for axes nearer than this to the trailing edge.

N-36851*

Aeronautical Research Council (Gt. Brit.)
THE SECONDARY FLOW IN CURVED PIPES. H. G. Cuming. 1955. 17p. diagrs., 3 tabs. (ARC R & M 2880. Formerly ARC 13,979; FM 1558)

The Navier-Stokes equations for the flow of a viscous incompressible fluid through curved pipes of different sections are solved in power series of the curvature of the pipe. The solution is given as far as the first power of the curvature for the case of an elliptic section and a discussion given of the effect of the aspect ratio of the pipe on the intensity of the secondary flow. The solution is also given to the first power of the curvature for the case of a square section and as far as the second power of the curvature for the case of flow through a curved pipe of circular section when suction proportional to the curvature is applied at the walls. The result shows that with the particular distribution of suction considered the diminution in flux through a curved pipe may be almost entirely eliminated.

N-36873*

Forest Products Research Lab. (Gt. Brit.)
TRIALS OF TIMBER FOR PLYWOOD MANUFACTURE. ADWEA - PACHYLOBUS BARTERI - GOLD COAST. (48 POUNDS PER CUBIC FOOT AT 15 PER CENT MOISTURE CONTENT) APPENDIX B: STRENGTH TESTS ON ADWEA PLYWOOD. W. T. Curry. APPENDIX C: TESTS DESIGNED TO COMPARE THE LIMITING RADIUS OF CURVATURE IN THE BENDING OF ADWEA (PACHYLOBUS BARTERI) 3-PLY WITH THOSE OF CANADIAN YELLOW BIRCH (BETULA LUTEA). N. Turner. (PROGRESS REPORT TWENTY-FIVE) January 1955. 21p. 6 tabs. (Forest Products Research Lab.)

Earlier tests had indicated that Adwea plywood possessed strength properties similar to those of Canadian birch. It was agreed by the Plywood Research Panel that tests to confirm this were most desirable, and that at the same time, an assessment should be made of the potentialities of the species for general plywood manufacture. Results of these tests and some comparisons with Canadian yellow birch are presented in this report.

UNPUBLISHED PAPERS

N-37178*

HELICAL VORTICES AND CYLINDRICAL BOUNDARIES OF CIRCULAR CROSS SECTION. (Rasen uzu to Ento Kyokai). Hisawo Takeyama. 8p. (Trans. from Oyo Rigaku, v. 3, no. 13, Aug., 1949, p. 6-8)

The velocity potential of helical vortices in the cylindrical boundaries, whose cross sections are circles coaxial with the vortices, is obtained in order to estimate the tip losses and body interference for axial blowers or propellers. In the case of the fixed boundary, the circulation is increased near the tip; but for the free boundary, it is decreased. It is also shown that the inner and outer boundaries can be treated separately in the usual blowers.

N-37216*

BREAKING DOWN OF CRYSTAL BLOCKS AND APPEARANCE OF MICROSTRESSES IN THE METAL DURING PLASTIC DEFORMATION. (Droblenie kristallicheskikh blokov i razvitie mikronapryazhenii v metalle pri plasticheskoi deformastsii). B. M. Rovinskii and L. M. Rybakova. 7p. diagrs. (Trans. from Akademiya Nauk SSSR Otdelenie Tekhnicheskikh Nauk, Izvestiya, no. 10, Oct.,1952, p.1483-1487)

The question as to whether the breaking up of the regions which had been dispersed regularly into a lattice called blocks or the appearance and development of microstresses actually takes place, dominates, or causes the regular growth of the width of the interference lines as a function of the magnitude of the residual deformation during plastic deformation has not been answered sufficiently. This present paper is concerned with the character of the processes in steel for simple tension.

N-37217*

INTEGRAL EQUATIONS OF CONSTRAINED TORSION AND STABILITY OF THIN-WALLED RODS. (Integralnye uravneniya stesnennogo krucheniya i ustoichivosti tonkostennykh sterzhnei).
V. V. Bolotin. 7p. (Trans. from Prikladnaya Mat. i Mekhanika, v.17, no.2, Mar.-Apr.,1953, p.245-248)

The problem of the strength of thin-walled rods is reduced to an integral equation. The computation of the critical parameters of the load is affected by the method of successive approximations and also by the method of approximate integration.

National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1187

THEORETICAL AND EXPERIMENTAL INVESTIGATION OF ADDITIVE DRAG. Merwin Sibulkin. 1954. ii, 12p. diagrs. (NACA Rept. 1187. Formerly RM E51B13)

The significance of additive drag is discussed and equations for determining its approximate value are derived. Charts are presented giving values of additive drag for open-nose inlets and for annular-nose inlets with conical flow at the inlet. The effects of variable inlet total-pressure recovery and static pressures on the center body are investigated, and an analytical method of predicting the variation of pressure on the center body with mass-flow ratio is given. Experimental values of additive drag are compared with values predicted by the methods presented.

NACA RM L55E09a

SUMMARY OF RECENT THEORETICAL AND EXPERIMENTAL WORK ON BOX-BEAM VIBRATIONS. John M. Hedgepeth. June 1955. 10p. diagrs., photo., 2 tabs. (NACA RM L55E09a)

A discussion of various secondary effects which have an important influence on the vibration characteristics of box beams is presented. Means of incorporating these effects in vibration analyses of actual built-up box beams are discussed. Comparisons with experiment are given; good agreement between theory and experiment is obtained when the secondary effects are included.

NACA RM L55E11b

PRELIMINARY INVESTIGATION OF THE COMPRESSIVE STRENGTH AND CREEP LIFETIME OF 2024-T3 (FORMERLY 24S-T3) ALUMINUM-ALLOY PLATES AT ELEVATED TEMPERATURES. Eldon E. Mathauser and William D. Deveikis. June 1955. 12p. diagrs. (NACA RM L55E11b)

The results of elevated-temperature compressive strength and creep tests of 2024-T3 (formerly 24S-T3) aluminum-alloy plates supported in V-grooves are presented. A relation previously developed for predicting plate compressive strength at room temperature was satisfactory for determining elevated temperature strength. Creep-lifetime results are presented for the plates in the form of master creep-lifetime curves using a time temperature parameter. A comparison is made between tensile and compressive creep lifetime for the plates, and the magnitude by which the design stress is decreased because of material creep and loss of strength due to exposure at elevated temperatures is indicated.

NACA RM L55E12b

TENSILE PROPERTIES OF SOME SHEET MATERIALS UNDER RAPID-HEATING CONDITIONS. George J. Heimerl and John E. Inge. June 1955. 10p. diagrs. (NACA RM L55E12b)

Results are presented of tests to determine the effect of heating at uniform temperature rates from 0.2° F to 100° F per second on the tensile properties of some sheet materials under constant load conditions - 7075-T6 (75S-T6) and 2024-T3 (24S-T3) aluminum alloys, Inconel, and RS-120 titanium alloy. Some comparisons are given between yield and rupture stresses obtained under rapid-heating conditions and those obtained from elevated-temperature stress-strain tests for 1/2-hour exposure. Master yield- and rupture-stress curves based on the use of a linear temperature-rate parameter are included which provide a convenient method for predicting yield and rupture stresses and temperatures for different temperature rates.

NACA TM 1341

APPROXIMATE HYDRODYNAMIC DESIGN OF A FINITE SPAN HYDROFOIL. (Priblizhennyi gidrodinamicheskii raschet podvodnogo kryla konechnogo razmakha). A. N. Vladimirov. June 1955. 68p. diagrs., 5 tabs. (NACA TM 1341. Trans. from Central Aero-Hydrodynamical Institute, Rept. 311, 1937).

Previous work on the motion of various bodies under the surface of a heavy fluid is discussed. The solution of the motion of a flat plate by Keldysh and Lavrentiev is applied to the motion of a hydrofoil, making possible the presentation of charts for determining the lift and resistance of an infinite span hydrofoil operating in a heavy frictionless fluid having infinite depth below the free water surface. Consideration is given to the effects of viscosity and a method is suggested to correct for the finite span. The effect of the water surface on the downwash behind the foil is also discussed. A comparison of theoretical results obtained from this work with experimental data indicates that a basis for the approximate hydrodynamic design of a finite span hydrofoil has been achieved.

NACA TN 3378

ACOUSTICAL TREATMENT FOR THE NACA 8- BY 6-FOOT SUPERSONIC PROPULSION WIND TUNNEL. Leo L. Beranek, Samuel Labate and Uno Ingard, Bolt Beranek and Newman, Inc. June 1955. 86p. diagrs., photo., 7 tabs. (NACA TN 3378)

*AVAILABLE ON LOAN ONLY.
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This report summarizes the results of a project at the Lewis Flight Propulsion Laboratory to silence the 8- by 6-foot supersonic wind tunnel. Sound measurements in the neighborhood surrounding the tunnel were conducted to evaluate the noise-attenuation requirements. A muffler-development program was continued until these attenuations were achieved. The final design for the acoustic treatment is described and experimental performance curves are compared with anticipated theoretical results.

NACA TN 3382

EXPERIMENTS WITH A ROTATING-CYLINDER VISCOMETER AT HIGH SHEAR RATES. J. A. Cole, R. E. Petersen and H. W. Emmons, Harvard University. June 1955. 31p. diagrs., tab. (NACA TN 3382)

Two straight mineral oils and a polymer-containing oil have been tested in a rotating-cylinder viscometer at high shear rates (maximum 0.25 million reciprocal seconds) and the accompanying heat effects have been investigated. The torque measurements are of low accuracy and fail to establish the moderately non-Newtonian behavior of the polymer-containing oil, but the temperature measurements, which are in good agreement with a thermal analysis, do indicate the presence of temporary viscosity decrease at high shear rates for this oil.

NACA TN 3411

PRESSURE WAVES GENERATED BY ADDITION OF HEAT IN A GASEOUS MEDIUM. Boa-Teh Chu, Johns Hopkins University. June 1955. 47p. diagrs. (NACA TN 3411)

The approximate formula of a linearized solution for the pressure field generated by a moderate rate of heat release is given. The analogies between the pressure waves generated by heat release and those generated by (1) mass release, (2) piston motion, or (3) a two-dimensional body in a supersonic stream are established analytically. The exact solution of an idealized problem in which heat is released uniformly at a section of tube with a given rate, large or small, is also constructed. The corresponding problems in three dimensions are also solved. Some applications of the theory are given.

NACA TN 3412

CREEP AND CREEP-RUPTURE CHARACTERISTICS OF SOME RIVETED AND SPOT-WELDED LAP JOINTS OF AIRCRAFT MATERIALS. Leonard Mordfin, National Bureau of Standards. June 1955. 53p. diagrs., photos., 6 tabs. (NACA TN 3412)

Equipment, test techniques, and results are presented for an experimental investigation of the creep of lap joints. Riveted aluminum-alloy joints fabricated from 75S-T6 and 24S-T3 sheet with 24S and 24S-T31 rivets were tested at 300°, 400°, and 500° F. Spot-welded joints of 1/4-hard, type 301 stainless steel were tested at 800° F. Each type of joint was also tested in tension at room temperature.

NACA TN 3416

THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE EFFECT OF TUNNEL WALLS ON THE FORCES ON AN OSCILLATING AIRFOIL IN TWO-DIMENSIONAL SUBSONIC COMPRESSIBLE FLOW. Harry L. Runyan, Donald S. Woolston and A. Gerald Rainey. June 1955. 41p. diagrs., photo. (NACA TN 3416)

The integral equation defining the problem of an oscillating wing in a tunnel is treated and is presented in a form adapted to calculations. Application is made to a number of examples to illustrate the influence on the magnitude of wall effects of variations in frequency, Mach number, and ratio of tunnel height to wing semichord. Comparison is made with experimental measurements for several subsonic Mach numbers.

NACA TN 3448

THEORETICAL ANALYSIS OF INCOMPRESSIBLE FLOW THROUGH A RADIAL-INLET CENTRIFUGAL IMPELLER AT VARIOUS WEIGHT FLOWS. I - SOLUTION BY A MATRIX METHOD AND COMPARISON WITH AN APPROXIMATE METHOD. Vasily D. Prian, James J. Kramer and Chung-Hua Wu. June 1955. 39p. diagrs., tab. (NACA TN 3448)

A method for the solution of the incompressible, nonviscous flow through a centrifugal impeller, including the inlet region, is presented. Several numerical solutions are obtained for four weight flows through an impeller at one operating speed. The results are presented in a series of figures showing streamlines and resultant velocity contours. A comparison is made with the results obtained by use of a rapid approximate method of analysis.

NACA TN 3449

THEORETICAL ANALYSIS OF INCOMPRESSIBLE FLOW THROUGH A RADIAL-INLET CENTRIFUGAL IMPELLER AT VARIOUS WEIGHT FLOWS. II - SOLUTION IN LEADING-EDGE REGION BY RELAXATION METHODS. James J. Kramer. June 1955. 19p. diagrs. (NACA TN 3449)

The detailed solution of the flow around the blade nose of a 48-inch-diameter radial-inlet centrifugal impeller has been obtained by relaxation methods for four weight flows. The results are presented in a series of figures showing streamlines and relative velocity contours. Minimum velocity gradients around the blade nose occurred for the weight flow corresponding to a mean angle of attack of -4.6° computed from blade speed and an upstream axial-radial velocity for which blade blockage has been taken into account. A small positive local angle of attack seems desirable for blades with rounded leading edges.

NACA TN 3457

ESTIMATION OF INLET LIP FORCES AT SUBSONIC AND SUPERSONIC SPEEDS. W. E. Moeckel. June 1955. 12p. diagrs. (NACA TN 3457)

The effects of inlet lip thickness on inlet performance are estimated as functions of mass flow for subsonic and supersonic flight speeds. At subsonic speeds, pressure-recovery losses and additive drag are shown to decrease linearly with increasing lip frontal area if the maximum suction force is attained. At supersonic speeds, inlet drag increases linearly with inlet lip frontal area at full mass flow. For reduced mass flow, some reduction in additive drag is possible with lips of moderate thickness, but the magnitude of this reduction becomes negligible as flight speed increases.

NACA TN 3461

TURBULENT-HEAT-TRANSFER MEASUREMENTS AT A MACH NUMBER OF 1.62. Maurice J. Brevoort and Bernard Rashis. June 1955. 15p. diagrs., tab. (NACA TN 3461)

An axially symmetric annular nozzle was used to obtain essentially flat-plate results for turbulent-heat-transfer coefficients and temperature-recovery factors. The test results are for a Mach number of 1.62 and for a Reynolds number range of 7.22×10^5 to 1.20×10^8. The heat-transfer-coefficient results agree with theoretical results for $M = 1.60$ and $T_w/T_\infty = 1.60$. The recovery factors are on the average 1.5 percent lower than data for a Mach number of 2.4.

NACA TN 3499

CALCULATION OF THE SUPERSONIC PRESSURE DISTRIBUTION ON A SINGLE-CURVED TAPERED WING IN REGIONS NOT INFLUENCED BY THE ROOT OR TIP. Walter G. Vincenti and Newman H. Fisher, Jr. June 1955. 32p. diagrs. (NACA TN 3499)

The shock-expansion method for the calculation of the pressures on cylindrical wings in supersonic flow is extended to tapered wings made up of single-curved surfaces. The method applies in regions where (a) the component of velocity normal to the surface rulings is supersonic and (b) the flow is not influenced by tips or junctures. In these regions the flow is defined by a pair of ordinary differential equations whose solution is readily obtained by numerical means. Results are shown and discussed for a representative triangular wing.

NACA TN 3502

THE TRANSONIC CHARACTERISTICS OF 38 CAMBERED RECTANGULAR WINGS OF VARYING ASPECT RATIO AND THICKNESS AS DETERMINED BY THE TRANSONIC-BUMP TECHNIQUE. Warren H. Nelson and Walter J. Krumm. June 1955. 173p. diagrs., photos. (NACA TN 3502. Formerly RM A52D11)

An investigation was made in the Ames 16-foot high-speed wind tunnel utilizing the transonic-bump technique to determine the aerodynamic characteristics at transonic Mach numbers of 38 cambered rectangular wings. The wings had aspect ratios of 4, 3, 2, 1.5, and 1, and NACA 63A2XX and 63A4XX sections with thickness-to-chord ratios of 10, 8, 6, 4, and 2 percent. The Mach number range was 0.6 to 1.12 with corresponding Reynolds numbers of 1.7 to 2.2 million. The data are presented without analysis.

BRITISH REPORTS

N-36887*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) DETERMINATION OF THE VARIATION WITH ALTITUDE OF THE RECOVERY FACTOR OF AIR THERMOMETERS. December 17, 1954. 28p. diagrs., photos., 10 tabs. (AAEE/Tech/111)

Tests were made for the standard knife edge and two other available air thermometer bulbs. The results show a significant decrement with altitude in the value of the recovery factor of the order of 0.2 between 5,000 and 40,000 feet. That means a change from 0.69 to 0.51 in the values for the standard knife edge bulb. In view of these findings, it appears imperative in performance tests which are sensitive to ambient air temperature, to determine the recovery factor of the outside air thermometer over the altitude range of the aircraft. Alternatively, there is a need for an air thermometer whose recovery factor remains constant with change of altitude.

N-36890*

Royal Aircraft Establishment (Gt. Brit.) THE TORSIONAL VIBRATIONS OF A CLASS OF THIN, TAPERED, SOLID WINGS. Elizabeth A. Frost. January 1955. 22p. diagrs., tab. (RAE Tech. Note Structures 152)

This report considers the torsional vibrations of thin solid wings of doubly symmetrical chordwise section, with linear variation of chord and parabolic variation of thickness. Frequencies of symmetrical and antisymmetrical vibrations are presented graphically for a range of values of the aspect ratio and the taper ratio.

N-36902*

Royal Aircraft Establishment (Gt. Brit.) TESTS ON THE PROTECTION GIVEN TO METALS BY ETCH PRIMERS. H. G. Cole. January 1955. 13p. 6 tabs. (RAE Tech. Note Met. 209)

Long term seawater spray corrosion tests have shown that the relative performance of painting schemes based on six commercial etch primers varied markedly from metal to metal. On zinc and cadmium-plated steel, the etch primer schemes gave better performance than conventional paints applied over classical methods of surface treatment. On steel and aluminum alloys, the use of etch primers is an acceptable substitute for conventional methods of protection, provided that the etch primer is followed by a full protective scheme. Their use on magnesium alloys is risky because of the danger of attack on the metal.

N-36905*

Royal Aircraft Establishment (Gt. Brit.) A JUNCTION TRANSISTOR DECADE COUNTER. H. W. P. Knapp. January 1955. 11p. diagrs., photo. (RAE Tech. Note GW 354)

A junction transistor decade counter is described which is tolerant of supply voltage, input amplitude, and ambient temperature variations.

DECLASSIFIED NACA REPORTS

NACA RM A52G17

THE USE OF LEADING-EDGE AREA SUCTION TO INCREASE THE MAXIMUM LIFT COEFFICIENT OF A 35° SWEPT-BACK WING. Curt A. Holzhauser and Robert K. Martin. September 1952. 37p. diagrs., photo., 3 tabs. (NACA RM A52G17) (Declassified from Confidential, 6/10/55)

Measurements were made of the increase in lift coefficient obtained with various amounts of area suction. Flow coefficients and power inputs required to obtain these lift coefficients were measured at free-stream velocities from 112 to 180 feet per second. With full-span area suction and a maximum chordwise opening of 2.2 percent, the $C_{L_{max}}$ of the model with flaps deflected was increased from 1.33 to 2.00 with a flow coefficient of 0.00108 and a suction horsepower of 47 at a free-stream velocity of 129 feet per second. There appeared to be no unacceptable characteristics that a 35° swept-wing airplane would exhibit in low-speed flight as a result of employing area suction.

NACA RM L7F30

FREE-FLIGHT INVESTIGATION OF CONTROL EFFECTIVENESS OF FULL-SPAN, 0.2-CHORD PLAIN AILERONS AT HIGH SUBSONIC, TRANSONIC, AND SUPERSONIC SPEEDS TO DETERMINE SOME EFFECTS OF WING SWEEPBACK, TAPER, ASPECT RATIO, AND SECTION-THICKNESS RATIO. Carl A. Sandahl. August 13, 1947. 16p. diagrs., photos., tab. (NACA RM L7F30) (Declassified from Confidential, 6/10/55)

The aileron control characteristics of untapered, 45° sweptback wings of aspect ratio 3 were found to be generally the same for the 65-006 and 65-009 sections. The tapered 45° sweptback wings of aspect ratio 3 and 65-009 section exhibited a small abrupt change in rolling effectiveness from M = 0.92 to 1.00 which was not characteristic of untapered wings tested having the same sweep, aspect ratio, and section. A reduction in aspect ratio from 3 to 1.75 for unswept, untapered wings gave an increase in rolling effectiveness. Both aspect-ratio configurations showed undesirable control characteristics at transonic speeds.

NACA RM L51F11

RECENT EXPERIMENTAL FLUTTER STUDIES. Arthur A. Regier and Dennis J. Martin. June 12, 1951. 18p. diagrs. (NACA RM L51F11) (Declassified from Confidential, 6/10/55)

This paper presents in a rather brief fashion some of the highlights of recent experimental flutter studies. Material from several papers is brought together and compared. The material includes trend studies of flutter of swept and unswept wings at transonic speeds; studies of a bending-type flutter of swept wings; flutter involving body modes; and preliminary studies of M and W and delta wing configurations.

NACA RM L51L03

PRESSURE DISTRIBUTIONS AT MACH NUMBERS FROM 0.6 TO 1.9 MEASURED IN FREE FLIGHT ON A PARABOLIC BODY OF REVOLUTION WITH SHARPLY CONVERGENT AFTERBODY. William E. Stoney, Jr. April 1952. 34p. diagrs., photos. (NACA RM L51L03) (Declassified from Confidential, 6/10/55)

A flight test was made, at Mach numbers from 0.6 to 1.9, of a fin-stabilized parabolic body of revolution having a sharply convergent afterbody. Pressures were measured at eight longitudinal stations on the body and on the base with and without a simulated wind-tunnel sting extending from the base of the model. The results were compared with theoretical determinations of the pressures by linear and exact methods.

NACA RM L52L05

WIND-TUNNEL INVESTIGATION OF STALL CONTROL BY SUCTION THROUGH A POROUS LEADING EDGE ON A 37° SWEPTBACK WING OF ASPECT RATIO 6 AT REYNOLDS NUMBERS FROM 2.50×10^6 to 8.10×10^6. Robert R. Graham and William A. Jacques. March 1953. 67p. diagrs., photo., 2 tabs. (NACA RM L52L05) (Declassified from Confidential, 6/10/55)

Stall control by suction through a porous leading-edge upper surface was investigated on a plain wing and on the same wing with half-span split or double slotted flaps. Some effects of varying the chordwise and spanwise extent of porosity and varying the flow coefficient were investigated on the plain wing. Force and moment data are presented along with minimum measured leading-edge pressure coefficients across the span of the wing.

NACA RM L53C02

THE BASE PRESSURE AT SUPERSONIC SPEEDS ON TWO-DIMENSIONAL AIRFOILS AND BODIES OF REVOLUTION (WITH AND WITHOUT FINS) HAVING TURBULENT BOUNDARY LAYERS. Eugene S. Love. April 1953. 65p. diagrs., photos. (NACA RM L53C02) (Declassified from Confidential, 6/10/55)

An analysis is made of available experimental data to show the effect of most of the variables that are more predominant in determining base pressure at supersonic speeds. The analysis is restricted to turbulent boundary layers and covers two-dimensional bases and the bases of bodies of revolution, with and without stabilizing fins. An analogy to the pressure rise required to separate the boundary layer is presented as are simple semiempirical methods for the estimation of base pressure.

NACA RM L53F15a

STUDIES OF THE SPEED STABILITY OF A TANDEM HELICOPTER IN FORWARD FLIGHT. Robert J. Tapscott and Kenneth B. Amer. August 1953. 35p. diagrs., photos., tab. (NACA RM L53F15a) (Declassified from Confidential, 6/10/55)

Analytical and experimental studies and corresponding pilots' opinions of the speed stability of a tandem helicopter are presented and means for improving the speed stability are discussed. An analytical expression is derived for use in predicting changes in speed stability of a tandem helicopter brought about by changes in the rotor geometry. Constants for use with the analytical expression are presented in chart form.

NACA RM L53G15a

THE VARIATION OF ATMOSPHERIC TURBULENCE WITH ALTITUDE AND ITS EFFECT ON AIRPLANE GUST LOADS. Robert L. McDougal, Thomas L. Coleman and Philip L. Smith. November 1953. 16p. diagrs., 2 tabs. (NACA RM L53G15a) (Declassified from Confidential, 6/10/55)

Analysis of turbulence data for altitudes up to 60,000 feet indicates substantial reductions in the amount and relative intensity of the turbulence at the higher altitudes. The implications of these reductions in the turbulence are discussed in regard to the gust loads for assumed airplane operations.

NACA RM L54B16b

FLIGHT TESTS OF A 0.4-SCALE MODEL OF A STAND-ON TYPE OF VERTICALLY RISING AIRCRAFT. Marion O. McKinney and Lysle P. Parlett. March 1954. 23p. diagrs., photos. (NACA RM L54B16b) (Declassified from Confidential, 6/10/55)

The results of a free-flight investigation of the stability and control of a 0.4-scale model of a stand-on type of vertically rising aircraft in take-offs and landings and in hovering and forward flight are presented. The aircraft component of the model consisted of a motor-driven, single-rotation propeller in a short shroud with antitorque vanes and control surfaces at the rear of the shroud.

National Advisory Committee for Aeronautics

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CURRENT NACA REPORTS

NACA Rept. 1174

THE STRUCTURE OF TURBULENCE IN FULLY DEVELOPED PIPE FLOW. John Laufer, National Bureau of Standards. 1954. ii, 18p. diagrs. (NACA Rept. 1174. Formerly TN 2954)

Measurements, principally with a hot-wire anemometer, were made in fully developed turbulent flow in a 10-inch pipe at speeds of 10 and 100 feet per second. It is shown that rates of turbulent-energy production, dissipation, and diffusion have sharp maximums near the edge of the laminar sublayer and that there exist a strong movement of kinetic energy away from this point and an equally strong movement of pressure energy toward it. It is suggested that the flow field may be divided into three regions: Wall proximity where turbulence production, transfer, and viscous action are of about equal importance; the central region of the pipe where energy diffusion predominates; and the intermediate region where the local rate of change of turbulent-energy production dominates the energy received by diffusive action.

NACA Rept. 1181

STRUCTURAL RESPONSE TO DISCRETE AND CONTINUOUS GUSTS OF AN AIRPLANE HAVING WING-BENDING FLEXIBILITY AND A CORRELATION OF CALCULATED AND FLIGHT RESULTS. John C. Houbolt and Eldon E. Kordes. 1954. ii, 22p. diagrs., 4 tabs. (NACA Rept. 1181. Formerly TN 3006)

An analysis is made of the structural response to gusts of an airplane having the degrees of freedom of vertical motion and wing bending flexibility. Convenient solutions of the response equations are developed for discrete and sinusoidal-gust encounter, and the procedure is given for treating the realistic condition of continuous random atmospheric turbulence. Flight and calculated results are then given for several airplanes to evaluate the influence of wing bending flexibility on the structural response to gusts. The discrete-gust approach is shown to reveal the general nature of the flexibility effects and leads to qualitative correlation with flight results. The continuous-turbulence approach shows good quantitative correlation and indicates a much greater degree of resolution of flexibility effects.

NACA Rept. 1193

THEORETICAL PERFORMANCE CHARACTERISTICS OF SHARP-LIP INLETS AT SUBSONIC SPEEDS. Evan A. Fradenburgh and DeMarquis D. Wyatt. 1954. ii, 8p. diagrs. (NACA Rept. 1193. Formerly TN 3004)

A method is presented for the estimation of the subsonic-flight-speed characteristics of sharp-lip inlets applicable to supersonic aircraft. The analysis, based on a simple momentum balance consideration, permits the computation of inlet pressure recovery - mass-flow relations and additive-drag coefficients for forward velocities from zero to the speed of sound. Operation of a sharp-lip inlet at velocity ratios less than 1.0 results in an additive drag that is not cancelled by lip suction, while at velocity ratios greater than 1.0, losses in inlet total pressures result. In particular, at the take-off condition, the total pressure and the mass flow for a choked inlet are only 79 percent of the values ideally attainable with a rounded lip.

NACA RM 54L29

METEOROLOGICAL PROBLEMS ASSOCIATED WITH COMMERCIAL TUBOJET-AIRCRAFT OPERATION. A working group of the NACA Subcommittee on Meteorological Problems. June 1955. 46p. (NACA RM 54L29)

Meteorological requirements and problems anticipated with the safe, efficient, and economical operation of commercial turbojet aircraft have been analyzed and evaluated. Problems of temperature, wind, pressure, ceiling, visibility, cloud and clear-air turbulence, icing, and communication are discussed. Characteristics such as high cruising speed, high cruise level, relatively high fuel consumption, and engine performance sensitive to temperature and air density are considered.

NACA RM E55D07b

EXPLORATORY INVESTIGATION OF FLOW IN THE SEPARATED REGION AHEAD OF TWO BLUNT BODIES AT MACH NUMBER 2. Harry Bernstein and William E. Brunk. June 1955. 27p. diagrs., photos. (NACA RM E55D07b)

Flow separation from a flat plate ahead of two blunt two-dimensional bodies was investigated at Mach number 2.0. Interferograms were obtained for the regions, and the pitot-pressure distribution and flow directions were surveyed in one of the regions. Mach numbers were generally less than 0.5 in the reverse-flow regions near the plate surface. A flow-direction survey for a model with separation at the leading edge of the flat plate showed a reverse-flow component in about half of the separated region.

NACA RM L55D21

VELOCITY DISTRIBUTIONS MEASURED IN THE SLIPSTREAM OF EIGHT-BLADE AND SIX-BLADE DUAL-ROTATING PROPELLERS AT ZERO ADVANCE. Leland B. Salters, Jr. June 1955. 27p. diagrs., photo. (NACA RM L55D21)

* AVAILABLE ON LOAN ONLY.

ADDRESS REQUESTS FOR DOCUMENTS TO NACA, 1512 H ST., NW., WASHINGTON 25, D. C., CITING CODE NUMBER ABOVE EACH TITLE, THE REPORT TITLE AND AUTHOR.

This report contains the results of a slipstream survey behind NACA 8.75-(5)(05)-037 eight- and six-blade dual-rotating propellers at zero advance. The slipstream-boundary cone angle was found to agree qualitatively with the theoretical angle of spread for an unheated jet.

NACA RM L55E10b

EXPERIMENTAL ANALYSIS OF MULTICELL WINGS BY MEANS OF PLASTIC MODELS. George W. Zender. June 1955. 6p. diagrs. (NACA RM L55E10b)

The stresses and deflections of a plastic model of a delta multicell wing are compared with results obtained by the use of the Cal-Tech analog computer. The comparison indicates that valuable information may be obtained for experimental structural analyses from tests of plastic models.

NACA RM L55E12c

VERTICAL AND DRAG GROUND-REACTION FORCES DEVELOPED IN LANDING IMPACTS OF A LARGE AIRPLANE. Richard H. Sawyer, Albert W. Hall and James M. McKay. June 1955. 12p. diagrs. (NACA RM L55E12c)

Tests were conducted on a large-bomber-type airplane to determine the ground reactions imposed on the landing gear under actual landing conditions. The program covered landings made at vertical velocities up to 8.5 feet per second and forward speeds at contact from 95 to 120 miles per hour. Landings were made on both wet and dry concrete runways. Results are presented of the effects of vertical velocity at contact and the effects of runway surface condition (wet and dry) on the vertical and drag ground reactions obtained during the landing impact.

NACA TM 1391

REDUCTION OF THE SHIMMY TENDENCY OF TAIL AND NOSE-WHEEL LANDING GEARS BY INSTALLATION OF SPECIALLY DESIGNED TIRES. (Verminderung der Flatterneigung von Sporn- und Bugwerken durch Einbau besonders geformter Reifen). H. Schrode. July 1955. 13p. diagrs. (NACA TM 1391. Trans. from Deutschen Versuchsanstalt für Luftfahrt E. V., Berlin-Adlershof. Technische Berichte, v. 10, 1943, p. 113-116)

An experimental study is made of the shimmy tendency of several conventional and modified German aircraft tires ranging in size from about 11 to 15 inches in diameter. The effects of tire size, shape, loading and wear, type of rolling motion (acceleration or deceleration), trail and rolling velocity on the shimmy tendency are investigated. It is found that tires of small main dimensions with stiff flattened running surfaces, high lateral and torsional stiffnesses and small ground contact areas are favorable for reduction of the shimmy tendency.

NACA TN 3299

MAXIMUM THEOREMS AND REFLECTIONS OF SIMPLE WAVES. P. Germain, Brown University. June 1955. 22p. (NACA TN 3299)

The properties of the solutions corresponding to the reflection of a centered simple wave along a straight line or along a free streamline are shown to be closely related to some important theorems predicting "a priori bounds" for special mathematical problems. These properties thus appear to be a physical interpretation of those theorems.

NACA TN 3421

AERODYNAMICS OF A RECTANGULAR WING OF INFINITE ASPECT RATIO AT HIGH ANGLES OF ATTACK AND SUPERSONIC SPEEDS. John C. Martin and Frank S. Malvestuto, Jr. July 1955. 114p. diagrs., tab. (NACA TN 3421)

Perturbation of the flow over a two-dimensional flat plate at finite angles of attack is used to obtain a first-order evaluation of damping in roll, lift and moment due to an increment in angle of attack, and lift and moment due to steady pitching velocity for a rectangular wing of infinite aspect ratio at supersonic speeds. Results are valid for the range of Mach number and angle of attack for which the flow behind the shock is supersonic. The analysis is based on the equations for rotational flow so that the change in entropy is taken into account. Approximate estimates of a number of aerodynamic derivatives of rectangular wings at finite angles of attack are also presented.

NACA TN 3443

SHEARING EFFECTIVENESS OF INTEGRAL STIFFENING. Robert F. Crawford and Charles Libove. June 1955. 37p. diagrs., photo., tab. (NACA TN 3443)

Values of coefficients for defining the effectiveness of integral stiffeners in resisting shear deformations of the plate of which they are an integral part are presented for a variety of proportions of rectangular stiffeners with circular fillets. Formulas are given in which these coefficients may be employed to calculate the elastic constants associated with the twisting and shearing of integrally stiffened plates. The size of fillet radius is shown to contribute appreciably to the degree of penetration of the stresses from the skin into the stiffener.

NACA TN 3455

RECOVERY AND TIME-RESPONSE CHARACTERISTICS OF SIX THERMOCOUPLE PROBES IN SUBSONIC AND SUPERSONIC FLOW. Truman M. Stickney. July 1955. 25p. diagrs., photos., 2 tabs. (NACA TN 3455)

Experimental data obtained from three shielded and three unshielded thermocouple probes are presented. Data taken in air at room temperature over the ranges 0.2 to 2.2 Mach number and 0.2 to 2.2 atmospheres total pressure show reproducible systematic variations of recovery with Mach number, ambient pressure, flow angle, and probe design. Time-constant data determined at Mach 0.2 and room temperature and pressure indicate that unshielded probes are several times faster in response to temperature changes than shielded probes.

NACA TN 3456

PROPAGATION OF A FREE FLAME IN A TURBULENT GAS STREAM. William R. Mickelsen and Norman E. Ernstein. July 1955. 89p. diagrs., photos., 2 tabs. (NACA TN 3456)

Effective turbulent free-flame speeds measured in turbulent, flowing propane-air mixtures were found to have statistical distributions about mean values. The statistical spread was greater for rich and lean fuel-air ratios and at high turbulence intensities. The measured flame speeds, together with hot-wire-anemometer measurements, formed a basis for comparison with three theories and other types of flames. Although the free-flame speeds are lower than those for turbulent Bunsen and stabilized flames, values calculated from the Tucker analysis and a modified Scurlock-Grover analysis seem to form an upper limit to the turbulent free-flame-speed data.

NACA TN 3458

UNSTABLE CONVECTION IN VERTICAL CHANNELS WITH HEATING FROM BELOW, INCLUDING EFFECTS OF HEAT SOURCES AND FRICTIONAL HEATING. Simon Ostrach. July 1955. 38p. diagrs., 3 tabs. (NACA TN 3458)

Solutions are found for the cases in which the wall temperature variations are linear and (1) the wall temperatures are specified, (2) the walls are both insulated, and (3) the net mass flow in the channel is zero. The heat sources affect the flows in essentially a quantitative manner, changing the stability characteristics of the flows only when both walls are insulated. The effects of frictional heating are important in certain ranges of the parametric values, especially near critical Rayleigh numbers.

NACA TN 3459

SIMPLIFIED PROCEDURES AND CHARTS FOR THE RAPID ESTIMATION OF BENDING FREQUENCIES OF ROTATING BEAMS. Robert T. Yntema. June 1955. ii, 90p. diagrs., 6 tabs. (NACA TN 3459. Supersedes and extends RM L54G02)

A Rayleigh energy approach utilizing the nonrotating-beam bending modes in the determination of the bending frequencies of the rotating beam is evaluated and is found to give good practical results for helicopter blades. Charts are presented for the rapid estimation of the first three bending frequencies for rotating and nonrotating cantilever and hinged beams. A more exact mode-expansion method used in evaluating the Rayleigh approach is also described. Numerous mode shapes and derivatives are presented in tabular form and discussed.

NACA TN 3500

CORRECTION OF ADDITIONAL SPAN LOADINGS COMPUTED BY THE WEISSINGER SEVEN-POINT METHOD FOR MODERATELY TAPERED WINGS OF HIGH ASPECT RATIO. John DeYoung and Walter H. Barling, Jr. July 1955. 31p. diagrs. (NACA TN 3500)

A simple procedure is found which results in more accurate span loadings, lift-curve slopes, and spanwise centers of pressure being read directly from the charts of NACA Report 921. The new results compare very well with experiment and with theoretical results believed to be accurate.

NACA TN 3501

THE TRANSONIC CHARACTERISTICS OF 22 RECTANGULAR, SYMMETRICAL WING MODELS OF VARYING ASPECT RATIO AND THICKNESS. Warren H. Nelson and John B. McDevitt. June 1955. 109p. diagrs., photos. (NACA TN 3501. Formerly RM A51A12)

An investigation utilizing the transonic-bump technique was made to determine the aerodynamic characteristics at transonic Mach numbers of 22 rectangular wings having aspect ratios of 6, 4, 3, 2, 1.5, 1, and 0.5, and NACA 63A0XX sections with thickness-to-chord ratios of 10, 8, 6, 4, and 2 percent. The Mach number range was 0.4 to 1.1, corresponding under the test conditions to a Reynolds number range from 1.25 to 2.05 million. These data are presented without analysis.

NACA TN 3504

EFFECT OF TRAILING-EDGE THICKNESS ON LIFT AT SUPERSONIC VELOCITIES. Dean R. Chapman and Robert H. Kester. June 1955. 19p. diagrs. (NACA TN 3504. Formerly RM A52D17)

Lift forces on various rectangular-plan-form wings were measured in the Mach number range between 1.5 and 3.1 at Reynolds numbers between 0.55 and 2.2 million. The wings differed in trailing-edge thickness, profile shape, maximum thickness ratio, and aspect ratio. Measurements were made on wings with and without a boundary-layer trip and are compared to theoretical calculations. Calculated results using shock-expansion theory are presented for Mach numbers up to 10. In general, thickening the trailing edge resulted in an increase in lift-curve slope. This increase varied between a few percent and about 15 percent, depending primarily on the trailing-edge thickness. Calculations indicate that somewhat greater increases are possible at high supersonic Mach numbers.

NACA TN 3508

LAMINAR FREE CONVECTION ON A VERTICAL PLATE WITH PRESCRIBED NONUNIFORM WALL HEAT FLUX OR PRESCRIBED NONUNIFORM WALL TEMPERATURE. E. M. Sparrow. July 1955. 34p. diagrs. (NACA TN 3508)

An analysis is made for laminar free convection on a vertical plate with prescribed nonuniform thermal conditions at the surface. For the situation where the wall-heat-flux variation is prescribed, graphs are presented from which the resulting variation of the wall temperature and local heat-transfer coefficient can be found. Results for the important special case of uniform wall heat flux are given. For the situation where the wall-temperature variation is prescribed, graphs are given for the over-all heat-transfer rate and local heat-transfer coefficient. All results are given for Prandtl numbers from 0.01 to 1000. Boundary-layer theory is used in conjunction with the Kármán-Pohlhausen method.

NACA TN 3513

HEAT TRANSFER AT THE FORWARD STAGNATION POINT OF BLUNT BODIES. Eli Reshotko and Clarence B. Cohen. July 1955. 17p. diagrs. (NACA TN 3513)

Relations are presented for the calculation of heat transfer at the forward stagnation point of both two-dimensional and axially symmetric blunt bodies. The relations for the heat transfer, which were obtained from exact solutions to the equations of the laminar boundary layer, are presented in terms of the local velocity gradient at the stagnation point. These exact solutions include effects of variation of fluid properties, Prandtl number, and transpiration cooling. Examples illustrating the calculation procedure are presented.

NACA TN 3517

APPROXIMATE METHOD FOR DETERMINING EQUILIBRIUM OPERATION OF COMPRESSOR COMPONENT OF TURBOJET ENGINE. Merle C. Huppert. July 1955. 25p. diagrs. (NACA TN 3517)

A method is presented for estimating the equilibrium operating line for a compressor as a component part of a turbojet engine. The results of this analysis are presented in chart form to facilitate rapid determination of the equilibrium operating line. Predicted and measured equilibrium operating conditions are compared in terms of compressor pressure ratio and equivalent weight flow; satisfactory agreement is indicated.

BRITISH REPORTS

N-38032*

Royal Aircraft Establishment (Gt. Brit.)
A REVISED ESTIMATE OF A RELATIONSHIP BETWEEN BEARING STRENGTH AND HARDNESS FOR METALLIC STRUCTURAL MATERIALS. R. F. Mousley. January 1955. 9p. diagr., 4 tabs. (RAE Tech. Note Structures 144)

A revised estimate is made of a relationship between bearing strength and hardness for metallic structural materials.

N-38033*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF NUMBER OF RIGGING LINES ON THE STRENGTH OF AN EXETER TYPE 12 PARACHUTE CANOPY. J. Picken. January 1955. 11p. diagrs., photos., 2 tabs. (RAE Tech. Note Mech. Eng. 197)

The number of rigging lines has been shown to have an effect on the strength of an Exeter-type 12 parachute canopy. In a series of flight tests it was demonstrated that a canopy rigged with eight lines is not so strong as one rigged with 16 lines. Amendments to the appropriate design formula are suggested.

N-38034*

Royal Aircraft Establishment (Gt. Brit.)
THE ELECTRICAL RESISTIVITY OF SODIUM BETWEEN 78° K AND 372° K. F. J. Bradshaw and S. Pearson. February 1955. 14p. diagrs. (RAE Met. 84)

The electrical resistivity of sodium has been measured from 78° K to slightly beyond the melting point. The specimens used consisted of distilled sodium in fine thin-walled nickel tubes. The results are compared with previously published figures. There is a small rise in the R/T v. T curve in the region 300° K to the melting point, which is not simply accountable for by present conductivity theories, and the hypothesis that part of the high temperature resistance is due to the presence of lattice defects is considered. Measurements on solid sodium were made to within 0.04° of the melting point and the resistance increased uniformly to this temperature. Some attempts were made to measure excess resistivity due to defects retained after quenching the solid from temperatures near the melting point, or after mechanical deformation at 63° K, but these were unsuccessful.

N-38035*

Royal Aircraft Establishment (Gt. Brit.)
TITANIUM-VANADIUM ALLOYS. G. I. Lewis, K. S. Jepson and H. Brooks. February 1955. 40p. diagrs., photos., 12 tabs. (RAE Tech. Note Met. 208)

Titanium-base alloys containing 5- to 30-percent vanadium were prepared as 0.07-in. thick rolled strip and tested in various conditions to determine the best tensile properties obtainable from them by heat treatment. An alloy with 16-percent vanadium showed most promise as a structural sheet material. After quenching from 800° C it had a tensile strength of 51 tons/sq in. with 29-percent total and 26-percent uniform elongation, and a minimum bend radius of IT. By overaging at 400 to 475° C, this soft condition could be converted to various hard conditions with strengths ranging from 71 tons/sq in. with 12-1/2 percent elongation to 88 tons/sq in. with 5-percent elongation. When aged to a 20° C strength of 81 tons/sq in., the tensile and shear moduli were 14.3 and 5.4 x 10^6 lb/sq in., respectively; the strength at 350° C was 65 tons/sq in. and after 1000 hours exposure at this temperature, the 20° C properties were substantially unchanged. The density of the alloy was 4.74 gm/cc or 0.17 lb/cu in. A number of ternary alloys based on the Ti-16-percent V composition were also examined.

N-38041*

Royal Aircraft Establishment (Gt. Brit.)
A CONSTRUCTIONAL METHOD FOR MINIMISING THE HAZARD OF CATASTROPHIC FAILURE IN A PRESSURE-CABIN. D. Williams. March 1955. 7p. (RAE Tech. Note Structures 156)

A method is put forward for substantially reducing the chances of a local failure in the shell of a pressure cabin from developing into catastropic failure of the cabin. The increased safety is achieved without weight penalty, and consists essentially in using closely spaced (10 inches or thereabouts) transverse flat bands, the material for which is obtained by reducing the sheet thickness normally available for the shell walls.

N-38042*

Nat. Gas Turbine Establishment (Gt. Brit.)
SOME EFFECTS OF SCALE AND MATERIAL ON THE BURSTING SPEEDS OF TURBINE DISCS. A. Graham, T. M. Jones and V. C. H. Bailey. January 1955. 12p. diagrs., 5 tabs. (NGTE R.166)

The measured bursting speeds of turbine disks of related profiles and several diameters in several materials are compared. Within the experimental range, the desirable amount of reinforcement about a central bore is found to vary with material and scale, but a moderate amount of reinforcement will offset the weakness due to a bore. Larger disks in various materials appear to behave like smaller disks in a brittle material. It is concluded that model experiments offer a better basis for comparison of disk profiles than elastic calculations.

N-38043*

Royal Aircraft Establishment (Gt. Brit.)
LUBRICATION: THE RATE OF SPREADING AND CREEP OF OILS AND OTHER LIQUIDS OVER SOLID SURFACES. E. B. Bielak, G. F. N. Calderwood and E. J. W. Mardles. March 1955. 21p. diagrs., 3 tabs. (RAE Tech. Note Chem. 1245)

The rate of radial spreading of liquid pools over and between horizontal surfaces and of the spontaneous movement of liquid columns into horizontal capillaries has been measured for a variety of liquids under different conditions of test. A resistance to flow, due to thin films extending from the liquid periphery, and which is variable with time of resting, rate of movement, etc., has been recorded. The slow movement which is non-Newtonian and affected by a number of specific factors other than the physical ones of viscosity, density, etc. can be correlated with results for several liquid properties, that is, friction, adhesion, and the dispersive power of the liquids for finely divided solids. The contact angle and hysteresis of contact angles hypotheses are inadequate for explaining the results obtained. The significance of the results in relation to lubrication theory is discussed briefly.

N-38044*

Royal Aircraft Establishment (Gt. Brit.)
LOADING CONDITIONS FOLLOWING AN AUTOMATIC PILOT FAILURE (RUDDER CHANNEL). D. R. Puttock. February 1955. 35p. diagrs., tab. (RAE Tech. Note Structures 154)

A method is presented for the determination of the critical loading conditions of aircraft that ensue from an automatic pilot failure in the rudder channel. General expressions have been derived through response theory for the angle of sideslip, fin-and-rudder load, and lateral acceleration both at the c. g. of the aircraft and at the tail, that result from the sequence of rudder movements assumed to follow an automatic pilot failure. Analysis of these general expressions leads to formulas suitable for assessing the numercial values of the critical loading conditions and it is suggested that these formulas might form a basis for the interpretation of the appropriate design requirement. An example is given to illustrate the type of response produced by a rudder channel failure and the calculation procedure.

N-38045*

Royal Aircraft Establishment (Gt. Brit.)
LOADING CONDITIONS FOLLOWING AN AUTOMATIC PILOT FAILURE (ELEVATOR CHANNEL). D. R. Puttock. February 1955. 50p. diagrs., tab. (RAE Tech. Note Structures 153)

A proposal is made for a standard procedure for calculating the critical loading conditions ensuing from an automatic pilot failure in the elevator channel. General expressions are derived through response theory for the increments in normal acceleration at the c. g. of the aircraft, normal acceleration at the tail, and aerodynamic load on the tailplane which result from the sequence of elevator movements assumed to follow a failure. Analysis of these general expressions leads to formulas suitable for assessing the numerical values of the critical loads on the wing and tailplane. The influence of the sequence of elevator movements on the loading conditions is discussed with reference to an example.

MISCELLANEOUS

N-37238*

INTERPRETATION OF WIND-TUNNEL DATA IN TERMS OF DYNAMIC BEHAVIOR OF AIRCRAFT AT HIGH ANGLES OF ATTACK. Ralph W. Stone, Jr. (Presented to Wind Tunnel and Model Testing Panel of Advisory Group for Aeronautical Research and Development, Ottawa, Canada, June 10-14, 1955) 32p. diagrs.

With the advent of jet-propelled aircraft and flight near and beyond the speed of sound, the basic airplane configuration has changed markedly. Most noticeable and important in this change has been the trend to low-aspect-ratio wings, swept-wing plan forms, and the general concentration of weight along the fuselage. The aerodynamic characteristics which basically result from the major changes in airplane configurations and which tend to cause inadvertent excursions of airplanes to large angles of attack and sideslip are nonlinear static pitching-moment characteristics at moderately low-lift coefficients, losses in directional stability, dihedral effectiveness, and roll damping at angles below the stall; and loss of directional stability with increasing Mach number in the supersonic range. The effect of inertia coupling is also of major influence. These characteristics which can cause inadvertent and uncontrolled motions and their recognition from wind-tunnel measure-moments are discussed.

N-37434*

AEROELASTIC EFFECTS OF AERODYNAMIC HEATING. Hugh L. Dryden and John E. Duberg. (Presented to Fifth General Assembly of Advisory Group for Aeronautical Research and Development, Ottawa, Canada, June 10-17, 1955) 18p. diagrs.

The design of aircraft to withstand aeroelastic difficulties at high supersonic speeds will of necessity require the consideration of the effects of aerodynamic heating. Among the various aeroelastic consequences of aerodynamic heating, the reduction of over-all stiffness through the action of thermal

stress is the most novel and may well turn out to be the most serious. An appreciation of this phenomenon must become part of the working equipment of the modern aeroelastician.

N-37552*

THE SIMULATION AND MEASUREMENT OF AERODYNAMIC HEATING AT SUPERSONIC AND HYPERSONIC MACH NUMBERS. Jackson R. Stalder and Alvin Seiff. (Presented to Wind Tunnel and Model Testing Panel of Advisory Group for Aeronautical Research and Development, Ottawa, Canada, June 10-14, 1955) 25p. diagrs., photos.

The purpose of this paper is to review the experience of the Ames Laboratory of the NACA with respect to the simulation and measurement of aerodynamic heat transfer at supersonic and hypersonic speeds.

UNPUBLISHED PAPERS

N-37541*

GYROPLANES (HELICOPTERS) WITH ROTORS THERMOPROPELLED BY LOW-PRESSURE FLUID. (Giravions à rotors thermopropulsés par fluide moteur à basse pression). M. René Dorand. June 1955. 52p. diagrs., photo., tabs. (Trans. from Technique et Science Aéronautiques, no. 3, 1951, p. 158-189)

The propelling fluid has a compression ratio of from 1.15 to 1.4; temperature of the order of 130° C; and velocity of from 200 m/sec to 300 m/sec. It is produced by a generator placed in the fuselage and distributed by means of a rotating joint in the longerons of the rotor and escapes by means of streamline propulsion nozzles in the blade profile whose orifices are distributed over span and depth of the blade. Part of the propelling fluid is used for directional maneuvering, and in certain cases, for direct propulsion of the machine. Expensive power transmission machinery is eliminated and fuel economy results.

N-37596*

ESTIMATION OF ERRORS IN THE APPROXIMATE SOLUTION OF LINEAR PROBLEMS. (Otsenki pogreshnostei priblizhennykh reshenii lineinykh zadach). M. G. Slobodyanskii. 23p. (Trans. from Prikladnaya Matematika i Mekhanika, v. 17, no. 2, Mar.-Apr., 1953, p. 229-244)

The present paper is devoted to the further development of the method of constructing the approximate solution and estimation of the error in linear problems reducible to variational problems. The results are applied to the boundary problem for the ordinary differential equation, and certain numerical examples are considered.

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Research Abstracts

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CURRENT NACA REPORTS

NACA RM E55E17a

PRELIMINARY DATA ON RAIN DEFLECTION FROM AIRCRAFT WINDSHIELDS BY MEANS OF HIGH-VELOCITY JET-AIR BLAST. Robert S. Ruggeri. July 1955. 17p. diagrs., photos. (NACA RM E55E17a)

Results indicate that rain deflection by jet-air blast appears feasible for flight speeds comparable with landing and take-off; however, visibility through the mist generated by raindrop breakup presents a problem. For the simulated windshield used, air-flow rates of about 3.3 lb/min-in. of span were required for adequate rain deflection at an airspeed of 135 mph. A method was devised whereby large-diameter water drops (1000 to 1500 μ) can be produced in a moving air stream, without breakup, at speeds in excess of 175 mph.

NACA RM L55E13c

A STUDY OF THE RESPONSE OF PANELS TO RANDOM ACOUSTIC EXCITATION. Robert W. Hess, Leslie W. Lassiter and Harvey H. Hubbard. July 1955. 9p. diagrs. (NACA RM L55E13c)

An application is made of the method of generalized harmonic analysis to the problem of prediction of stresses in airplane-skin panels due to excitation by jet noise. The concepts of the theory are reviewed briefly and some of the significant parameters are evaluated in the tests. Measurements of stresses in some panels due to random acoustic excitation are presented and are found to be in general agreement with calculated results.

NACA RM L55E20c

BEHAVIOR OF A CANTILEVER PLATE UNDER RAPID-HEATING CONDITIONS. Louis F. Vosteen and Kenneth E. Fuller. July 1955. 17p. diagrs. (NACA RM L55E20c)

The temperature distributions encountered in thin solid wings subjected to aerodynamic heating induce thermal stresses that may effectively reduce the stiffness of the wing. The effects of this reduction in stiffness were investigated experimentally by rapidly heating the edges of a cantilever plate. The midplane thermal stresses imposed by the nonuniform temperature distribution caused the plate to buckle torsionally, increased the deformations of the plate under a constant applied torque, and reduced the frequency of the first two natural modes of vibration. By using small-deflection theory and employing energy methods, the effect of nonuniform heating on the plate stiffness was calculated. The theory predicts the general effects of the thermal stresses, but becomes inadequate as the temperature difference increases and plate deflections become large.

NACA RM L55F10

SOME EFFECTS OF FLUID IN PYLON-MOUNTED TANKS ON FLUTTER. James R. Reese. July 1955. 7p. diagrs., tab. (NACA RM L55F10)

Fluid-dynamics studies were made of a tank of fineness ratio 7.0 which was pylon mounted on a simplified two-dimensional flutter model in order to determine the effects of the fluid on flutter. The flutter speed was found experimentally for three cases as follows: with various amounts of water in the tank, with weights having the same mass and moment of inertia as the fluid considered to be a frozen solid, and with weights having the same mass and moment of inertia as the actual fluid. The results of the two methods of fuel representation were compared with the actual-fluid case, and it was concluded that, in flutter analyses and tests, the fuel in wing tanks must be represented by the effective-moment-of-inertia values. The damping action of the fluid was also studied, and it was found that sufficient damping was present to limit the amplitude of the flutter and that, at a frequency ratio near 1.0, the fluid damping may produce an increase in the flutter speed.

NACA TM 1390

ON THE MECHANISM OF BUCKLING OF A CIRCULAR CYLINDRICAL SHELL UNDER AXIAL COMPRESSION. Y. Yoshimura. July 1955. 46p. diagrs., tab. (NACA TM 1390)

The present paper deals with the buckling of a circular cylindrical shell under axial compression from the viewpoint of energy and the characteristics of deformation. It is shown first, both theoretically and experimentally, that the reason why the buckling of a cylindrical shell is quite different from that of a flat plate is attributable to the existence of a nearly developable surface far apart from the original cylindrical surface, which is equivalent to the existence of an approximately inextensional finite deformation. Based upon this result, the experimental fact that the buckling is really not general but local, that is, that the buckled region is limited axially to a range of 1.5 times the wave length of the lobe, is explained by the theoretical result that the minimum buckling load is smaller in the local buckling than in the general buckling case. The occurrence of local

buckling is affirmed also from the viewpoint of the energy barrier to be jumped over during buckling, and from a comparison of the theoretical post-buckling state with the experimental results. Finally, the local buckling with the load applied by a spring is analyzed, and it is proved that the minimum buckling load increases with an increase of rigidity of the spring.

NACA TN 3218

FLIGHT DETERMINATION OF THE DRAG AND PRESSURE RECOVERY OF AN NACA 1-40-250 NOSE INLET AT MACH NUMBERS FROM 0.9 TO 1.8. R. I. Sears and C. F. Merlet. July 1955. 30p. diagrs., photos., 2 tabs. (NACA TN 3218. Formerly RM L50L18)

External-drag and pressure-recovery data are presented for the NACA 1-40-250 nose inlet. The tests were made using rocket-propelled models in free flight at Mach numbers from 0.9 to 1.8. The Reynolds number based on body diameter varied from 4×10^6 to 10×10^6.

NACA TN 3384

EFFECT OF HYDROCARBON STRUCTURE ON REACTION PROCESSES LEADING TO SPONTANEOUS IGNITION. Donald E. Swarts and Charles E. Frank, University of Cincinnati. July 1955. 23p. diagrs., 6 tabs. (NACA TN 3384)

The present study compares the reaction processes of other aliphatic hydrocarbons with those of the heptane and isooctane previously studied. A study of the behavior of olefins and some exploratory work on the effect of the ratio of surface to volume on the extent of oxidation in the early stages was also included.

NACA TN 3419

NACA MODEL INVESTIGATIONS OF SEAPLANES IN WAVES. John B. Parkinson. (Presented at Conference on Ships and Waves, Stevens Institute of Technology, Oct. 25-27, 1954) July 1955. 28p. diagrs., photos. (NACA TN 3419)

The models, apparatus, and instrumentation developed for investigations of the rough-water characteristics of seaplanes in the Langley tanks are described briefly. The results of several investigations to improve these characteristics are combined and summarized. The large effect of waves in take-off resistance is illustrated. The general relationship of the measured quantities of importance to wave length and height are also illustrated.

NACA TN 3422

NOISE SURVEY OF A 10-FOOT FOUR-BLADE TURBINE-DRIVEN PROPELLER UNDER STATIC CONDITIONS. Max C. Kurbjun. July 1955. 25p. diagrs., photo. (NACA TN 3422)

Overall sound-level measurements and tape recordings of the noise emitted from a 10-foot-diameter, four-blade propeller mounted on a propeller-research vehicle have been made under static conditions at stations spaced on a 75-foot-radius circle about the propeller. The tape recordings were analyzed to obtain the frequency spectra at each station and comparisons of the results are made with theory. The effects of microphone position above the ground are also given.

NACA TN 3460

TABLES OF COEFFICIENTS FOR THE ANALYSIS OF STRESSES ABOUT CUTOUTS IN CIRCULAR SEMIMONOCOQUE CYLINDERS WITH FLEXIBLE RINGS. Harvey G. McComb, Jr. and Emmet F. Low, Jr. July 1955. 98p. diagrs., 30 tabs. (NACA TN 3460)

Tables of coefficients are presented which facilitate the stress analysis of circular semimonocoque cylinders with cutouts by the method published in NACA TN 3200. When the values of two simple structural parameters are known, use of these coefficients enables shear flows and stringer loads in the neighborhood of a cutout to be calculated. The effect of bending flexibility of the rings in their planes has been taken into consideration in the computation of the coefficients. Included as a limiting case are the tables from NACA TN 3200 which were computed on the assumption that there is no distortion of the rings in their planes.

NACA TN 3462

TENSILE PROPERTIES OF 7075-T6 AND 2024-T3 ALUMINUM-ALLOY SHEET HEATED AT UNIFORM TEMPERATURE RATES UNDER CONSTANT LOAD. George J. Heimerl and John E. Inge. July 1955. 46p. diagrs., photos., 4 tabs. (NACA TN 3462)

Results are presented of tests to determine the effect of heating at uniform temperature rates from 0.2° to 100° F per second on the tensile properties of 7075-T6 (75S-T6) and 2024-T3 (24S-T3) aluminum-alloy sheet under constant-load conditions. Yield and rupture stresses, obtained under rapid-heating conditions, are compared with results of elevated-temperature stress-strain tests for 1/2-hour exposure. Master yield- and rupture-stress curves based on a linear temperature-rate parameter are presented. Yield and rupture stresses and temperatures may be predicted by means of master curves and the parameter.

NACA TN 3465

THEORETICAL INVESTIGATION OF FLUTTER OF TWO-DIMENSIONAL FLAT PANELS WITH ONE SURFACE EXPOSED TO SUPERSONIC POTENTIAL FLOW. Herbert C. Nelson and Herbert J. Cunningham. July 1955. 60p. diagrs., tab. (NACA TN 3465)

A Rayleigh type analysis is used to treat the flutter of a two-dimensional flat panel supported at its leading and trailing edges and subjected to a middle-

plane tensile force, with a supersonic stream over its upper surface and still air below. Numerical results in the form of stability boundaries are presented for determining some effects of number of modes, Mach number, densities of the supersonic stream and still air, panel mass and stiffness, edge fixity, structural damping, and middle-plane tensile force.

NACA TN 3466

AN INVESTIGATION OF THE DISCHARGE AND DRAG CHARACTERISTICS OF AUXILIARY-AIR OUTLETS DISCHARGING INTO A TRANSONIC STREAM. Paul E. Dewey and Allen R. Vick. July 1955. 38p. diagrs., photos. (NACA TN 3466)

The aerodynamic characteristics of auxiliary-air outlets of rectangular cross section discharging into a transonic stream have been investigated. The effects of aspect ratio, inclination, curvature, and recess depth upon the discharge coefficients have been determined for thin-plate and ducted-approach outlets. Surface pressure distributions in the vicinity of ducted outlets and vent pressures with no discharge are also presented. In addition, force coefficients have been measured for a few of the ducted-approach models.

NACA TN 3468

EFFECTS OF SWEEP ON THE MAXIMUM-LIFT CHARACTERISTICS OF FOUR ASPECT-RATIO-4 WINGS AT TRANSONIC SPEEDS. Thomas R. Turner. July 1955. 25p. diagrs. (NACA TN 3468. Formerly RM L50H11)

An investigation at transonic speeds has been made to determine the effect of wing sweep on the maximum lift characteristics of a series of wings having an aspect ratio of 4, a taper ratio of 0.6, and the quarter-chord line swept back 0°, 35°, 45°, and 60°. The Mach number varied from 0.61 to 1.20 with a Reynolds number variation from 380,000 to 460,000. Lift data are presented from approximately zero lift to beyond maximum lift. Drag and pitching-moment data are also presented.

NACA TN 3472

FLOW STUDIES ON FLAT-PLATE DELTA WINGS AT SUPERSONIC SPEED. William H. Michael, Jr. July 1955. 40p. diagrs., photos. (NACA TN 3472)

An experimental study has been made to investigate some aspects of the nature of the flow around flat-plate delta wings. Vapor-screen, pressure-distribution, and ink-flow studies were made at a Mach number of 1.9 on a series of semispan delta-wing models with slender wedge airfoil sections and very sharp leading edges. The models had semi-apex angles ranging from 5° to 31.75°.

NACA TN 3509

A STUDY OF BOUNDARY-LAYER TRANSITION AND SURFACE TEMPERATURE DISTRIBUTIONS AT MACH 3.12. Paul F. Brinich. July 1955. 39p. diagrs., photo. (NACA TN 3509)

Surface temperature distributions and high-speed schlieren motion pictures were used to study transition with and without single roughness elements on a hollow cylinder at various wind-tunnel Reynolds numbers. Increasing the sharpness of the leading edge increased the abruptness of the recovery temperature rise near the transition point and decreased the transition Reynolds number. Single roughness elements in the laminar boundary layer moved transition upstream and produced slight local changes in temperature distributions. Roughness elements in transitional and turbulent boundary layers produced large perturbations in temperature distributions.

NACA TN 3511

EXTRAPOLATION TECHNIQUES APPLIED TO MATRIX METHODS IN NEUTRON DIFFUSION PROBLEMS. Robert R. McCready. July 1955. 32p. diagrs. (NACA TN 3511)

An iterative scheme is developed for the matrix solution of the type of characteristic-value problem arising from homogeneous linear equations. The scheme is shown to minimize a suitable form at each step. Extrapolation techniques for speeding convergence are developed and refined. An example from nuclear-reactor theory is presented.

NACA TN 3512

EFFECT OF SOME SELECTED HEAT TREATMENTS ON THE OPERATING LIFE OF CAST HS-21 TURBINE BLADES. Francis J. Clauss, Floyd B. Garrett and John W. Weeton. July 1955. 39p. diagrs., photos. (NACA TN 3512)

Effects of heat treatment depend upon initial microstructure of cast blades. Blades from one manufacturer performed best in the as-cast condition; blades from a second manufacturer performed best after aging 48 hours at 1500° F. Solution treatments at 2050° F and above often caused damage by eutectic melting. Before the full benefits of heat treatment can be realized, casting conditions must be controlled to produce uniform structures with finely distributed carbides and a minimum of interdendritic segregation.

BRITISH REPORTS

N-38175*

Forest Products Research Lab. (Gt.Brit.) INVESTIGATIONS INTO GLUES AND GLUING. PROGRESS REPORT EIGHTY-TWO - OCTOBER 1954. DURABILITY OF ASSEMBLY GLUES - SERIES B. SEVENTH-YEAR REPORT ON LAMINATED BEAMS. R. J. Newall and J. E. Grosert. 8p. diagrs. (Supersedes Progress Report 67, September 1952) (Forest Products Research Lab.)

The durability of animal, casein, urea-formaldehyde and phenol-formaldehyde glues is being investigated in laminated beams 7 feet long, 6 inches thick and

2 inches, 4 inches, and 6 inches wide when fully exposed to the weather and when stored in an unheated shed. Controls are stored in a building air-conditioned at 8-10 percent moisture content. Results are available up to 84 months.

N-38176*

Forest Products Research Lab. (Gt.Brit.)
INVESTIGATIONS INTO GLUES AND GLUING. PROGRESS REPORT EIGHTY-FOUR - FEBRUARY 1955. THE COLD GLUING OF OAK AND AFRICAN MAHOGANY LAMINATES. PART I. R. J. Newall and J. E. Grosert. 6p., 2 tabs. (Forest Products Research Lab.)

Laminated blocks made with a pure resorcinol and an acid catalysed phenolic resin and having 10-12 percent, 15 percent, and 18 percent moisture content were cured at 50° F, 80° F, and 100° F. Double and single spreading have been compared. The quality of adhesion has been tested by a cyclical treatment of vacuum-pressure wetting followed by drying at an equilibrium moisture content of 7 percent.

N-38177*

Forest Products Research Lab. (Gt.Brit.)
INVESTIGATIONS INTO GLUES AND GLUING. PROGRESS REPORT EIGHTY-EIGHT - MARCH 1955. THE COMPARATIVE DURABILITY OF ASSEMBLY GLUES IN ENGLAND AND IN NIGERIA. ANALYSIS AFTER THIRTY MONTHS EXPOSURE. J. F. S. Carruthers. 9p., 4 tabs. (Supersedes Progress Report 79, December 1953) (Forest Products Research Lab.)

Animal, casein, urea-formaldehyde, phenol-formaldehyde and resorcinol formaldehyde were investigated in two types of joints (grain directions at right angles or parallel). A glue was considered as having failed when seven out of ten glue lines displayed delamination of a defined amount. On this basis the results of 30 months exposure were assessed.

N-38241*

Royal Aircraft Establishment (Gt. Brit.)
LOADING CONDITIONS OF TAILED AIRCRAFT IN LONGITUDINAL MANOEUVRES. T. Czaykowski. February 1955. 80p. diagrs., tab. (RAE Structures 177)

This analysis of aircraft response and loading conditions in symmetrical maneuvers is based on the theory of aircraft response to elevator induced longitudinal maneuvers. Basic response functions have been derived for the chosen, exponential type of elevator motion, and from these, general expressions have been obtained for various derived response quantities, such as tail plane loads, elevator hinge moments, normal accelerations at the tail, etc. A computational method is given in the appendix which allows the evaluation of the complete time histories of response quantities or, alternatively, their significant maxima. The simplifying assumptions underlying the analysis are critically reviewed and possible limitations of the method are discussed.

N-33242*

Nat. Gas Turbine Establishment (Gt. Brit.)
THE PERFORMANCE TESTING OF AIRCRAFT GAS TURBINE COMBUSTION CHAMBERS UNDER ALTITUDE CONDITIONS. P. Martin and M. V. Herbert. November 1954. 24p. diagrs., 3 tabs. (NGTE Memo. M. 231)

Combustion chamber test conditions chosen according to Ashwood's method of standardization are too limited for current general use. The inlet conditions found in existing engines have been investigated, and the overall range of temperature and pressure has been defined. A standard division of this range is proposed. The constancy of $\frac{Q\sqrt{T_2}}{p_2}$ over the subsonic working range of an engine enables air mass flow to be determined for any combination of temperature and pressure, and variation of this parameter at supersonic speeds is considered. Test results may be presented as a chamber characteristic, offering easy comparison between individual combustion systems.

N-38244*

Royal Aircraft Establishment (Gt. Brit.)
SOME MICROSCOPICAL OBSERVATIONS ON THE EFFECT OF FATIGUE AND CORROSION FATIGUE STRESSES ON D. T. D. 683. C. A. Stubbington and P. J. E. Forsyth. February 1955. 11p. photos. (RAE Tech. Note Met. 211)

It has been found that D. T. D. 683 shows transcrystalline failure and slip-band exudation when subjected to cyclic stress except under conditions of corrosion fatigue when some intercrystalline cracking has been observed. The tendency to produce intercrystalline corrosion fatigue failure was found to be greatest in certain conditions of heat treatment. Some observations have also been made on the microstructure of D. T. D. 683 after various heat treatments and suggestions are made for modification of existing heat treatments to obtain improved corrosion fatigue properties.

N-38251*

Aeronautical Research Council (Gt. Brit.)
COMPRESSOR CASCADE FLUTTER TESTS - 20° CAMBER BLADES, MEDIUM AND HIGH STAGGER CASCADES. D. A. Kilpatrick and J. Ritchie. 1955. 19p. diagrs., photos. (ARC CP 187)

The tests reported show the existence of three main zones of flutter at high stress: stalling flutter, shock-stalling flutter, and choking flutter. These zones are similarly located (with reference to the aerodynamic characteristics) for both the medium and the high stagger cascades tested, and they extend over a wide range of incidence. Good correlation between the zones of flutter and the experimentally measured blade force derivatives, with respect to Mach number and incidence, has been obtained. More experimental data are, however, required before a quantitative analysis of the problem can be achieved.

N-38252*

Aeronautical Research Council (Gt. Brit.) SOME VISUAL OBSERVATIONS OF THE FLOW OVER A SWEPT-BACK WING IN A WATER TUNNEL, WITH PARTICULAR REFERENCE TO HIGH INCIDENCES. N. C. Lambourne and P. S. Pusey. 1955. 20p. diagrs., photos. (ARC CP 192)

These tests were restricted to low Reynolds numbers (about 10^5 based on mean chord). Visualization was effected by two techniques, namely, (1) the addition of small aluminum particles to the water, and (2) the introduction of air into the stream close to the model. In addition, the surface patterns produced by the flow after the wing had been coated with oil were obtained. Attention has been concentrated on the flow that exists at high incidence which is characterized by a flat horn-shaped region of separated flow expanding in extent over the suction surface from a position inboard near the leading edge. A part-span trailing vortex has been revealed and appears to be a continuation of a discrete vortex situated in the separated region.

MISCELLANEOUS

N-37714

Advisory Group for Aeronautical Research and Development. PROCEEDINGS OF THE FOURTH AGARD GENERAL ASSEMBLY, MAY 5 AND 6, 1954: HUMAN FACTORS IN AIRCRAFT DESIGN. Morley Gray Whillans, Defence Research Board, Canada. SUBJECTIVE EXPERIENCES AND REACTIONS DURING FLIGHT TESTING IN THE TRANSONIC REGION. (Test Pilots Round Table Discussion). LOW TEMPERATURE OPERATION OF AIRCRAFT. R. M. Aldwinckle, RCAF. THE USE OF PERSONAL EQUIPMENT IN ARCTIC SURVIVAL. F. Vogt Lorentzen, Royal Norwegian Air Force. SOME PROBLEMS IN CANADIAN AERONAUTICAL RESEARCH AND DEVELOPMENT. D. C. MacPhail, National Aeronautical Establishment, Canada. SOME ASPECTS OF THE LIGHT INTERCEPTOR PROBLEM. Sergio Stefanutti. SELECTED AERODYNAMIC PROBLEMS OF HIGH-SPEED FLIGHT. K. E. van Every, Douglas Aircraft Company. LAMINARISATION THROUGH BOUNDARY LAYER CONTROL. G. V. Lachmann, Handley Page, Ltd. AIRWORTHINESS REQUIREMENTS. Lucio Lazzarino, University of Pisa. SOME ASPECTS OF AERONAUTICAL RESEARCH. Pol Duwez, California Institute of Technology. AIRBORNE ELECTRONIC EQUIPMENT. M. Desirant, Physics Research Laboratory, Belgium. SOME STUDIES OF LABORATORY MANAGEMENT. Herbert A. Shepard, Massachusetts Institute of Technology. 160p. diagrs., photos. (Advisory Group for Aeronautical Research and Development. AG 14/P5)

N-37721*

Advisory Group for Aeronautical Research and Development. INTRODUCTION TO THE STUDY OF CHEMICAL REACTIONS IN FLOW SYSTEMS. S. S. Penner, California Institute of Technology. 1955. viii, 86p. diagrs., tabs. (AGARDograph 7)

This manuscript is comprised of four chapters which contain the following: a résumé of classical chemical kinetics with special reference to the limitations of the steady-state approximation for chain reactions; a summary of the conservation laws for reacting fluids and suitable expressions for the determination of transport coefficients; an analysis of chemical reactions during adiabatic flow through a de Laval nozzle; a discussion of heterogeneous chemical reactions which includes stationary, isothermal, gas-solid systems and diffusion flames.

(May be purchased from Butterworth's Publications Ltd., 88 Kingsway, London, W. C. 2, England at $2.50.)

N-37722*

Advisory Group for Aeronautical Research and Development. COMBUSTION RESEARCHES AND REVIEWS: DIFFUSION FLAMES IN THE LABORATORY. J. Barr. SOME PROBLEMS PERTINENT TO THE COMBUSTION OF SPRAYS. M. Gerstein. SOME ASPECTS OF COMBUSTION OF LIQUID FUEL. C. C. Graves and M. Gerstein. LA FORMATION ET L'ÉVOLUTION DES BROUILLARDS COMBUSTIBLES. R. Kling. SOME NOTES ON SPRAY COMBUSTION. J. R. Joyce. THE CORRELATION OF COMBUSTION EFFICIENCY AND INJECTOR CHARACTERISTICS UNDER SIMULATED ALTITUDE CONDITIONS. Staff of NGTE. FLAME STABILIZATION AND FLAME PROPAGATION IN RAMJET COMBUSTORS. J. P. Longwell. ÉTUDE DES LIMITES DE STABILITÉ EN RELATION AVEC LA RÉSISTANCE DES OBSTACLES À L'ÉCOULEMENT. A. Mestre. A SPONTANEOUS IGNITION THEORY OF COMBUSTION INTENSITY AND COMBUSTION STABILITY BEHIND A BAFFLE. B. P. Mullins. THE MECHANISM OF CARBON FORMATION. G. Porter. FORMATION ET DÉPOT DE CARBONE DANS LES FOYERS DE TURBOMACHINES D'AVIATION. C. Fouré. SIMILARITY ANALYSIS FOR CHEMICAL REACTORS AND THE SCALING OF LIQUID FUEL ROCKET ENGINES. S. S. Penner. RAYONNEMENT DES FLAMMES ET SIMILITUDE. C. Codegone. THE ROLE OF WAKE TRANSITION IN THE PROCESS OF FLAME STABILIZATION ON BLUFF BODIES. E. E. Zukoski and F. E. Marble. (Invited papers presented at the 6th and 7th AGARD Combustion Panel Meetings held respectively in Scheveningen, the Netherlands, May 1954 and in Paris, France, November 1954). 1955. xv, 187p. diagrs., photos., tabs. (AGARDograph 9)

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National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1176

DETERMINATION OF MEAN CAMBER SURFACES FOR WINGS HAVING UNIFORM CHORDWISE LOADING AND ARBITRARY SPANWISE LOADING IN SUBSONIC FLOW. S. Katzoff, M. Frances Faison and Hugh C. DuBose. 1954. ii, 17p. diagrs., tab. (NACA Rept. 1176. Formerly TN 2908)

Methods involving integrations around the wing boundary are presented for computing mean camber surfaces to support uniform chordwise loading, with either uniform or nonuniform spanwise loading, in subsonic flow. For polygonal wings with uniform area loading, analytical expressions are developed for both the slopes and the ordinates of the mean camber surfaces. Mean camber surfaces of several calculated wings are shown.

NACA Rept. 1178

CALIBRATION OF STRAIN-GAGE INSTALLATIONS IN AIRCRAFT STRUCTURES FOR THE MEASUREMENT OF FLIGHT LOADS. T. H. Skopinski, William S. Aiken, Jr. and Wilber B. Huston. 1954. ii, 29p. diagrs., 10 tabs. (NACA Rept. 1178. Formerly TN 2993; RM L52G31)

A general procedure is developed for calibrating strain-gage installations in aircraft structures for application to flight measurements of loads. The basic procedure can be modified as necessary to suit the requirements of any particular structure. The application of the procedure is illustrated by results for two typical structures.

NACA Rept. 1183

SUPERSONIC FLOW PAST OSCILLATING AIRFOILS INCLUDING NONLINEAR THICKNESS EFFECTS. Milton D. Van Dyke. 1954. ii, 17p. diagrs. (NACA Rept. 1183. Formerly TN 2982)

A solution to second order in thickness is derived for harmonically oscillating two-dimensional airfoils in supersonic flow. For slow oscillations of an arbitrary profile, the result is found as a series including the third power of frequency. For arbitrary frequencies, the method of solution for any specific profile is indicated, and the explicit solution derived for a single wedge. Nonlinear thickness effects are found generally to reduce the torsional damping, and so enlarge the range of Mach numbers within which torsional instability is possible.

NACA Rept. 1184

THE NORMAL COMPONENT OF THE INDUCED VELOCITY IN THE VICINITY OF A LIFTING ROTOR AND SOME EXAMPLES OF ITS APPLICATION. Walter Castles, Jr. and Jacob Henri De Leeuw, Georgia Institute of Technology. 1954. ii, 15p. diagrs., 3 tabs. (NACA Rept. 1184. Formerly TN 2912)

A method is presented for computing the approximate values of the normal component of the induced velocity at points in the flow field of a lifting rotor. Tables and graphs of the relative magnitudes of the normal component of the induced velocity are given for selected points in the longitudinal plane of symmetry of the rotor and on the lateral rotor axis. A method is also presented for using the tables and graphs to determine the interference induced velocities arising from the second rotor of a tandem- or side-by-side-rotor helicopter and the induced flow angle at a horizontal tail plane.

NACA Rept. 1188

ON THE USE OF THE INDICIAL FUNCTION CONCEPT IN THE ANALYSIS OF UNSTEADY MOTIONS OF WINGS AND WING-TAIL COMBINATIONS. Murray Tobak. 1954. iii, 43p. diagrs. (NACA Rept. 1188)

The concept of indicial aerodynamic functions is applied to the analysis of the short-period pitching mode of aircraft. By the use of simple physical relationships associated with the indicial-function concept, qualitative studies are made of the separate effects on the damping in pitch of changes in Mach number, aspect ratio, plan-form shape, and frequency. The concept is further shown to be of value in depicting physically the induced effects on a tail surface which follows in the wake of a starting forward surface. Considerable effort is devoted to the development of theoretical techniques whereby the transient response in lift at the tail to the wing wake may be estimated. Numerical results for several representative cases are presented, and these are analyzed to reassess the importance of the contribution to the rotary damping moment of the interference lift at the tail.

NACA Rept. 1194

A STUDY OF HYPERSONIC SMALL-DISTURBANCE THEORY. Milton D. Van Dyke. 1954. ii, 21p. diagrs. (NACA Rept. 1194. Formerly TN 3173)

The small-disturbance equations are derived for inviscid flow past thin bodies at high supersonic speeds. Reinterpreted, they apply throughout the

supersonic range. The theory is used to find pressures on cones and wedges, initial gradients on ogives, and initial pressure curvatures on ogives of revolution. Additional approximations from existing theories are discussed.

NACA Rept. 1196

AN ANALYTICAL STUDY OF THE EFFECT OF AIRPLANE WAKE ON THE LATERAL DISPERSION OF AERIAL SPRAYS. Wilmer H. Reed, III. 1954. ii, 16p. diagrs., 3 tabs. (NACA Rept. 1196. Formerly TN 3032)

An analysis is made to determine the trajectories and deposit of aerial spray droplets which are issued into the air disturbances generated by an agricultural airplane. Various nozzle arrangements and droplet-size spectra are considered with a view to improving the uniformity and effective width of the deposit.

NACA RM 55F08

METAL-BONDING ADHESIVES FOR HIGH-TEMPERATURE SERVICE. John M. Black and R. F. Blomquist, Forest Products Laboratory. July 1955. 22p. tab. (NACA RM 55F08)

Results of an investigation made for the purpose of developing a metal-bonding adhesive with improved heat-resistant properties are reported. The most promising results were obtained with a formulation of a phenol resin and an epoxy resin with certain heat stabilizers and catalysts. An improved straight epoxy-resin adhesive that has superior strength properties at 250° to 300° F compared with any other known epoxy-resin adhesive formulation is also reported.

NACA TN 3298

A LOW-DENSITY WIND-TUNNEL STUDY OF SHOCK-WAVE STRUCTURE AND RELAXATION PHENOMENA IN GASES. F. S. Sherman, University of California. July 1955. 83p. diagrs., photos., 2 tabs. (NACA TN 3298)

The profiles and thicknesses of normal shock waves of moderate strength were determined in terms of the variation of the equilibrium temperature of an insulated transverse cylinder in free-molecule flow. The shock waves were produced in a steady state in the jet of a low-density wind tunnel at initial Mach numbers of 1.72 and 1.82 in helium and 1.78, 1.85, 1.90, 1.98, 3.70, and 3.91 in air. The shock thickness was determined from the maximum slope of the cylinder temperature profile. The experimental shock profiles are compared with various theoretical predictions.

NACA TN 3470

GUST-TUNNEL INVESTIGATION OF THE EFFECT OF A SHARP-EDGE GUST ON THE FLAPWISE BLADE BENDING MOMENTS OF A MODEL HELICOPTER ROTOR. Domenic J. Maglieri and Thomas D. Reisert. August 1955. 24p. diagrs., photos. (NACA TN 3470)

Preliminary investigations have been made in the Langley gust tunnel to determine the effects of a sharp-edge vertical gust on the blade flapwise vibratory bending moments of small model rotors having either fixed-at-root or teetering blades. Both rotor configurations were tested up to a tip-speed ratio of about 0.35. The results for simulated forward flight indicate that the effect of the gust on the maximum vibratory bending moments is of less importance for the teetering rotor than for the fixed-at-root rotor. Increasing the rotor speed decreases the magnitude of the vibratory bending moments resulting from a given gust. At a given rotor speed, the magnitude of the vibratory components due to the gust increases with increasing tip-speed ratio. Increasing the rotor speed at a constant forward velocity decreases the maximum vibratory bending moments for all conditions tested.

NACA TN 3471

THEORETICAL ANALYSES TO DETERMINE UNBALANCED TRAILING-EDGE CONTROLS HAVING MINIMUM HINGE MOMENTS DUE TO DEFLECTION AT SUPERSONIC SPEEDS. Kennith L. Goin. August 1955. 52p. diagrs., tab. (NACA TN 3471. Formerly RM L51F19)

Theoretical analyses have been made to determine the plan forms of unbalanced trailing-edge flap-type controls having minimum hinge moments due to deflection and requiring minimum work to overcome the hinge moments due to deflection at supersonic speeds. Ratios of lift and rolling moment to hinge moment and lift and rolling moment to deflection work at fixed values of lift and rolling effectiveness were used as bases for the analyses. The effects of control plan form, control location, and Mach number have been considered.

NACA TN 3473

EFFECTS OF SWEEP AND ANGLE OF ATTACK ON BOUNDARY-LAYER TRANSITION ON WINGS AT MACH NUMBER 4.04. Robert W. Dunning and Edward F. Ulmann. August 1955. 31p. diagrs., photos. (NACA TN 3473)

Wind-tunnel tests were conducted at Mach number 4.04 to determine the effects of leading-edge sweep, angle of attack, and leading-edge thickness on the boundary-layer transition on flat-plate wings. In addition, some results were obtained on wings having rounded leading-edge sections. Transition points were determined for angles of attack up to

20° and for leading-edge sweep angles from 0° to 72°. A correlation has been obtained, for the present data, of the effects of leading-edge sweep and angle of attack on boundary-layer transition on plane surfaces when the equivalent stagnation pressure (stagnation pressure calculated from the local static pressure and the local Mach number normal to the leading-edge) and the rate of change of the transition Reynolds number with equivalent stagnation pressure are considered.

NACA TN 3482

SUPPLEMENTARY CHARTS FOR ESTIMATING PERFORMANCE OF HIGH-PERFORMANCE HELICOPTERS. Robert J. Tapscott and Alfred Gessow. July 1955. 31p. diagrs. (NACA TN 3482)

Charts published in NACA TN 3323 for estimating the performance of high-performance helicopters were applicable to rotors having hinged rectangular blades with a linear twist of -8°. Supplementary charts are presented herein covering twists of 0° and -16°.

NACA TN 3484

ON SPECTRAL ANALYSIS OF RUNWAY ROUGHNESS AND LOADS DEVELOPED DURING TAXIING. John C. Houbolt, James H. Walls and Robert F. Smiley. July 1955. 9p. diagrs. (NACA TN 3484)

The application of the technique of generalized harmonic analysis as a means for determining airplane taxiing loads is considered in a cursory manner. Some results on runway roughness are reviewed and some results obtained from taxiing tests of a large airplane are given. An elementary extrapolation of results for low taxiing velocities to higher velocities is shown to be conservative. Also, oleo-strut friction is shown to be a very important factor. With regard to the load-prediction phase of taxiing loads by spectral techniques, much additional work is required, especially with respect to the treatment of the transfer function.

NACA TN 3487

ACOUSTIC RADIATION FROM TWO-DIMENSIONAL RECTANGULAR CUTOUTS IN AERODYNAMIC SURFACES. K. Krishnamurty, California Institute of Technology. August 1955. 33p. diagrs., photos. (NACA TN 3487)

The acoustic radiation from two-dimensional rectangular cavities cut into a flat surface was investigated by schlieren, hot-wire, and optical interferometric techniques. The relation of the frequency, as measured in the gap by a hot-wire, to the gap breadth at a particular Mach number and free-stream temperature is shown. The intensity of the radiation was measured by means of an optical interferometer.

NACA TN 3488

SOME MEASUREMENTS OF FLOW IN A RECTANGULAR CUTOUT. Anatol Roshko, California Institute of Technology. August 1955. 21p. diagrs. (NACA TN 3488)

The flow in a rectangular cavity, or slot, in the floor of a wind tunnel is described by the results of pressure and velocity measurements. Pressure distributions on the cavity walls as well as measurements of friction are presented. The effects of varying depth-breadth ratio are shown.

NACA TN 3507

PRACTICAL CONSIDERATIONS IN SPECIFIC APPLICATIONS OF GAS-FLOW INTERFEROMETRY. Walton L. Howes and Donald R. Buchele. July 1955. ii, 95p. diagrs., photos. (NACA TN 3507)

By extending the analysis in NACA TN 3340, equations which simultaneously account for refraction and corner effects are derived for evaluating one-dimensional density fields from optical interferograms. The random error in measuring fringe shifts is determined. Spurious surface phenomena are discussed and a simple method for model alinement is described. A method for determining the density at a surface is described. Systematic and random errors are computed for three representative experimental situations, namely, boundary layers associated with supersonic and subsonic flows along flat plates and free convection of heat from a horizontal cylinder. Reasons for discrepancies between theory and experiment are offered.

NACA TN 3515

ANALYSIS OF TWO-DIMENSIONAL COMPRESSIBLE-FLOW LOSS CHARACTERISTICS DOWNSTREAM OF TURBOMACHINE BLADE ROWS IN TERMS OF BASIC BOUNDARY-LAYER CHARACTERISTICS. Warner L. Stewart. July 1955. 48p. diagrs. (NACA TN 3515)

Equations are derived for obtaining compressible-flow boundary-layer characteristics for a simple power velocity profile. Loss coefficients at the trailing edge and after mixing are then obtained in terms of these boundary-layer characteristics. This analysis is used to study the general effect of compressibility on blade-exit loss characteristics, the significance of mixing downstream of the blade row, and the effect of trailing-edge thickness on overall loss coefficients.

NACA TN 3516

SUMMARY EVALUATION OF TOOTHED-NOZZLE ATTACHMENTS AS A JET-NOISE-SUPPRESSION DEVICE. Warren J. North. July 1955. 19p. diagrs., photo. (NACA TN 3516)

Toothed attachments to a full-scale turbojet nozzle

were investigated for possible jet-noise reduction and thrust penalty. The attachments caused slight reductions in total sound power that are insignificant when evaluated in terms of engine thrust losses and aircraft payload penalty. At the reduced thrust levels obtained with the toothed nozzles, corresponding sound power reductions could be realized by throttling the standard turbojet engine. Sound pressure levels were reduced behind the engine but were increased elsewhere. A typical resident in the airport neighborhood would hear increased loudness in the middle frequencies; however, the resulting overall auditory effect is considered to be negligible.

NACA TN 3518

ROTATING-STALL CHARACTERISTICS OF A ROTOR WITH HIGH HUB-TIP RADIUS RATIO. Eleanor L. Costilow and Merle C. Huppert. August 1955. 59p. diagrs., photos. (NACA TN 3518)

The rotating-stall characteristics of a 0.9 hub-tip ratio rotor are investigated. The test setup approximates the two-dimensional model upon which recent theories have been based. Measurements of pressure, temperature, and flow fluctuations during stalled operation are reported. Experimental stall-propagation rates are compared with those predicted by theory.

NACA TN 3520

FLAME PROPAGATION LIMITS OF PROPANE AND n-PENTANE IN OXIDES OF NITROGEN. Riley O. Miller. August 1955. 29p. diagrs., 3 tabs. (NACA TN 3520)

Flame propagation limits with propane and n-pentane in oxides of nitrogen were obtained at subatmospheric pressures in a 2-inch-diameter, 48-inch-length tube. Three oxidants were investigated; namely, nitric oxide NO, nitrogen tetroxide N_2O_4, and a nearly equimolar mixture of these two oxides. Flames propagate through all these mixtures with the composition limits occurring at equivalence ratios of roughly 1/3 and 3. The minimum propagation pressure of the fuel-NO mixtures in the 2-inch-diameter tube were appreciably greater than that of the fuel-N_2O_4 mixtures. In general, the data attest to the relative chemical stability of NO in the hydrocarbon flames.

NACA TN 3521

A COMPARISON OF THE MEASURED AND PREDICTED LATERAL OSCILLATORY CHARACTERISTICS OF A 35° SWEPT-WING FIGHTER AIRPLANE. Walter E. McNeill and George E. Cooper. August 1955. 22p. diagrs., photo., 3 tabs. (NACA TN 3521. Formerly RM A51C28)

Flight measurements of the lateral oscillatory characteristics were obtained at altitudes of 10,000 and 35,000 feet for an over-all Mach number range from 0.41 to 1.04. Period, time to damp to half amplitude, and ratio of angle-of-bank amplitude to angle-of-sideslip amplitude, $|\varphi| / |\beta|$, are presented as functions of Mach number for each test altitude, and are compared with values computed from wind-tunnel data and estimated stability derivatives.

NACA TN 3540

A REEVALUATION OF GUST-LOAD STATISTICS FOR APPLICATIONS IN SPECTRAL CALCULATIONS. Harry Press and May T. Meadows. August 1955. 19p. diagrs. (NACA TN 3540)

The available information on the spectrum of atmospheric turbulence is briefly reviewed. On the basis of these results, a method is developed for the conversion of available gust statistics normally given in terms of counts of gust peaks into a form appropriate for use in spectral calculation. The fundamental quantity for this purpose appears to be the probability distribution of the root-mean-square gust velocity. Estimates of the variation of this distribution with altitude and weather condition are also derived from available gust statistics.

DECLASSIFIED NACA REPORTS

NACA RM A51G13

AERODYNAMIC CHARACTERISTICS OF THE NACA RM-10 RESEARCH MISSILE IN THE AMES 1- BY 3-FOOT SUPERSONIC WIND TUNNEL NO. 2 - PRESSURE AND FORCE MEASUREMENTS AT MACH NUMBERS OF 1.52 AND 1.98. Edward W. Perkins, Forrest E. Gowen, and Leland H. Jorgensen. September 1951. 37p. diagrs. (NACA RM A51G13) (Declassified from Confidential, 7/20/55)

The pressure distribution along the body of zero angle of attack and around the body for various longitudinal stations and for angles of attack to 15° are presented. These data are compared with the method of characteristics and with linear and second-order theories. Aerodynamic coefficients for the body alone and the body-tail combination were obtained at Reynolds numbers, based on model length, of 8.6 and 17.4 millions. The body-alone aerodynamic coefficients are compared with the theory of NACA RM A9I26 and with potential theory.

NACA RM A55C07

FLIGHT TESTS OF LEADING-EDGE AREA SUCTION ON A FIGHTER-TYPE AIRPLANE WITH A 35° SWEPTBACK WING. Richard S. Bray and Robert C. Innis. June 1955. 30p. diagrs., photos., tab. (NACA RM A55C07) (Declassified from Confidential, 7/20/55)

Flight measurements made of the low-speed lift characteristics of an F-86 airplane equipped with a porous leading-edge installation confirmed the results obtained from wind-tunnel tests of a similar installation. Large gains in maximum lift coefficient were obtained. Stalling characteristics were tolerable to good. The porous leading edge had no marked effect on the operational performance of the airplane.

NACA RM E51F28

SOME EFFECTS OF BLADE TRAILING-EDGE THICKNESS ON PERFORMANCE OF A SINGLE-STAGE AXIAL-FLOW COMPRESSOR. J. J. Moses and G. K. Serovy. October 1951. 14p. diagrs., tab. (NACA RM E51F28) (Declassified from Confidential, 7/20/55)

A set of modified NACA 65-series blower blades designed for axial inlet velocity, high inlet Mach number, and high blade loading was investigated for trailing-edge thicknesses of 0.015, 0.030, and 0.045 inch to determine the effect of trailing-edge thickness on single-stage axial-flow-compressor performance. Trailing-edge thickness effects were small except at the highest tip speed investigated (915 ft/sec). Trailing-edge thicknesses up to 30 percent of maximum blade thickness were used without sacrifice of performance of NACA 65-series blades.

NACA RM E52K13

PRELIMINARY INVESTIGATION IN J33 TURBOJET ENGINE OF SEVERAL ROOT DESIGNS FOR CERAMAL TURBINE BLADES. George C. Deutsch, Andre J. Meyer, Jr., and William C. Morgan. January 1953. 24p. diagrs., photos., 2 tabs. (NACA RM E52K13) (Declassified from Confidential, 7/20/55)

The practicability of using ceramals with comparatively low strategic material content for the blades of aircraft turbines was determined in an experimental investigation. Four blade root configurations were examined. The most favorable results were obtained for ceramal turbine blades with single serration interlock and dovetail root configurations. Six of the interlock type were operated in a J33-A-33 engine for 68 hours, 23 minutes at rated service speed and six of the dovetail type were operated for 58 hours, 28 minutes at rated speed. This result confirms the conclusions of previous static design studies.

NACA RM E53B27

AN INVESTIGATION OF HIGH-FREQUENCY COMBUSTION OSCILLATIONS IN LIQUID-PROPELLANT ROCKET ENGINES. Adelbert O. Tischler, Rudolph V. Massa, and Raymond L. Mantler. June 1953. 37p. diagrs., photos. (NACA RM E53B27) (Declassified from Confidential, 7/20/55)

An experimental investigation of high-frequency combustion oscillations (screaming) was conducted with a 100-pound-thrust acid-hydrocarbon rocket engine and a 500-pound-thrust oxygen-fuel rocket engine. The oscillation frequencies could be correlated as a linear function of the parameter C^*/L, where C^* is the experimentally measured characteristic velocity and L is the combustion-chamber length. The tendency of the engines to scream increased as chamber length was increased. With engine configurations that normally had a low efficiency, screaming resulted in increased performance; at the same time, a five to tenfold increase in heat-transfer rate occurred. It was possible, however, to achieve good performance without screaming.

NACA RM E53G02

PRELIMINARY INVESTIGATION OF SEVERAL ROOT DESIGNS FOR CERMET TURBINE BLADES IN TURBOJET ENGINE. II - ROOT DESIGN ALTERATIONS. A. J. Meyer, Jr., G. C. Deutsch, and W. C. Morgan. October 1953. 34p. photos., diagrs., tab. (NACA RM E53G02) (Declassified from Confidential, 7/20/55)

Twelve engine evaluation tests of cermet turbine blades are reported herein. The first five runs were similar to the 10 engine tests reported previously. The cermet blades were then redesigned on the basis of information gained during the earlier runs. The profile of the root was changed; the airfoil was relocated on the platform and root; the root center line was rotated with respect to the turbine axis; and an attempt was made to improve the blade material. These alterations primarily accomplished a reduction in root bending stresses and resulted in greatly increased blade life. The modified blades were operated under increased power output from the engine and were subjected to cyclic conditions between take-off speed and idling speed.

NACA RM E53L15b

PRELIMINARY INVESTIGATION OF SEVERAL TARGET-TYPE THRUST-REVERSAL DEVICES. Fred W. Steffen, H. George Krull, and Carl C. Ciepluch. March 1954. 43p. diagrs., tab. (NACA RM E53L15b) (Declassified from Confidential, 7/20/55)

Thrust-reversal performance of several basic target-type jet deflectors of various size and with various modifications was obtained with unheated air over a range of exhaust-nozzle pressure ratios from 1.7 to 3.0. Reversed thrusts up to 58 percent were achieved. Maximum, or near maximum, reversal

for any deflector occurred at a spacing which was mechanically feasible and which did not affect nozzle air flow. Two easily retractable deflectors, a simple hemisphere and a double-skin hemisphere, the latter designed to control reversed jet direction, were investigated while installed on a model of a turbojet engine tail pipe and cowling assembly. Reversal produced by the installation with either deflector was found to be about 40 percent at a nozzle pressure ratio of 2.0. With the simple hemisphere, 50 percent of the available thrust was lost through insufficient turning and 11 percent was lost through air-flow reduction, shock, and friction.

NACA RM L7C25

AERODYNAMIC MEASUREMENTS MADE DURING NAVY INVESTIGATION OF HUMAN TOLERANCE TO WIND BLASTS. Donald L. Loving. March 11, 1947. 34p. diagrs., photos., 2 tabs. (NACA RM L7C25) (Declassified from Confidential, 6/10/55)

Tests were made to obtain direct evidence of the forces involved when the human head is suddenly thrust into a rapidly moving air stream, as is the case in bail-outs from aircraft at high speeds, and also to determine the maximum speed considered safe for the unprotected face to be exposed to wind blasts. Included are the aerodynamic results of the pressure measurements over a dummy forehead and the air-blast forces on the unprotected heads tested as obtained through the use of a strain gage attached to the head rest of the test apparatus.

NACA RM L8G21

MEASUREMENTS OF THE CHORDWISE PRESSURE DISTRIBUTIONS OVER THE WING OF THE XS-1 RESEARCH AIRPLANE IN FLIGHT. De E. Beeler, Milton D. McLaughlin, and Dorothy C. Clift. August 4, 1948. 35p. diagrs., photo., tab. (NACA RM L8G21) (Declassified from Confidential, 7/20/55)

Presents results of chordwise pressure-distribution measurements at a section near the midspan of the left wing of the XS-1 research airplane with an 8-percent-thick wing for a Mach number range of 0.75 to 1.25 at a normal-force coefficient of about 0.33 and for normal-force coefficients up to 0.93 at a Mach number of about 1.16.

NACA RM L51F27

WATER LANDING INVESTIGATION OF A HYDRO-SKI MODEL AT BEAM LOADINGS OF 18.9 AND 4.4. Sidney A. Batterson. September 1951. 54p. diagrs., photos., tab. (NACA RM L51F27) (Declassified from Confidential, 7/20/55)

Presents results obtained from an investigation conducted in the Langley impact basin of a model having a flat rectangular planing surface, a pulled-up bow, and a simulated landing wheel. Runs were made at beam loading of 18.9 and 4.4. The results include plots showing the variation of the non-dimensional loads and motions with both the wetted length and flight-path angle.

NACA RM L54H09

DRAG MEASUREMENTS ON A 1/6-SCALE, FINLESS, STING-MOUNTED NACA RM-10 MISSILE IN FLIGHT AT MACH NUMBERS FROM 1.1 TO 4.04 SHOWING SOME REYNOLDS NUMBER AND HEATING EFFECTS. Robert O. Piland. October 1954. 20p. diagrs., photos. (NACA RM L54H09) (Declassified from Confidential, 7/20/55)

A 1/6-scale, finless NACA RM-10 missile, sting-mounted on a parent body, has been flight tested to a peak Mach number of 4.04. Measurements of total drag, base drag, and wall temperature were obtained. Reynolds numbers of 17×10^6 to 47×10^6, based on body length, corresponding to Mach numbers 1.07 to 4.04 were encountered. Total- and base-drag coefficients are correlated with wind-tunnel results. The base-pressure coefficients are also compared with calculations using Love's methods for the estimation of base pressures. The friction drag is estimated from test measurements and a calculated pressure drag and is compared with theory.

NACA RM L54I03

AN INVESTIGATION OF THE CHARACTERISTICS OF THE NACA RM-10 (WITH AND WITHOUT FINS) IN THE LANGLEY 11-INCH HYPERSONIC TUNNEL AT A MACH NUMBER OF 6.9. William D. McCauley and William V. Feller. November 1954. 37p. diagrs., photos. (NACA RM L54I03) (Declassified from Confidential, 7/20/55)

Pressure distributions on the body and force balance results for the NACA RM-10 with and without fins are presented for angles of attack from 0 to about 20° at $M = 6.9$. The experimental results are compared with the following theories: method of characteristics, Van Dyke's second-order theory, conical-shock two-dimensional expansion theory, Newtonian impact theory, Grimminger, Williams, and Young's correlation prediction, and linear theory. Interference between fins and body is discussed. The effect of Mach number on the components of zero-lift drag and of the pitching moment, center of pressure, and lift-curve slope at zero lift are presented.

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Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1190

AXIAL-LOAD FATIGUE PROPERTIES OF 24S-T AND 75S-T ALUMINUM ALLOY AS DETERMINED IN SEVERAL LABORATORIES. H. J. Grover and W. S. Hyler, Battelle Memorial Institute, Paul Kuhn and Charles B. Landers, Langley Aeronautical Laboratory and F. M. Howell, Aluminum Company of America. 1954. ii, 25p. diagrs., photos., 7 tabs. (NACA Rept. 1190. Formerly TN 2928)

In the initial phase of an NACA program on fatigue research, axial-load tests on 24S-T3 and 75S-T6 aluminum-alloy sheet have been made at the Battelle Memorial Institute and at the Langley Aeronautical Laboratory of the NACA. The test specimens were polished and unnotched. The manufacturer of the material, the Aluminum Company of America, has made axial-load tests on 24S-T4 and 75S-T6 rod material. The test techniques used at the three laboratories are described in detail; the test results are compared with each other and with results obtained on unpolished sheet by the National Bureau of Standards.

NACA RM E55F09

PRELIMINARY PERFORMANCE DATA OF SEVERAL TAIL-PIPE-CASCADE-TYPE MODEL THRUST REVERSERS. James G. Henzel, Jr. and Jack G. McArdle. August 1955. 48p. diagrs., photos., tab. (NACA RM E55F09)

The performance of several tail-pipe-cascade-type-model thrust reversers was obtained with symmetrical and asymmetrical cascade blade shapes. One reverser with a symmetrical cascade-blade shape had a maximum reversed thrust ratio of 76 percent of full forward thrust. This reverser also had good thrust modulation characteristics. Another reverser but with an asymmetrical cascade blade shape had a maximum reversed thrust ratio of 90 percent of full forward thrust.

NACA TN 3467

EFFECT OF INTERACTION ON LANDING-GEAR BEHAVIOR AND DYNAMIC LOADS IN A FLEXIBLE AIRPLANE STRUCTURE. Francis E. Cook and Benjamin Milwitzky. August 1955. 75p. diagrs., 2 tabs. (NACA TN 3467)

The effects of interaction between a landing gear and a flexible airplane structure on the behavior of the landing gear and the loads in the structure have been studied by treating the equations of motion of the airplane and the landing gear as a coupled system, where the landing gear is considered to have nonlinear characteristics. Numerical examples, based on the characteristics of two large airplanes, show the effects of interaction on the loads in the landing gear and in the structure. The effects of neglecting interaction and using the landing-gear forcing function for a rigid body in a dynamic analysis of a flexible airframe are also discussed.

NACA TN 3474

RAPID RADIANT-HEATING TESTS OF MULTIWEB BEAMS. Joseph N. Kotanchik, Aldie E. Johnson, Jr., and Robert D. Ross. September 1955. 30p. diagrs., photos., tab. (NACA TN 3474)

Results are described of rapid-heating tests on four unloaded multiweb box beams. Temperature distributions and strains measured during a heating cycle are given. An analysis of the thermal stress required to cause buckling is in agreement with the experimentally observed results. A transient heating apparatus used in the tests and capable of producing heating rates up to 100 Btu/ft^2-sec is described.

NACA TN 3478

ON BOATTAIL BODIES OF REVOLUTION HAVING MINIMUM WAVE DRAG. Keith C. Harder and Conrad Rennemann, Jr. August 1955. 28p. diagrs., tab. (NACA TN 3478)

The problem of determining the shape of slender boattail bodies of revolution for minimum wave drag has been reexamined. It was found that minimum solutions for Ward's slender-body drag equation can exist only for the restricted class of bodies for which the rate of change of cross-sectional area at the base is zero. In order to eliminate this restriction, certain higher order terms must be retained in the drag equation and isoperimetric relations. The minimum problem for the isoperimetric conditions of given length, volume, and base area is treated as an example. According to Ward's drag equation, the resulting body shapes have slightly less drag than those determined by previous investigators.

NACA TN 3480

FREE-SPINNING-TUNNEL INVESTIGATION OF GYROSCOPIC EFFECTS OF JET-ENGINE ROTATING PARTS (OR OF ROTATING PROPELLERS) ON SPIN AND SPIN RECOVERY. James S. Bowman, Jr. August 1955. 21p. diagrs., photo., 2 tabs., 6 charts. (NACA TN 3480)

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A rotating flywheel powered by a model airplane engine mounted on a model in the Langley 20-foot free-spinning tunnel was used to simulate the gyroscopic effects of jet-engine rotating parts (or of rotating propellers) on the erect spin and spin-recovery characteristics of a military attack airplane. The effects of flywheel rotation on the angle of attack, the rate of rotation in spins, and the number of turns required for recovery are presented for various control settings and for a range of loadings.

NACA TN 3483

AN ANALYSIS OF ACCELERATION, AIRSPEED, AND GUST-VELOCITY DATA FROM A FOUR-ENGINE TRANSPORT AIRPLANE IN OPERATIONS ON AN EASTERN UNITED STATES ROUTE. Thomas L. Coleman and Mary W. Fetner. September 1955. 20p. diagrs., 3 tabs. (NACA TN 3483)

Time-history data obtained by the NACA VGH recorder from one model of a four-engine civil transport airplane during operations on an eastern United States route are analysed to determine the magnitude and frequency of occurrence of gusts, gust accelerations, and the associated airspeeds. Comparison of the results with previously reported results indicates the gust-load history to be more severe than for two other similar operations involving other types of four-engine transports. The present airplane was operated in rough air at a higher percentage of its design speed than were the other airplanes and this condition was primarily responsible for the more severe load history for the operation.

NACA TN 3489

CONTRIBUTIONS ON THE MECHANICS OF BOUNDARY-LAYER TRANSITION. G. B. Schubauer and P. S. Klebanoff, National Bureau of Standards. September 1955. 31p. diagrs. (NACA TN 3489)

The manner in which flow in a boundary layer becomes turbulent was investigated on a flat plate at wind speeds generally below 100 feet per second. Hot-wire techniques were used, and many of the results are derived from oscillograms of velocity fluctuations in the transition region. The more familiar aspects of transition are discussed, and the facts discovered while studying the characteristics of artificially produced turbulent spots are presented.

NACA TN 3505

AN EXPERIMENTAL INVESTIGATION OF REGIONS OF SEPARATED LAMINAR FLOW. Donald E. Gault. September 1955. 65p. diagrs., photos., 4 tabs. (NACA TN 3505)

Results are given for an experimental investigation of regions of separated flow initiated by separation of the laminar boundary layer (laminar separation "bubbles"). Total- and static-pressure surveys, hot-wire anemometer observations, and detailed pressure-distribution measurements were made in regions of separated flow on two airfoils. The measurements were obtained for a wide range of angles of attack and for Reynolds numbers from 1.5 to 10 million. Some results on the effects of an increase in turbulence level of the free stream are also included.

NACA TN 3506

CRITERIONS FOR PREDICTION AND CONTROL OF RAM-JET FLOW PULSATIONS. William H. Sterbentz and John C. Evvard. August 1955. 60p. diagrs., photos. (NACA TN 3506. Formerly RM E51C27)

Results of a theoretical and experimental study of ram-jet diffuser flow pulsing, commonly referred to as a "buzz condition," with and without combustion are presented. The theoretical approach to the problem is a simplified treatment of the ram jet likened to act as a Helmholtz resonator. The theoretical resonance criterions reasonably predicted the occurrence of diffuser-flow pulsations.

NACA TN 3510

AN AUTOMATIC VISCOMETER FOR NON-NEWTONIAN MATERIALS. Ruth N. Weltmann and Perry W. Kuhns. August 1955. 34p. diagrs., photos., tab. (NACA TN 3510)

A concentric-cylinder rotational viscometer is described that can measure viscosities from 0.05 to 20,000 poises, program and record meaningful flow curves of rate of shear against shearing stress for most non-Newtonian materials, record time-torque curves, and produce dynamic flow measurements. A program feature provides for selecting (1) the maximum rate of shear up to 4000 sec^{-1}, (2) the time required to increase rotational speed from zero to the preset maximum, and (3) two sequences of rate of shear, which is varied automatically at a constant acceleration. Test data and curves are presented.

NACA TN 3565

CHEMICAL ACTION OF HALOGENATED AGENTS IN FIRE EXTINGUISHING. Frank E. Belles. September 1955. 28p. diagrs., 3 tabs. (NACA TN 3565)

The action of halogenated fire-fighting agents is discussed in terms of chain-breaking reactions between agent and active particles (atoms and free radicals). Literature data on flammability peaks of n-heptane-agent-air mixtures are roughly correlated by reactivities assigned to halogen and hydrogen atoms in agent molecules. The value of hydrogen in agents is discussed. A method for the estimation of rate constants for the reaction of agent with active particles is described, and the rate constant for methyl bromide is obtained. The result predicts the observed peak concentration of methyl bromide quite well. The assumed mechanism is consistent with the observed facts.

BRITISH REPORTS

N-38122*

Royal Aircraft Establishment (Gt. Brit.)
THE REPRESENTATION OF ENGINE AIRFLOW IN WIND TUNNEL MODEL TESTING. J. Seddon and L. F. Nicholson. May 1955. 38p. diagrs., photos. (RAE Tech. Note Aero 2371)

The problems of engine air-flow representation in wind-tunnel models are reviewed. Methods which have been used satisfactorily in low subsonic tunnels are described briefly. Special difficulties associated with testing at transonic speeds are noted. Techniques of special application to small supersonic tunnels are described in some detail. It is shown that there are reasons why the representation of jets may be more important at supersonic speeds than at subsonic speeds and a description is given of the RAE jet interference tunnel, which is designed for the study of some of the problems involved.

N-38123*

Royal Aircraft Establishment (Gt. Brit.)
BOUNDARY LAYERS ON SWEPT WINGS: THEIR EFFECTS AND THEIR MEASUREMENT. D. Kuchemann. April 1955. 37p. diagrs. (RAE Tech. Note Aero 2370)

This is a brief review of some work which has been done mainly at the RAE in the field of three-dimensional boundary layers, in particular on swept wings. Theoretical results are briefly mentioned, and some examples of measured boundary layers are given to illustrate the various effects that can now be distinguished as being characteristic of swept wings. The lift reduction and the drag increment which result from the boundary layer in comparison with the values in inviscid flow are discussed; and some types of flow which may occur as a consequence of boundary-layer separation are described. In view of the importance of obtaining further experimental evidence, reference is made to the instrumentation needed for that purpose.

N-38124*

Royal Aircraft Establishment (Gt. Brit.)
THE USE OF PITOT TUBES IN THE MEASUREMENT OF LAMINAR BOUNDARY LAYERS IN SUPERSONIC FLOW. R. J. Monaghan. May 1955. 37p. diagrs., photos., 2 tabs. (RAE Tech.Note Aero 2369)

This note summarizes the results of some research on the laminar problem at the Royal Aircraft Establishment. It describes the various effects (real or apparent) of pitot size found in a series of measurements of laminar boundary layers in supersonic flow. These lead to errors in the values of displacement and momentum thickness calculated from the pitot measurements, but it seems that it may be possible to obtain the correct experimental values by applying a simple correction factor dependent only on the ratio of pitot diameter to boundary-layer thickness.

N-38466*

Royal Aircraft Establishment (Gt. Brit.)
PRESSURE-CABIN DESIGN: A DISCUSSION OF SOME OF THE STRUCTURAL PROBLEMS INVOLVED, WITH SUGGESTIONS FOR THEIR SOLUTION. D. Williams. March 1955. 51p. diagrs., tab. (RAE Tech. Note Structures 155)

The structural factors governing the design of a pressure cabin are discussed with a view to indicating possible practical approaches.

N-38467*

Marine Aircraft Experimental Establishment (Gt. Brit.) FULL SCALE MEASUREMENT OF IMPACT LOADS ON A LARGE FLYING BOAT (SUNDERLAND MK. 5). PART III - DATA FOR IMPACTS ON MAIN STEP. R. Parker. August 1954. 37p. diagrs., 2 tabs. (MAEE F/Res/259)

The results of a series of full-scale impact tests on the hull of a Sunderland Mk. 5 flying boat at an all up weight of 50,000 lb were compared with an appropriate theory and discussed generally in a previous report. As discrepancies between this data and the theory were shown and explanation of this has not been forthcoming, this report presents complete time histories of a number of the actual measurements to permit comparison with other theories when such become available and application by empirical methods where appropriate.

N-38468*

Marine Aircraft Experimental Establishment (Gt. Brit.) INVESTIGATION OF HIGH LENGTH/BEAM RATIO SEAPLANE HULLS WITH HIGH BEAM LOADINGS - HYDRODYNAMIC STABILITY. PART 18 - THE STABILITY AND SPRAY CHARACTERISTICS OF MODEL N. D. M. Ridland, J. K. Friswell, and A. G. Kurn. April 1955. 25p. diagrs., photos., 3 tabs. (MAEE F/Res/254)

In this report results are presented of limited tests on the hydrodynamic characteristics of Model N of the series, these tests being designed solely to provide information on the interactions of the different parameters relevant to the series. The model has a length-to-beam ratio of 13 (the forebody being 6 beams in length and the afterbody 7 beams), 4° forebody warp, an afterbody to forebody keel angle of 8°, and a straight transverse step with a step depth of 0.15 beams. The tests comprised the determination of longitudinal stability limits without slipstream at $C_{\Delta_0} = 2.75$ and an investigation of spray at this loading. A short discussion of the results is also included.

N-38469*

Marine Aircraft Experimental Establishment (Gt. Brit.) INVESTIGATION OF HIGH LENGTH/BEAM RATIO SEAPLANE HULLS WITH HIGH BEAM LOADINGS - HYDRODYNAMIC STABILITY. PART 13 - THE EFFECT OF AFTERBODY ANGLE ON STABILITY AND SPRAY CHARACTERISTICS. D. M. Ridland. February 1955. 31p. diagrs., photos., 3 tabs. (MAEE F/Res/248)

The effects of afterbody angle on longitudinal stability, spray and directional stability characteristics, and elevator effectiveness are deduced from the results of tests on three models of the series which were alike in every major respect except that of afterbody angle. The models had afterbody angles of 4°, 6°, and 8°, respectively. It was found that increasing afterbody angle improved longitudinal stability characteristics considerably, both with and without disturbance, increased trim generally, gave a slight improvement in spray and directional stability characteristics, and increased elevator effectiveness. The best hydrodynamic configuration was that with the 8° afterbody angle.

N-38470*

Royal Aircraft Establishment (Gt. Brit.)
THE USE OF NEGATIVE FEEDBACK FOR DERIVING SHARP LIMITS IN ELECTRONIC ANALOGUE COMPUTERS. M. Squires and P. R. Benyon. April 1955. 27p. diagrs. (RAE Tech. Note GW 361)

This note draws attention to improvements in electronic limiting action which results when standard limiting devices are enclosed with d-c amplifiers in negative feedback loops. Experiments in which a "high-gain" amplifier was used yielded limiters which were ideal to within practical limits of observation. Three types of limiter are recommended. In one the limiting characteristic of an output cathode follower forming part of the amplifier is used. In the remaining two, the high reverse resistance of diodes is used to give a single-sided and a two-sided limit, respectively.

N-38471*

Royal Aircraft Establishment (Gt. Brit.)
HEAT TREATMENT AND TENSILE PROPERTIES OF A TITANIUM - 13-PERCENT MOLYBDENUM ALLOY. G. I. Lewis, J. I. M. Forsyth, and H. Brooks. March 1955. 10p. diagrs., photos. (RAE Tech. Note Met. 215)

Titanium - 13-percent molybdenum alloy strip 0.06 in. thick prepared from magnesium reduced titanium sponge and molybdenum strip by arc melting and hot and cold rolling had a strength of 48.6 tons/in.^{2} with 33-percent uniform and 37-percent total elongation after quenching from 825° C to retain the β phase. Strengths obtained by subsequent overaging in the $\alpha + \beta$ field at 500°-550° C ranged from 79.3 tons/in.^{2} with 6-percent elongation and $E = 15.5 \times 10^{6}$ lb/in.^{2} to 87.4 tons/in.^{2} with 4-percent elongation and $E = 15.9 \times 10^{6}$ lb/in.^{2}. Deformation in the quenched condition caused partial martensitic breakdown of the metastable β structure and for the one set of conditions investigated (test pieces quenched from 825° C, strained 10 percent in tension, and aged 24 hours at 550° C) reduced the strength and modulus obtained on aging. The density of the alloy was 4.92 gm/cc or 0.18 lb/cu in.

N-38472*

Royal Aircraft Establishment (Gt. Brit.)
SOME EXPERIMENTS ON THE EXTRUSION OF MAGNESIUM AND ALUMINIUM POWDERS. H. G. Cole. February 1955. 23p. diagrs., photos., 5 tabs. (RAE Met. 85)

Smooth extrusions of good mechanical properties can be made from magnesium powders at low extrusion speeds provided the billet temperature exceeds 470° C. Conditions for the extrusion of some aluminum powders coarser than S. A. P. have been determined. The relation between pressure and density during the cold compacting of some magnesium and aluminum powders is recorded. Remnants of natural oxide films in extrusions often, but not always, stop the propagation of slip during straining. Some electron micrographs of aluminum oxide remnants are shown.

N-38473*

Royal Aircraft Establishment (Gt. Brit.)
TRIALS OF BANNER TARGETS LAUNCHED ON A FIXED TOW LENGTH. D. R. Bettison and A. Eldridge. March 1955. 20p. diagrs., photos., 3 tabs. (RAE Tech. Note Mech. Eng. 199)

As a result of flight trials it has been established that a modified R.F.D. banner target can be launched on a fixed tow length of 900 ft, at a speed of 130 knots and at altitudes up to 20,000 ft. To avoid tangling and searing of the tow rope and safety webbing link it is essential that, during the launch, they are deployed from a tray fitted to the target container, or in the aircraft bomb-bay.

N-38474*

Nat. Gas Turbine Establishment (Gt. Brit.)
THE PERFORMANCE OF A MULTI-STAGE COMBUSTION SYSTEM. PART I - FLAME STABILITY OF RECIRCULATION ZONES. S. W. White and W. G. E. Lewis. May 1955. 16p. diagrs. (NGTE R.165)

As part of a general investigation into optimum rates of addition of combustible mixtures into a gaseous zone at high temperature, this report describes an experimental study into the factors influencing flame stability of cylindrical baffles admitting mixtures through a single row of holes in the periphery, the axis of the cylinder being parallel to the approaching airstream. The results show that for geometrically similar baffles the stability range can be correlated with $\frac{Q}{D^{2.4}p^{1.5}}$ where Q is the air flow rate, D is the baffle diameter and P is the combustion pressure.

N-38499*

Royal Aircraft Establishment (Gt. Brit.)
THE FLOW THROUGH SHORT STRAIGHT PIPES IN A COMPRESSIBLE VISCOUS STREAM. J. Seddon. April 1955. 34p. diagrs., photos. (RAE Aero 2542)

In the design of small models of aircraft or missiles for testing in supersonic tunnels, it may be desired to represent jet engine nacelles by means of simple hollow pipes. The note sets out the principal characteristics of compressible flow in such pipes at zero yaw and gives a theory for calculating the effect of the boundary layer. This is checked against the results of tests with a series of pipes of varying

size, at Mach numbers from 1.34 to 2.41. Curves are presented for determining the maximum length/radius ratio of a parallel pipe which will permit supersonic internal flow, in terms of the Mach number of the stream and Reynolds number of the pipe: the curves are given for both laminar and turbulent internal boundary layers. The effect of inclination of the pipe to the stream is discussed briefly, on the basis of results at one Mach number (1.86).

N-38501*

Royal Aircraft Establishment (Gt. Brit.)
PRELIMINARY LOW SPEED WIND TUNNEL TESTS ON FLAT PLATES AND AIR BRAKES: FLOW, VIBRATION AND BALANCE MEASUREMENTS. R. Fail, T. B. Owen, and R. C. W. Eyre. January 1955. 45p. diagrs., 5 tabs. (RAE Tech. Note Aero 2356)

Flow measurements have been made behind sharp-edged flat plates: (a) at 90° for various shapes, and (b) for a square plate over an incidence range. The results of (a) show a closed bubble about 3 plate sides long, with a constant pressure boundary up to the maximum diameter, followed by mixing. Measurements of velocity fluctuations were made for (b), showing that a regular shedding of turbulent eddies occurs for $\theta = 50^{\circ}$ and over, but stops by 40°. Large random low frequency longitudinal fluctuations are associated with the shedding. Lift, drag, and pitching moment increments were measured on a square plate mounted on (a) a long cylinder, and (b) near the end of several shapes of rear fuselage, to see how the moments on opening the brake could be modified. Velocity fluctuation measurements, at 70° only, show a much reduced longitudinal unsteadiness when the plate is in proximity to the fuselage. Comparative tests were made on a cascade brake and show that no shedding occurs.

N-38510*

Royal Aircraft Establishment (Gt. Brit.)
THE INFLUENCE OF METHYL BROMIDE ON FLAMES. I - PREMIXED FLAMES. II - DIFFUSION FLAMES. R. F. Simmons and H. G. Wolfhard. March 1955. 27p. diagrs., photos., 3 tabs. (RAE RPD 25)

The influence of methyl bromide and bromine on flames has been investigated. Both premixed and diffusion flames are chemically inhibited, in contrast to the purely diluting effect of inert gas. The most significant change in premixed flames on adding methyl bromide or bromine is that the limit temperature is raised. Limits of inflammability of mixtures cannot be calculated by Le Chatelier's rule. The action of methyl bromide in flames can be interpreted in terms of the addition of equivalent amounts of fuel and bromine. The structure of diffusion flames is completely changed when methyl bromide is introduced into the air, an additional reaction zone being formed on the air side in which the methyl bromide reacts with the air. Thus fuel and oxidant no longer meet in simple stoichiometric proportions in the main reaction zone. Methyl bromide has been found to be much more efficient as an extinguishant when introduced into the air than when added to the fuel.

N-38511*

Royal Aircraft Establishment (Gt. Brit.)
AN ELECTRONIC SINE WAVE GENERATOR FOR FREQUENCIES DOWN TO 1/100 C.P.S. O. H. Lange, J. P. Lonergan, and J. J. Gait. March 1955. 14p. diagrs. (RAE TECH. Note GW 360)

This paper describes an electronic generator of low output impedance for the production of sine waves of controlled amplitude in the frequency band from 1/100 cps to 10 cps.

N-38517*

Royal Aircraft Establishment (Gt. Brit.)
A FIXTURE FOR TESTING SHEET MATERIALS IN COMPRESSION AT ELEVATED TEMPERATURES. D. C. Hayward. March 1955. 19p. diagrs., photos., 3 tabs. (RAE Tech. Note Met. 193)

A fixture for compressive testing of sheet material at elevated temperatures up to 400° C has been developed. The thinnest sheet tested was 20 S.W.G. (0.036 in.) Lateral support, to prevent buckling of the test specimens under high stress, was obtained from a series of steel balls spaced evenly on both sides of the specimen. An averaging extensometer, attached to opposite edges of the specimen, recorded changes in gage length and enabled readings of strain to include the 0.5 percent proof stress to be made. Compressive test readings compared favorably both for sensitivity and reproducibility with corresponding readings taken by established tensile test methods, the facility and simplicity of the compression test procedure equaling that of the tensile test.

N-38520*

Royal Aircraft Establishment (Gt. Brit.)
STATIONARY FLAMES WITH METHYL NITRATE AND METHYL NITRITE. P. Gray, A. R. Hall, and H. G. Wolfhard. March 1955. 24p. diagrs., photos. (RAE RPD 26)

A kinetic and spectroscopic study was made at low pressures of a stationary, self-decomposition methyl nitrate flame, premixed with oxygen, nitric oxide, and nitrogen dioxide. Another flame, methyl nitrite and oxygen, was studied and was found to be similar in appearance and spectra at similar conditions. The basic features of these flames have been interpreted in terms of the occurrence of pyrolysis reactions before the main flame zone is reached and the stability of nitric oxide at lower temperatures and pressures.

N-38521*

Royal Aircraft Establishment (Gt. Brit.)
CORROSION FATIGUE TESTS AT SLOW RATES OF LOADING ON ALUMINIUM ALLOY SHEET TO SPEC. D.T.D. 546. J. T. Ballett and M. S. Binning. 9p. diagrs., photo., 2 tabs. (RAE Tech. Memo. Met. 145 (Second Issue))

Comparative fatigue tests were made on simple specimens of a De Havilland Comet fuselage skin material in air and in water. A testing machine was made which applied a loading the same as that

used to pressurize the fuselage in a full-scale test. The results showed that in repeated load fatigue tests for endurances of up to about 5000 cycles at a frequency of 1 cycle in 5 minutes, the endurances are not appreciably affected by immersing the specimens in water during testing.

N-38532*

Royal Aircraft Establishment (Gt. Brit.)
SOME CREEP PROPERTIES OF NIMONIC 95 AT 850° C AND NIMONIC 80A (SPECIAL PROCESS) AT 750° C AND 815° C. L. W. Larke and R. A. Whittaker. March 1955. 23p. diagrs., 7 tabs. (RAE Tech. Note Met. 217)

The overall purpose of the program is to determine the stresses necessary to produce total plastic strains of 0.1 percent to 1.0 percent and fracture where possible in times up to 2,000 hours at temperatures of 850°, 875°, and 900° C on Nimonic 95 and at 750°, 815°, and 875° C on Nimonic 80A "special process" material. On Nimonic 95 at 850° C, 5t/in.^{2} produces 0.1 percent strain in 1,000 hours. The data on Nimonic 80A "special process" for 0.1 percent strain in 1,000 hours are 4.9t/in.^{2} at 750° C and 1.7t/in.^{2} at 815° C. Comparison is made of test results for the two materials.

N-38533*

Royal Aircraft Establishment (Gt. Brit.)
FURTHER WORK ON THE EFFECT OF HARD-ANODISING ON THE FATIGUE STRENGTH OF D.T.D. 364B ALUMINIUM ALLOY. E. G. Savage and E. G. F. Sampson. March 1955. 11p. diagrs., 5 tabs. (RAE Tech. Note Met. 216)

As suggested in a previous note, a modified form of treatment was used to produce hard anodic coatings on Wöhler-type fatigue test-pieces made from D.T.D. 364B aluminum alloy, with the object of reducing the ill effects due to treatment at a constant current density. This modified treatment failed to reduce the fatigue loss significantly. However, it was found that sealing the coatings in a boiling dichromate solution substantially improved the fatigue strength of parts which had been hard anodised by either the "standard" or the modified process, the losses of fatigue strength at 10 million cycles being reduced from 47 to 8 percent and 36 to 4 percent, respectively. The sealing treatment reduced the abrasion-resistance of the coatings by 20 percent. No further work is proposed.

N-38559*

Royal Aircraft Establishment (Gt. Brit.)
DIODE TEST EQUIPMENT TYPE NO. 2281 AS MODIFIED FOR THE TESTING OF VALVES, TYPE VX.9156. J. C. Le Grice. April 1955. 16p. diagrs., photos. (RAE Tech. Note EL.90)

Operating instruction, circuit descriptions and calibration procedure are given for this equipment which performs striking voltage measurements on VX.9156 cold cathode diodes as required by their acceptance specification.

N-38561*

Royal Aircraft Establishment (Gt. Brit.)
A COMPARISON OF SOME DEVICES FOR REDUCING THE GROUND RUN DURING LANDING. D. Lean. May 1955. 29p. diagrs. (RAE Tech. Note Aero 2379)

With the thrust/weight ratios common today on jet aircraft, the size of brake parachute needed to equal the effect of the available reversed thrust is large but not excessive. For the future, increased touchdown speeds tend to favor the brake parachute, simply by increasing the mean drag. This gain is probably only partly cancelled by higher available reversed thrust. On the score of weight, cost, and complications, the parachute has the advantage, but from the handling point of view, pilots are likely to prefer the more controllable reversed thrust system. Too little is yet known of actual installations of thrust reversal schemes on typical aircraft for a comparison to be made on the grounds of reliability, or effect on the aircraft and its occupants.

N-38562*

Royal Aircraft Establishment (Gt. Brit.)
FLIGHT EXPERIMENTS ON BOUNDARY LAYER CONTROL FOR LOW DRAG. M. R. Head, D. Johnson, and M. Coxon. March 1955. 48p. diagrs., photos., 2 tabs. (RAE Aero 2541)

Tests have been made with distributed suction applied to a short span sleeve fitted to the upper surface of the wing of a single seat Vampire aircraft. Full chord laminar flow was maintained up to Reynolds numbers in the region of 29 million and Mach numbers up to 0.70, which was very nearly the critical Mach number of the sleeve section. The suction quantities required were sufficiently small to result in overall reductions in profile drag of between 70 and 80 percent, account being taken of the power required for suction. Difficulties were experienced due to surface roughness, and although these are believed to have resulted largely from the particular type of porous covering used in the tests, the problem of maintaining a sufficiently smooth and clean surface is evidently of crucial importance to full-scale application.

N-38563*

Royal Aircraft Establishment (Gt. Brit.)
STRESS CONSIDERATIONS IN THE DESIGN OF PRESSURISED SHELLS. E. H. Mansfield. April 1955. 27p. (RAE Structures 178)

This report considers the design and stress analysis of pressurized thin-walled shells with special reference to openings in the shell wall.

N-38565*

Royal Aircraft Establishment (Gt. Brit.)
OPTICAL CHARACTERISTICS OF LAMINATED CAMERA WINDOWS. A. C. Marchant and B. M. Mathieson. March 1955. 24p. diagrs., photos., 2 tabs. (RAE Tech.Note Ph.489)

This note describes optical tests on laminated camera windows of both plane and spherical form. Photographic tests of their effect upon the resolving

power of an associated camera system have been carried out. The wedge angle of the windows has been measured, and the surface flatness and internal homogeneity of the plane windows tested; while the effects of the curved windows, upon the correction of the camera lens associated with them, has been assessed visually. It is concluded that the laminating process does not, in itself, introduce deleterious effects on optical performance. Plane windows, unless optically worked to a high degree of flatness, may introduce a focal shift which will, in practice, reduce resolving power. Curved windows, even when worked to have zero power, are shown to reduce overall resolution through the introduction of astigmatism and field curvature.

N-38609*

Royal Aircraft Establishment (Gt. Brit.) IMPURITIES IN TITANIUM: SULPHUR. D. A. Sutcliffe. March 1955. 13p. diagrs., photos., 7 tabs. (RAE Tech. Note Met. 218)

Binary titanium sulphur alloys containing up to 1.05 percent sulphur have been prepared by arc melting. Tensile, hardness, and impact tests have been made on the alloys at room temperature. The results show that the addition of approximately 0.1 percent sulphur causes a marked rise in tensile strength and hardness with a corresponding fall in elongation and impact strength. Further additions up to 1.05 percent sulphur cause only a small increase in tensile strength and hardness, but the elongation and impact strength continue to decrease steadily, though less rapidly than at first.

MISCELLANEOUS

N-37766*

THE ICING PROBLEM: CURRENT STATUS OF NACA TECHNIQUES AND RESEARCH. Uwe H. von Glahn. (Preprint of paper presented at Ottawa AGARD Conference, June 10-17, 1955). 44p. diagrs., photos.

Icing tunnel facilities, operational techniques, and icing instruments are described in appendices to this paper.

DECLASSIFIED NACA REPORTS

We have

NACA RM A50L04

PRELIMINARY FLIGHT INVESTIGATION OF THE MANEUVERING ACCELERATIONS AND BUFFET BOUNDARY OF A 35° SWEPT-WING AIRPLANE AT HIGH ALTITUDE AND TRANSONIC SPEEDS. George A. Rathert, Jr., Howard L. Ziff, and George E. Cooper. February 21, 1951. 12p. diagrs., photo., tab. (NACA RM A50L04) (Declassified from Confidential, 7/20/55)

Results are presented from a series of exploratory flights on a swept-wing fighter airplane up to 1.09 Mach number to show the effects of compressibility presently limiting the maneuverability. The buffet boundary is also presented.

NACA RM A51B21

TESTS IN THE AMES 40- BY 80-FOOT WIND TUNNEL OF AN AIRPLANE CONFIGURATION WITH AN ASPECT RATIO 2 TRIANGULAR WING AND AN ALL-MOVABLE HORIZONTAL TAIL-LONGITUDINAL CHARACTERISTICS. David Graham and David G. Koenig. April 23, 1951. 35p. diagrs., photo., 3 tabs. (NACA RM A51B21) (Declassified from Confidential, 8/17/55)

Force tests were made with an all-movable horizontal tail in three vertical positions above the extended wing-chord plane (0, 0.25, and 0.50 wing semispan) at one longitudinal distance aft of the wing. Downwash variations at the position of the horizontal tail as obtained from force tests and from a downwash survey are compared. The results indicated that, from a standpoint of longitudinal stability at low speed, the best of the positions of the horizontal tail tested would be that in the extended wing-chord plane. The Reynolds number of the tests was 14.6×10^6 and the Mach number was 0.13.

NACA RM A51H10a

TESTS IN THE AMES 40- BY 80-FOOT WIND TUNNEL OF AN AIRPLANE CONFIGURATION WITH AN ASPECT RATIO 4 TRIANGULAR WING AND AN ALL-MOVABLE HORIZONTAL TAIL - LONGITUDINAL CHARACTERISTICS. David Graham and David G. Koenig. October 1951. 27p. diagrs., photo., 4 tabs. (NACA RM A51H10a) (Declassified from Confidential, 8/17/55)

Force tests were made of the wing alone, wing fuselage, wing-fuselage vertical-tail, and complete configuration with each of two horizontal tails. The tails were located at each of three vertical positions above the extended wing-chord plane (0, 0.18, and 0.36 wing semispan) at one longitudinal distance aft of the wing. Downwash variations as obtained from force tests are presented. The Reynolds number of the tests was 10.9×10^6 and the Mach number was 0.13. The results indicated that, from a standpoint of longitudinal stability at low speed, the best of the positions of the horizontal tail tested would be that in the extended wing-chord plane.

NACA RM A53E01

COMPARISON OF THE EXPERIMENTAL AND THEORETICAL DISTRIBUTIONS OF LIFT ON A SLENDER INCLINED BODY OF REVOLUTION AT M = 2. Edward W. Perkins and Donald M. Kuehn. August 1953. 39p. diagrs., photos., 2 tabs. (NACA RM A53E01) (Declassified from Confidential, 8/17/55)

An investigation of the pressure distribution for a body of revolution, consisting of a 33-1/3-caliber (5.75 fineness ratio) tangent ogival nose and a cylindrical afterbody, has been made for an angle-of-attack range of 0° to 35.5° at a Mach number of 1.98 and a Reynolds number of approximately 0.5×10^6, based on body diameter. Comparisons of the theoretical and experimental pressure distributions are made to show the nature of the effects of both viscosity and cross-flow compressibility. The experimental load distributions are compared with those predicted by the method suggested in NACA RM A9I26 which includes an approximate method for taking into account the effects of viscosity on the lift distribution.

NACA RM E50H07

PERFORMANCE OF 4600-POUND-THRUST CENTRIFUGAL-FLOW-TYPE TURBOJET ENGINE WITH WATER-ALCOHOL INJECTION AT INLET. Philip W. Glasser. October 9, 1950. 24p. diagrs. (NACA RM E50H07) (Declassified from Confidential, 8/17/55)

An experimental investigation of the effects of injecting a water-alcohol mixture of 2:1 at the compressor inlet of a centrifugal-flow-type turbojet engine was conducted in an altitude test chamber at static sea-level conditions and at an altitude of 20,000 feet with a flight Mach number of 0.78 with an engine operating at rated speed. The net thrust was augmented by 0.16 for both flight conditions with a ratio of injected liquid to air flow of 0.05. Further increases in the liquid-air ratio did not give comparable increases in thrust.

NACA RM E50H30

ALTITUDE INVESTIGATION OF PERFORMANCE OF TURBINE-PROPELLER ENGINE AND ITS COMPONENTS. Lewis E. Wallner and Martin J. Saari. October 5, 1950. 65p. diagrs., photos. (NACA RM E50H30) (Declassified from Confidential, 8/17/55)

An investigation was conducted on a turbine propeller engine in the NACA Lewis altitude wind tunnel at altitudes from 5,000 to 35,000 feet. The applicability of generalized parameters to turbine-propeller engine data, analyses of the compressor, the combustion chambers, and the turbine, and a study of the overall engine performance are reported. Engine performance data obtained at sea-level static conditions could be used to predict static performance at altitudes up to 35,000 feet by use of the standard generalized parameters.

NACA RM E52H07

PROCEDURE FOR CALCULATING TURBINE BLADE TEMPERATURES AND COMPARISON OF CALCULATED WITH OBSERVED VALUES FOR TWO STATIONARY AIR-COOLED BLADES. W. Byron Brown, Henry O. Slone, and Hadley T. Richards. September 1952. 38p. diagrs. (NACA RM E52H07) (Declassified from Confidential, 8/17/55)

Local and average blade temperatures were calculated for two stationary air-cooled turbine blades with 10 tubes and 13 fins forming the internal heat-transfer surfaces. These temperatures were calculated using previously published NACA temperature-distribution equations and the most recent theories for determining heat-transfer coefficients, including for the first time the allowance for effects of variable wall temperature on gas-to-blade heat-transfer coefficients at the leading and trailing sections of turbine blades. Comparison of calculated and experimental blade temperatures, for gas temperatures of 300° and 1000° F, resulted in good agreement.

NACA RM E53H05

CONSIDERATIONS IN THE ADAPTATION OF LOW-COST FUELS TO GAS-TURBINE-POWERED COMMERCIAL AIRCRAFT. Henry C. Barnett and Richard J. McCafferty. October 1953. 59p. diagrs., photo., 2 tabs. (NACA RM E53H05) (Declassified from Confidential, 8/17/55)

In recent months interest has increased in the possible use of distillate and residual fuel oils as fuels for commercial gas-turbine aircraft. However, the use of such fuels entails the solution of many problems pertaining to fuel physical properties and combustion characteristics. This report reviews some of these problems and discusses the status of current knowledge in relation to their solution. The fuel combustion characteristics considered in this study are ignition, combustion efficiency, combustion stability, and carbon deposition. In addition the effects of distillate and residual fuels on exhaust deposits and corrosion are discussed. Preliminary calculated data are presented to indicate preheating requirements for maintaining fuel fluidity and desirable fuel-injection properties.

NACA RM L7H26

FLIGHT INVESTIGATION TO DETERMINE THE HINGE MOMENTS OF A BEVELED-EDGE AILERON ON A 45° SWEPTBACK WING AT TRANSONIC AND LOW SUPERSONIC SPEEDS. William N. Gardner and Howard J. Curfman, Jr. November 12, 1947. 20p. diagrs., photos. (NACA RM L7H26) (Declassified from Confidential, 8/17/55)

An RM-1 stability and control research pilotless aircraft was used to measure aileron hinge moments in flight. The 20° beveled edge, $0.52c_a$ overhang balance aileron experienced a rapid increase and then decrease in hinge moments as the critical speed was exceeded (M = 0.86 to 0.92). At supercritical speeds (M = 0.92 to 1.23) the hinge moments increased rapidly. Rolling-moment balance data indicate aileron effectiveness reversal at supercritical speeds.

NACA RM L8E04

EFFECT OF WINDSHIELD SHAPE OF A PILOT'S CANOPY ON THE DRAG OF AN NACA RM-2 DRAG RESEARCH MODEL IN FLIGHT AT TRANSONIC SPEEDS. Sidney R. Alexander. July 21, 1948. 6p. diagrs. (NACA RM L8E04) (Declassified from Confidential, 8/17/55)

Results of flight tests of an NACA RM-2 drag research model equipped with a pilot's canopy having a vee windshield are presented for a Mach number range from 0.75 to 1.43. Comparison is made with test results of a similar canopy having a flat windshield. The vee-windshield canopy produced lower drag-coefficient values than the flat-windshield canopy for Mach numbers from 0.85 to about 1.2. From M = 1.2 to 1.4 both canopies produced the same drag coefficient.

NACA RM L8E10

FREE-FLIGHT INVESTIGATION OF THE ROLLING EFFECTIVENESS AT HIGH SUBSONIC, TRANSONIC, AND SUPERSONIC SPEEDS OF LEADING-EDGE AND TRAILING-EDGE AILERONS IN CONJUNCTION WITH TAPERED AND UNTAPERED PLAN FORMS. H. Kurt Strass. July 23, 1948. 19p. diagrs., photos. (NACA RM L8E10) (Declassified from Confidential, 8/17/55)

Additional results of an aerodynamic-control-effectiveness investigation using free-flight, rocket-propelled test vehicles have been obtained recently which show some effects of leading-edge and trailing-edge ailerons tested both individually and in combination on wings with tapered and untapered plan forms.

NACA RM L8E12

LONGITUDINAL STABILITY CHARACTERISTICS OF A 42° SWEPTBACK WING AND TAIL COMBINATION AT A REYNOLDS NUMBER OF 6.8×10^6. Stanley H. Spooner and Albert P. Martina. July 22, 1948. 44p. diagrs., photos., 2 tabs. (NACA RM L8E12) (Declassified from Confidential, 8/17/55)

Presents results of wind-tunnel investigation at a Reynolds number of 6.8×10^6 to determine the static longitudinal stability characteristics of a 42° sweptback wing and fuselage combination with a sweptback horizontal tail. Includes effects of vertical position of fuselage and tail with respect to wing for several combinations of high-lift and stall-control devices. Also includes effect of a simulated ground.

NACA RM L8G20a

FREE-FLIGHT INVESTIGATION AT TRANSONIC AND SUPERSONIC SPEEDS OF THE ROLLING EFFECTIVENESS OF A THIN, UNSWEPT WING HAVING PARTIAL-SPAN AILERONS. Carl A. Sandahl. October 22, 1948. 13p. diagrs., photos., tab. (NACA RM L8G20a) (Declassified from Confidential, 7/20/55)

Tests of the rolling effectiveness at transonic and supersonic speeds of a thin, unswept wing having partial-span ailerons have been made by means of rocket-propelled test vehicles. The results showed that with 4.6° aileron deflection, the only deflection tested, the rolling effectiveness decreased abruptly in the Mach number range from about 0.92 to 0.97. At supersonic speeds the rolling effectiveness was considerably lower than at subsonic speeds. The direction of roll was, in the correct sense, over the entire Mach number range investigated.

NACA RM L9H19

A STUDY OF SEVERAL FACTORS AFFECTING THE STABILITY CONTRIBUTED BY A HORIZONTAL TAIL AT VARIOUS VERTICAL POSITIONS ON A SWEPTBACK-WING AIRPLANE MODEL. Gerald V. Foster and Roland F. Griner. October 28, 1949. 28p. diagrs., tab. (NACA RM L9H19) (Declassified from Confidential, 8/17/55)

Results are presented of a study made in the Langley 19-foot pressure tunnel at a Reynolds number of 6.8×10^6 to determine the effects of fuselage afterbody shape, split flaps, and a reduction in the span of 0.575-span leading-edge flaps on the stability contributed by a horizontal tail at various heights to a 42° sweptback wing-fuselage combination. Results are also presented of air-flow surveys in the vicinity of the tail with the wing flaps deflected.

NACA RM L50G14b

EXPERIMENTAL DETERMINATION OF EFFECT OF STRUCTURAL RIGIDITY ON ROLLING EFFECTIVENESS OF SOME STRAIGHT AND SWEPT WINGS AT MACH NUMBERS FROM 0.7 TO 1.7. H. Kurt Strass, E. M. Fields, and Paul E. Purser. October 4, 1950. 40p. diagrs., photo., tab. (NACA RM L50G14b) (Declassified from Confidential, 7/20/55)

The effect of varying the wing structural rigidity on the control effectiveness of a 0.2-chord, plain, faired, full-span aileron on untapered wing plan forms having 0° and 45° sweep and aspect ratio of 3.7 has been investigated with rocket-propelled test vehicles. The test results are compared with results obtained from existing theory. Aerodynamic twisting moments are evaluated from the experimental rolling-loss data.

NACA RM L50H28

TABULATED PRESSURE COEFFICIENTS AND AERODYNAMIC CHARACTERISTICS MEASURED ON THE WING OF THE BELL X-1 AIRPLANE IN PULL-UPS AT MACH NUMBERS FROM 0.53 TO 0.99. Ronald J. Knapp and Gertrude V. Wilken. November 1, 1950. 77p. diagrs., photo., 11 tabs. (NACA RM L50H28) (Declassified from Confidential, 8/17/55)

Presents tabulated pressure coefficients and aerodynamic characteristics measured on the left wing of the Bell X-1 airplane in 10 pull-ups from Mach numbers of approximately 0.53 to 0.99.

NACA RM L50J16

DYNAMIC STABILITY AND CONTROL CHARACTERISTICS OF A VERTICALLY RISING AIRPLANE MODEL IN HOVERING FLIGHT. William R. Bates, Powell M. Lovell, Jr., and Charles C. Smith, Jr. February 23, 1951. 16p. diagrs., photos., tab. (NACA RM L50J16) (Declassified from Confidential, 8/17/55)

An investigation is being made to determine the stability and control characteristics of a vertically rising airplane model. This paper presents the results of some preliminary hovering flight tests made in still air with two center-of-gravity positions, 0-percent and 45-percent mean aerodynamic chord and with normal airplane-type controls operating in the slipstream.

NACA RM L51G05

EFFECT OF THE PROXIMITY OF THE GROUND ON THE STABILITY AND CONTROL CHARACTERISTICS OF A VERTICALLY RISING AIRPLANE MODEL IN THE HOVERING CONDITION. Charles C. Smith, Jr., Powell M. Lovell, Jr., and William R. Bates. September 1951. 16p. diagrs., tab. (NACA RM L51G05) (Declassified from Confidential, 8/17/55)

An investigation has been made to determine the effect of the proximity of the ground on the stability and control characteristics of a vertically rising airplane model in the hovering condition. The model was essentially a conventional airplane model having a dual-rotating propeller in a tractor arrangement, a rectangular wing and a cruciform tail with rectangular surfaces. The investigation included take-offs and landings and hovering flight tests near the ground, force tests with and without a ground board, and dynamic-pressure surveys at various radial and longitudinal stations behind the propeller.

NACA RM L51H13a

DYNAMIC STABILITY AND CONTROL CHARACTERISTICS OF A DELTA-WING VERTICALLY RISING AIRPLANE MODEL IN TAKE-OFFS, LANDINGS, AND HOVERING FLIGHT. Powell M. Lovell, Jr., William R. Bates and Charles C. Smith, Jr. October 1951. 14p. diagrs., photo., tab. (NACA RM L51H13a) (Declassified from Confidential, 8/17/55)

An investigation has been conducted by means of tests of a flying model in still air to determine the dynamic stability and control characteristics of a delta-wing vertically rising airplane in the take-off, landing, and hovering phases of flight. The model had a dual-rotating propeller in a tractor arrangement, a modified triangular wing, and modified triangular vertical-tail surfaces mounted symmetrically above and below the fuselage, but had no horizontal tail. Control was provided by elevons and rudders operating in the propeller slipstream.

NACA RM L51H14

DAMPING IN ROLL OF STRAIGHT AND 45° SWEPT WINGS OF VARIOUS TAPER RATIOS DETERMINED AT HIGH SUBSONIC, TRANSONIC, AND SUPERSONIC SPEEDS WITH ROCKET-POWERED MODELS. E. Claude Sanders, Jr. October 1951. 15p. diagrs. (NACA RM L51H14) (Declassified from Confidential, 8/17/55)

Rocket-powered flight tests have been conducted to determine the damping in roll of several wings of 0° and 45° quarter-chord line sweep with various taper ratios. The Mach number range of these tests was from 0.8 to 1.45. Damping in roll decreased with decreasing taper ratio at approximately the same rate for swept and unswept wings, and was also decreased by sweeping the quarter-chord line. Experimental data were much lower than that predicted by theory for the swept wings. The drag at zero lift was consistently of a lower magnitude for the 45° swept tapered series than for the unswept tapered series.

NACA RM L51H16

INVESTIGATION OF THE EFFECT OF A NACELLE AT VARIOUS CHORDWISE AND VERTICAL POSITIONS ON THE AERODYNAMIC CHARACTERISTICS AT HIGH SUBSONIC SPEEDS OF A 45° SWEPTBACK WING WITH AND WITHOUT A FUSELAGE. H. Norman Silvers, Thomas J. King, Jr., and Thomas B. Pasteur, Jr. September 1951. 71p. diagrs., photos., 3 tabs. (NACA RM L51H16) (Declassified from Confidential, 8/17/55)

An investigation of a nacelle was made over a Mach number range from 0.40 to 0.90 to determine the interference characteristics between the nacelle and a semispan model having a wing with the quarter-chord line swept back 45° and a fuselage of fineness ratio 10. The nacelle was a body of revolution of fineness ratio 5.0 with a profile that was a modified NACA 65-series airfoil section. The nacelle was investigated in several chordwise positions and vertical locations.

NACA RM L51I07a

ADDITIONAL STUDIES OF THE STABILITY AND CONTROLLABILITY OF AN UNSWEPT-WING VERTICALLY RISING AIRPLANE MODEL IN HOVERING FLIGHT INCLUDING STUDIES OF VARIOUS TETHERED LANDING TECHNIQUES. William R. Bates, Powell M. Lovell, Jr., and Charles C. Smith, Jr. Movember 1951. 25p. diagrs., photos., tab. (NACA RM L51I07a) (Declassified from Confidential, 8/17/55)

This paper is the third of a series presenting the results of an investigation of the stability and control characteristics of a flying model of an unswept-wing vertically rising airplane. The investigation consisted of flight tests to determine the effects of some miscellaneous factors on the stability and control characteristics for the hovering condition and to study the behavior of the model for various landing techniques involving the use of lines for pulling the model in for a landing.

NACA RM L52H12

LOW-LIFT BUFFET CHARACTERISTICS OBTAINED FROM FLIGHT TESTS OF UNSWEPT THIN INTERSECTING SURFACES AND OF THICK 35° SWEPTBACK SURFACES. Homer P. Mason. January 1953. 21p. diagrs., photos. (NACA RM L52H12) (Declassified from Confidential, 8/17/55)

Results of flight tests of two rocket-propelled rearch models are presented. The effect of the intersection of thin surfaces and the effect of moderate sweepback of a thick surface on the low-lift buffeting and trim characteristics of a clean body-tail configuration are shown. Drag coefficients are presented and compared with previous data to show the effect of tail position and sweep.

NACA RM L53G15

INVESTIGATION OF A RELATED SERIES OF TURBINE-BLADE PROFILES IN CASCADE. James C. Dunavant and John R. Erwin. December 1953. 100p. diagrs. (NACA RM L53G15) (Declassified from Confidential, 8/17/55)

Series of directly related turbine blade shapes uniformly variable in camber are designed to satisfy the usual turbine-blade operating requirements of inlet air angle and turning angle. Low-speed cascade test results of five blade sections and sample high-speed cascade tests for two blade sections of these series are presented. A method of properly cambering turbine blade shapes based on low-speed test results is given.

NACA RM L53H21

INVESTIGATION OF REYNOLDS NUMBER EFFECTS FOR A SERIES OF CONE-CYLINDER BODIES AT MACH NUMBERS OF 1.62, 1.93, AND 2.41. Carl E. Grigsby and Edmund L. Ogburn. October 1953. 20p. diagrs., photos. (NACA RM L53H21) (Declassified from Confidential, 8/17/55)

An investigation of the Reynolds number for transition and the skin-friction drag at zero lift of eight cone-cylinder bodies having varying fineness ratios has been made at Mach numbers of 1.62, 1.93, and 2.41 over a Reynolds number range from 0.3×10^6 to 10×10^6. The accuracy of the skin-friction data was not sufficient to permit any general conclusions to be drawn. The Reynolds number for transition was found to be dependent upon both the tunnel stagnation pressure and Mach number.

NACA RM L53K12

A SUMMARY OF INFORMATION ON SUPPORT INTERFERENCE AT TRANSONIC AND SUPERSONIC SPEEDS. Eugene S. Love. January 1954. 26p. diagrs. (NACA RM L53K12) (Declassified from Confidential, 8/17/55)

A compilation of available information on the problem of support interference at transonic and supersonic speeds is presented.

NACA RM L53L23a

WIND-TUNNEL INVESTIGATION OF A SHIELDED TOTAL-PRESSURE TUBE AT A MACH NUMBER OF 1.61. Walter R. Russell and William Gracey. March 1954. 9p. diagrs., photo. (NACA RM L53L23a) (Declassified from Confidential, 8/17/55)

Wind-tunnel tests of the variation of total-pressure error with angle of attack of a shielded total-pressure tube over an angle-of-attack range of 0° to 60° and at a Mach number of 1.61 are presented. The tests showed that the total-pressure error was zero up to an angle of attack of 34°, increased to $0.035q_c'$ (where q_c' is the indicated impact pressure) at 48°, then began to decrease and reached a value of zero at 55° and $-0.07q_c'$ at 59.5°.

NACA RM L54C18

DYNAMIC STABILITY AND CONTROL CHARACTERISTICS OF A DUCTED-FAN MODEL IN HOVERING FLIGHT. Robert H. Kirby. April 1954. 16p. diagrs., photos. (NACA RM L54C18) (Declassified from Confidential, 8/17/55)

This paper presents the results of an experimental investigation of the dynamic stability and control of a simple ducted-fan model in hovering flight and is intended to provide some basic information on the stability and control of jet vertically rising airplanes in hovering flight. The model consisted of an 18-inch-diameter dual-rotating propeller in a shroud 4 feet long. Control was provided by all-movable surfaces at the rear of the shroud. The investigation consisted mainly of flight tests with the model hovering at altitude and near the ground.

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NACA Rept. 1197

A STUDY OF THE CHARACTERISTICS OF HUMAN-PILOT CONTROL RESPONSE TO SIMULATED AIRCRAFT LATERAL MOTIONS. Donald C. Cheatham. 1954. ii, 14p. diagrs., photos., tab. (NACA Rept. 1197. Formerly RM L52C17)

There are presented studies of the characteristics of pilot ability to control dynamically unstable yawing oscillations, studies of pilot control response to simulated aircraft yawing motions, and studies of the feasibility of representing pilot control response in an analytical form.

NACA RM E55F28a

STATISTICAL SURVEY OF ICING DATA MEASURED ON SCHEDULED AIRLINE FLIGHTS OVER THE UNITED STATES AND CANADA FROM NOVEMBER 1951 TO JUNE 1952. Porter J. Perkins. September 1955. 44p. diagrs., photos., 2 tabs. (NACA RM E55F28a)

A statistical survey and a preliminary analysis are made in an interim report of over 600 icing encounters obtained from a continuing program sponsored by the NACA with the cooperation of the airlines. Pressure-type icing-rate meters were installed on 11 airline aircraft of various types. Icing conditions measured during scheduled operations gave relative frequencies of liquid-water content, icing rate, total ice accumulations, cloud temperatures, as well as horizontal and vertical extent of icing clouds. Liquid-water contents were higher than data from earlier research flights in layer-type clouds but slightly lower than previous data from cumulus clouds.

NACA TM 1330

THEORY OF DYNAMIC CREEP. (K teorii dinamicheskoi polzuchesti). A. A. Predvoditelev and B. A. Smirnov. September 1955. 12p. diagr. (NACA TM 1330. Trans. from Moscow Universitet, Vestnik, v.8, no.8, 1953, p.79-86)

An analysis is given of the causes of the increase in creep under varying loads. It is suggested that the increase in creep is due to local rise in temperature over the slip planes, thus facilitating slip. A theory of dynamic creep is proposed, based on the Becker theory of the after-effect, which treats the metal as a granular structure and includes a rate factor. Comparison of the theory with experimental results is reserved for a future paper.

NACA TN 3293

CUMULATIVE FATIGUE DAMAGE OF AXIALLY LOADED ALCLAD 75S-T6 AND ALCLAD 24S-T3 ALUMINUM-ALLOY SHEET. Ira Smith, Darnley M. Howard, and Frank C. Smith, National Bureau of Standards. September 1955. 49p. diagrs., photos., 5 tabs. (NACA TN 3293)

Results are presented of cumulative-fatigue-damage tests made on 607 specimens machined from alclad 75S-T6 aluminum-alloy sheet 0.064 inch thick and 198 specimens of alclad 24S-T3 and alclad 75S-T6 aluminum-alloy sheet 0.032 inch thick. The tests of the 0.064-inch-thick specimens consisted of 35 different loading conditions and the tests of the 0.032-inch material consisted of 13 different loading conditions.

NACA TN 3294

FRICTION STUDY OF AIRCRAFT TIRE MATERIAL ON CONCRETE. W. G. Hample, Boeing Airplane Company. September 1955. 34p. diagrs., photos. (NACA TN 3294)

A systematic study was made of the variation of frictional resistance between typical tire-tread material and three concrete surfaces of different roughness at various temperatures and normal pressures. The tire-tread specimens were taken from the thickest portion of worn ten-ply tires, and the three concrete test blocks were poured from the same mix but subjected to different surface finishes. Curves are presented of the apparent coefficient of friction as a function of normal pressure.

NACA TN 3477

HYDRODYNAMIC PRESSURE DISTRIBUTIONS OBTAINED DURING A PLANING INVESTIGATION OF FIVE RELATED PRISMATIC SURFACES. Walter J. Kapryan and George M. Boyd, Jr. September 1955. 82p. diagrs., photos., 5 tabs. (NACA TN 3477)

Hydrodynamic pressure distributions have been obtained during pure planing for five related prismatic surfaces. The distributions gave integrated lifts that in almost every case were well within 10 percent of the applied load. Comparison of experiment with theory shows that existing theories will adequately predict flat-plate pressures. For the V-shaped surfaces, experiment and theory are in poor agreement. The lift and center-of-pressure data for both the flat and V-shaped surfaces are in good agreement with recent experimental and theoretical NACA research on planing surfaces.

NACA TN 3479

ANALYSIS OF THE HORIZONTAL-TAIL LOADS MEASURED IN FLIGHT ON A MULTIENGINE JET BOMBER. William S. Aiken, Jr. and Bernard Wiener. September 1955. i, 69p. diagrs., photo., 6 tabs. (NACA TN 3479)

Horizontal-tail loads were measured in gradual and abrupt longitudinal maneuvers on two configurations of a four-engine jet bomber. The results obtained have been analyzed to determine the flight values of the coefficients important in calculations of horizontal tail loads. The least-squares procedure used to determine aerodynamic tail loads from strain-gage measurements of structural tail loads which were affected by temperature is covered in detail. The effect of fuselage flexibility on the airplane motion is considered in the analysis of the abrupt-maneuver data. When possible, wind-tunnel results are compared with flight results. Some calculations of critical horizontal-tail loads beyond the range of the tests are given and compared with design loads.

NACA TN 3486

MEASUREMENTS OF TURBULENT SKIN FRICTION ON A FLAT PLATE AT TRANSONIC SPEEDS. Raimo J(aakko) Hakkinen, California Institute of Technology. September 1955. 41p. diagrs., photo., tabs. (NACA TN 3486)

The design and construction of a floating-element skin-friction balance are described. This instrument was applied to measurements of local skin friction in the turbulent boundary layer of a smooth flat plate at high-subsonic Mach numbers and supersonic Mach numbers up to 1.75. The principal difficulties which exist in comparing skin-friction coefficients at various Mach numbers are discussed.

NACA TN 3491

EXPERIMENTAL INVESTIGATION OF ECCENTRICITY RATIO, FRICTION, AND OIL FLOW OF LONG AND SHORT JOURNAL BEARINGS WITH LOAD-NUMBER CHARTS. G(eorge) B. DuBois, F(red) W. Ocvirk, and R. L. Wehe, Cornell University. September 1955. 63p. diagrs., tabs. (NACA TN 3491)

The performance of plain bearings under steady central loading are compared and summarized by single-line curves covering the range of length-diameter ratios both above and below 1. Experimental date on eccentricity ratio, friction, and oil flow for length-diameter ratios of 1, 1-1/2, and 2 are shown for comparison with earlier data for length-diameter ratios of 1/4, 1/2, and 1. The combined data provide charts of plain-bearing performance which cover the practical range of length-diameter ratio.

NACA TN 3493

DEVELOPMENT OF EQUIPMENT AND OF EXPERIMENTAL TECHNIQUES FOR COLUMN CREEP TESTS. Sharad A. Patel, Martin Bloom, Burton Erickson, Alexander Chwick and N(icholas) J(ohn) Hoff, Polytechnic Institute of Brooklyn. September 1955. 20p. diagrs., photos., tab. (NACA TN 3493)

Equipment and procedures developed for testing aluminum-alloy columns subjected to constant loads at elevated temperatures are described. Particular emphasis was put on determination of the influence of initial deviations from straightness on the critical time of the column, that is, the time necessary for the column to buckle when subjected to a constant load. Results are presented of tests of a number of 2024-T4 aluminum-alloy columns having large slenderness ratios.

NACA TN 3503

REDUCTION OF PROFILE DRAG AT SUPERSONIC VELOCITIES BY THE USE OF AIRFOIL SECTIONS HAVING A BLUNT TRAILING EDGE. Dean R. Chapman. September 1955. 29p. diagrs., photo. (NACA TN 3503. Supersedes RM A9H11)

A preliminary theoretical and experimental investigation has been made on the aerodynamic characteristics of blunt-trailing-edge airfoils at supersonic velocities. The theoretical considerations indicate that properly designed airfoils with moderately blunt trailing edges can have less profile drag, greater lift-curve slope, and a higher maximum lift-drag ratio than conventional sections. These predictions have been substantiated by experimental measurements on airfoils of 10-percent-thickness ratio at Mach numbers of 1.5 and 2.0, and at Reynolds numbers between 0.2 and 1.2 million.

NACA TN 3514

RESPONSE OF HOMOGENEOUS AND TWO-MATERIAL LAMINATED CYLINDERS TO SINUSOIDAL ENVIRONMENTAL TEMPERATURE CHANGE, WITH APPLICATIONS TO HOT-WIRE ANEMOMETRY AND THERMOCOUPLE PYROMETRY. Herman H. Lowell and Norman (A.) Patton. September 1955. ii, 143p. diagrs., tabs. (NACA TN 3514)

A theoretical investigation of the response of homogeneous and two-material laminated, infinite cylinders to sinusoidal environmental temperature and/or small heat-transfer coefficient changes was made. Generalized results are given for the cylinder consisting of a shell of high thermal conductivity and a core of low conductivity. The behavior of a number of specific platinum-fused-quartz "wires" of varying construction and diameter exposed to a representative airstream is indicated. For ratios of metal thickness to over-all radius of 0.1, response amplitude gains of about 4.5 are predicted as compared with gains of more than 10 for infinitesimal shells. For a relative shell thickness of 0.05, frequency responses of hot-wire anemometers, exposed-wire resistance thermometers, or thermocouples would be extended by at least an order of magnitude. Simplified analyses are included which are not exact but are adequate for design use.

NACA TN 3522

MEASUREMENTS OF THE EFFECTS OF FINITE SPAN ON THE PRESSURE DISTRIBUTION OVER DOUBLE-WEDGE WINGS AT MACH NUMBERS NEAR SHOCK ATTACHMENT. Walter G. Vincenti. September 1955. 50p. diagrs. (NACA TN 3522)

Results are presented of measurements at low supersonic speeds of the pressure distribution on two wings having a common double-wedge section and aspect ratios 2 and 4. Comparable results for aspect ratio infinity have been published in NACA TN 3225. The results cover the Mach number range from 1.166 to 1.377, which brackets the value (1.221) for bow-wave attachment at zero angle of attack. The data are discussed and compared with the previous two-dimensional findings.

NACA TN 3523

THE EFFECTIVENESS OF WING VORTEX GENERATORS IN IMPROVING THE MANEUVERING CHARACTERISTICS OF A SWEPT-WING AIRPLANE AT TRANSONIC SPEEDS. Norman M. McFadden, George A. Rathert, Jr., and Richard S. Bray. September 1955. 43p. diagrs., photos., tab. (NACA TN 3523. Supersedes RM A51J18)

The effects of wing vortex generators, multiple boundary-layer fences, and extension of the outer two segments of the wing leading-edge slats on the aerodynamic characteristics of a 35° swept-wing fighter were measured in flight tests at transonic speeds and high altitudes. Significant improvements were obtained in the pitch-up and wing-dropping-tendency characteristics with certain arrnagements of vortex generators.

NACA TN 3562

VARIATION OF BOUNDARY-LAYER TRANSITION WITH HEAT TRANSFER ON TWO BODIES OF REVOLUTION AT A MACH NUMBER OF 3.12. John R. Jack and N. S. Diaconis. September 1955. 16p. diagrs., photos. (NACA TN 3562)

Cooling a cone-cylinder model to a wall-to-free-stream ratio of approximately 1.4 increased the transition Reynolds number from a value of 2.0×10^6 at equilibrium to 10.6×10^6. For temperature ratios less than 1.4, the boundary-layer flow was entirely laminar. For a parabolic-nosed body, the transition Reynolds number was about twice that of the cone-cylinder model over the temperature range investigated.

NACA TN 3563

HEAT LOSS FROM YAWED HOT WIRES AT SUBSONIC MACH NUMBERS. Virgil A. Sandborn and James C. Laurence. September 1955. 44p. diagrs., photo. (NACA TN 3563)

Heat-loss data at angles of yaw and fixed subsonic Mach numbers for several wires of different diameters commonly used in hot-wire anemometry are presented. Possible methods of correlating the data are examined. The relation of the Reynolds number normal to the flow, which has been used by most researchers, was inadequate except near a Mach number of zero. An empirical relation based on weighted addition of the heat losses of wires normal and parallel to the flow correlated all data reasonably well.

NACA TN 3566

A POLAR-COORDINATE SURVEY METHOD FOR DETERMINING JET-ENGINE COMBUSTION-CHAMBER PERFORMANCE. Robert Friedman and Edward R. Carlson. September 1955. 29p. diagrs., photo., tab. (NACA TN 3566)

An automatic polar-coordinate traversing system is described that sweeps a probe through a quarter-annular exhaust duct circumferentially at selected radial positions. With a single combined pressure and temperature probe, temperature and pressure are recorded simultaneously as a function of probe position. The use of these data in calculating temperature and flow profiles, combustion efficiency, and pressure loss is shown.

BRITISH REPORTS

N-38605*

Aeronautical Research Council (Gt. Brit.)
THE USE OF QUARTZ IN THE MANUFACTURE OF SMALL DIAMETER PITOT TUBES. J. R. Cooke. 1955. 14p. diagrs., photos., tab. (ARC CP 193)

This note describes the method of manufacture of small quartz-tipped pitot tubes (down to 0.005 in. outside tip diameter) which have been used successfully for boundary-layer measurements on small models in a supersonic wind tunnel. Tests have been made of the effects of taper and end finish on the accuracy of measurement, and of the effect of the inside diameter of the tip (for a standard taper) on response rate. For a given inside tip diameter the tapered quartz tubes gave a faster response rate than the stainless steel hypodermic tubes previously used.

N-38606*

Aeronautical Research Council (Gt. Brit.)
A NOTE ON THE SOUND FROM WEAK DISTURBANCES OF A NORMAL SHOCK WAVE. Alan Powell. 1955. 10p. diagrs. (ARC CP 194)

The disturbances of a shock wave by sound waves or temperature fluctuations are studied in one dimension to a first-order approximation. In general, both sound waves and temperature fluctuations arise behind the shock wave. Expressions are given for their amplitudes and calculated for $\gamma = 1.4$. Sound waves colliding with the shock wave are amplified, but sound waves are almost annihilated by weak shock waves if originally travelling in the same direction as the shock wave. Small temperature fluctuations give rise to much sound on an acoustical scale.

N-38607*

Aeronautical Research Council (Gt. Brit.)
REQUIREMENTS FOR UNIFORMITY OF FLOW IN SUPERSONIC WIND TUNNELS. D. E. Morris and K. G. Winter. 1955. 9p. diagr. (ARC CP 197)

An analysis is made of the effects of nonuniformity of flow on the pressure measurements on the surface of a model and also on the force and moment measurements. The following standards of flow uniformity are derived - variations in flow direction to be less than $\pm 0.1^{\circ}$ in the range $M = 1.4$ to 3; variation in Mach number to be less than ± 0.003 at $M = 1.4$ increasing to ± 0.01 at $M = 3$. A brief analysis is made of the errors in model manufacture and their effects on force and pressure measurements. Using the same standards as were used in deducing the requirements for flow uniformity quoted above, it is concluded that present standards of model manufacture are satisfactory overall, though for accurate pressure plotting tests at low supersonic Mach numbers a higher standard is desirable.

N-38608*

Aeronautical Research Council (Gt. Brit.)
A CRITERION FOR THE PREDICTION OF THE RECOVERY CHARACTERISTICS OF SPINNING AIRCRAFT. T. H. Kerr. 1955. 22p. diagrs., tabs. (ARC CP 195)

It has been deduced that the two most important parameters are the unbalanced rolling-moment coefficient about the wind axis in the spin and the ratio of pitching to rolling moment of inertia. Using the results of full-scale spinning tests on 33 aircraft, it has been possible to establish empirical relationships between the estimated unbalanced rolling-moment coefficient and the inertia ratio which effectively divide the aircraft into the three groups which have satisfactory, borderline, and unsatisfactory recovery characteristics. A simple method is presented for estimating the unbalanced rolling-moment coefficient knowing only the shape of the aircraft. The empirical relationships should give a good indication of the spin-recovery characteristics on new designs.

N-38616*

Aeronautical Research Council (Gt. Brit.)
MODEL TESTS ON THE EFFECTS OF SLIPSTREAM ON THE FLOW AT VARIOUS TAILPLANE POSITIONS ON A FOUR-ENGINED AIRCRAFT. PART I. TESTS WITH CONTRA-ROTATING PROPELLERS. D. E. Hartley, A. Spence, and D. A. Kirby. PART II. TESTS WITH SINGLE ROTATING PROPELLERS. D. A. Kirby. 1955. 37p. diagrs., tabs. (ARC R & M 2747; ARC 12,355; ARC 14,166. Supersedes RAE Aero 2322; RAE Aero 2322a)

Systematic wind-tunnel tests have been made to investigate the effects of slipstream on the flow near the tail plane of a typical civil transport with four contra-rotating propellers. Tail-plane height has been varied for each of several wing-body arrangements; only one tail plane and one propeller position have been used. This report presents the main results in the form of changes in mean downwash angle and velocity at the tail plane, as functions of tail-plane position, lift coefficient, and propeller thrust.

N-38617*

Aeronautical Research Council (Gt. Brit.)
DETERMINATION OF THE STRESS DISTRIBUTION IN REINFORCED MONOCOQUE STRUCTURES. PART I. A THEORY OF FLAT-SIDED STRUCTURES. L. S. D. Morley. 1955. 23p. diagrs., photos. (ARC R & M 2879; ARC 14,814. Supersedes RAE Structures 120)

This paper is concerned with the estimation of the stress distribution in the neighborhood of a discontinuity in reinforced monocoque flat-sided structures. A theory is given based upon a shell model possessing uniformly distributed stringers but discrete ribs, which can serve as a basis for the practical solution of a wide range of flat-sided structures such as rectangular or polygonal fuselages and wing boxes.

N-38618*

Aeronautical Research Council (Gt. Brit.)
THE THEORETICAL WAVE DRAG OF SOME BODIES OF REVOLUTION. L. E. Fraenkel. 1955. 26p. diagrs., tab. (ARC R & M 2842; ARC 14,334. Supersedes RAE Aero 2420)

This report investigates the wave drag of bodies of revolution with pointed or open-nose forebodies and pointed or truncated afterbodies. The "quasi-cylinder" and "slender-body" theories are reviewed, a reversibility theorem is established, and the concept of the interference effect of a forebody on an afterbody is introduced. The theories are applied to bodies whose profiles are either straight or parabolic arcs, formulas and curves being given for forebody and afterbody drag, and for the interference drag. The results of the two theories are compared and are seen to agree well in the region of geometries where both theories are applicable.

N-38619*

Aeronautical Research Council (Gt. Brit.)
AN EXPERIMENTAL INVESTIGATION OF STRESS DIFFUSION IN NON-BUCKLING PLATES. L. H. Mitchell. 1955. 20p. diagrs., photos. (ARC R & M 2878. Supersedes ARC 14,934; Strut 1540)

This report provides experimental results for comparison with theoretical analyses of stress diffusion problems. The structures considered consist of plane reinforced sheet which has been assumed not to buckle. Symmetrical loads are applied to the edge booms connected to the sheet by continuous no-slip joints. Attention is concentrated on the stress distribution near the ends of the parallel strips of plate. An outline of the existing theoretical work which is applicable to this type of problem is given. The stringer-sheet theory is compared with the photoelastic results. Some attention is also given to transverse end stiffeners which seem to have little effect on the shear stresses.

N-38620*

Aeronautical Research Council (Gt. Brit.)
THE BOUNDARY LAYER WITH DISTRIBUTED SUCTION. M. R. Head. 1955. 100p. diagrs., photos., tabs. (ARC R & M 2783. Supersedes ARC 13,897; FM 1547; Perf. 771)

Experiments performed in flight at Reynolds numbers in the region of 3×10^6 have clearly demonstrated the stabilizing effect of small amounts of distributed suction on the laminar boundary layer. In the absence of a pressure gradient and in adverse gradients similar to those occurring on a normal airfoil, transition of the boundary layer to the turbulent form has been prevented by the use of such suction quantities as may be expected to lead to very considerable reductions in effective drag. It appears, however, that for extensive laminar flow to be achieved in this way, the surface must be free from such excrescences as would cause transition in the absence of suction.

N-38621*

Aeronautical Research Council (Gt. Brit.)
METHODS FOR CALCULATING THE LIFT DISTRIBUTION OF WINGS (SUBSONIC LIFTING-SURFACE THEORY). H. Multhopp. 1955. 96p. diagrs., tabs. (ARC R & M 2884; ARC 13,439. Supersedes RAE Aero 2353)

These methods for calculating the load distribution on wings of any plan form are based on the conceptions of lifting-surface theory. Computer work time is shortened by careful choice of the positions of pivotal points, by plotting once for all those parts of the downwash integral which occur frequently and by a consequent application of approximate integration methods similar to those devised by the author for lifting-line problems. The basis of the method is to calculate the local lift and pitching moment at a number of chordwise sections from a set of linear equations satisfying the downwash conditions at two pivotal points in each section.

N-38711*

Aeronautical Research Council (Gt. Brit.)
SIMPLE EVALUATION OF THE THEORETICAL LIFT SLOPE AND AERODYNAMIC CENTRE OF SYMMETRICAL AEROFOILS. H. C. Garner. 1955. 20p. tabs. (ARC R & M 2847. Supersedes ARC 14,337; Perf. 847; S & C 2561)

This paper presents a simple method of calculating theoretical values of the lift slope $(a_1)_T$ and the position of aerodynamic center h_T in two-dimensional incompressible flow. Starting with the ordinates of an airfoil, the method in section 3 provides first and second approximations to both derivatives, which are compared with exact theory and other calculated values in Tables 2 and 3 for various symmetrical airfoils listed in Table 1. In section 5 a correction to the first approximation is introduced so as to permit the evaluation of $(a_1)_T$ within 1/2 percent and h_T within about 0.001 in less than a quarter of an hour. A complete illustrative calculation is set out in Table 4.

N-38712*

Aeronautical Research Council (Gt. Brit.)
BOUNDARY-LAYER CONTROL FOR HIGH LIFT BY SUCTION AT THE LEADING-EDGE OF A 40 DEG SWEPT-BACK WING. E. D. Poppleton. 1955. 38p. diagrs., tabs. (ARC R & M 2897; ARC 14,771. Supersedes RAE Aero 2440)

Wind-tunnel tests on the 10-percent-thick, constant-chord, aspect-ratio-4.6 wing are discussed. Boundary-layer control was applied along the whole leading edge; a comparison was made between the effects of distributed suction and suction through a

slot. A 45-percent Fowler flap was used in some tests. The overall effect of the two systems was similar, giving an increase in $C_{L_{max}}$ by increasing the stalling angle of attack and making the wing statically stable up to the stall, when there was a severe loss of lift. The tests were designed to determine whether leading-edge suction would produce comparable increases in $C_{L_{max}}$ on swept wings and, also whether tip stall could be prevented.

N-38713*

Aeronautical Research Council (Gt. Brit.)
ON THE APPLICATION OF OBLIQUE COORDINATES TO PROBLEMS OF PLANE ELASTICITY AND SWEPT-BACK WING STRUCTURES. W. S. Hemp. WITH AN APPENDIX. S. R. Lewis. 1955. 46p. diagrs., tabs. (ARC R & M 2754; ARC 12,981. Supersedes College of Aeronautics Rept. 31; College of Aeronautics Rept. 44)

Methods are discussed by which designers can solve problems of stress distribution and deflection for the case of sweptback wing structures whose ribs lie parallel to the direction of flight. The mathematical basis is developed and formulas are derived. The results are applied to a uniform, symmetrical, rectangular section sweptback box. Theories of stress distribution and deflections are obtained for the case of loading by normal forces and couples applied to the ends of the box. The main results are then generalized to cover the case of a more representative wing structure. Functions useful in the application of the theory are given in an appendix.

N-38714*

Aeronautical Research Council (Gt. Brit.)
LOW-SPEED TUNNEL MODEL TESTS ON TAIL-PLANE ROLLING MOMENTS IN SIDESLIP. A Spence, J. W. Leathers, and D. A. Kirby. 1955. 20p. diagrs., tabs. (ARC R & M 2941; ARC 14,701. Supersedes RAE Tech. Note Aero 2123)

Measurements were made of the effect of sideslip on the rolling moment on a 41.5° sweptback tail plane mounted at three heights on the fin of a model of a single jet aircraft with a 40° sweptback wing. Incidence and tail-plane setting were varied, and the effects of rudder deflection were obtained with the tail plane at the top of the fin. Brief results on a delta aircraft model with a delta tail plane at the top of the fin are also included. Values of the rolling moment on the tail plane were obtained from measurements of the bending moment on the starboard half of the tail plane about a hinge just outside the fin.

N-38715*

Aeronautical Research Council (Gt. Brit.)
TWO-DIMENSIONAL CONTROL CHARACTERISTICS. L. W. Bryant, A. S. Halliday, and A. S. Batson. 1955. 47p. diagrs. (ARC R & M 2730. Supersedes ARC 13,039; S & C 2385; ARC 13,065; S & C 2386)

Researches on the lift, pitching moments, and hinge moments of airfoils with plain flaps have been carried out at the National Physical Laboratory at a Reynolds number of about 10^6. The results have been presented in a generalized form, which shows promise of being applicable over a wide field. It appears that a suggestion due to Preston that the ratio of experimental lift slope ($dC_L/d\alpha = a_1$) to the theoretical value $(a_1)_T$, corresponding to the Joukowsky condition of flow past the trailing edge, provides a criterion giving the combined effects of Reynolds number, transition points, and airfoil shape on $dC_L/d\alpha$, and is a very useful starting point for the estimation of control characteristics.

N-38716*

Aeronautical Research Council (Gt. Brit.)
PERMISSIBLE DESIGN VALUES AND VARIABILITY TEST FACTORS. R. J. Atkinson. 1955. 20p. diagrs., tabs. (ARC R & M 2877; ARC 11,619; ARC 13,748. Supersedes RAE Tech. Note Structures 15; RAE Tech. Note Structures 61)

For the design of structural elements it is postulated that: not more than 10 percent of any given design should have strength below the design value, and not more than 0.1 percent should have strength below 90 percent of the design value. This rule forms a working basis for the interpretation of tests on statistical lines. On the basis of a fixed probability the report deduces: expressions for the derivation of permissible design values from a given number of test results, the number of test results required so that the estimates of permissible design values can be regarded as sufficiently accurate, and the factor which should be applied to the results of tests on any number of similar components designed to meet a specified requirement.

N-38717*

Aeronautical Research Council (Gt. Brit.)
IMPROVEMENTS IN THE FATIGUE STRENGTH OF JOINTS BY THE USE OF INTERFERENCE FITS. W. A. P. Fisher and W. J. Winkworth. 1955. 17p. diagrs., photos., tabs. (ARC R & M 2874; ARC 15,014. Supersedes RAE Structures 127)

Fatigue test results are given for aluminum alloy flat bars with a single hole loaded by a pin in double shear. In one series the pin was fitted directly in the hole with various degrees of interference fit up to 0.003 in. excess diameter. The other series had a mild steel bush interposed with similar degrees of interference in the bar, but with a push fit between pin and bush. Both sets showed a great increase in fatigue strength for interference fits above a critical value.

N-38718*

Aeronautical Research Council (Gt. Brit.)
AN EXAMINATION OF THE FLOW AND PRESSURE LOSSES IN BLADE ROWS OF AXIAL-FLOW TURBINES. D. G. Ainley and G. C. R. Mathieson. 1955. 33p. diagrs. (ARC R & M 2891; ARC 14,232. Supersedes NGTE R. 86)

Available information is studied and analyzed to determine magnitudes of gas pressure losses and deflections in a wide variety of blade rows and to determine the separate influences of variables such as blade shape, blade spacing, gas Mach number, Reynolds number, incidence, etc. Special attention is paid to "secondary losses." Effects of blade tip clearance are also considered. Empirical guiding rules and charts are derived from which approximate values of the overall pressure losses and gas deflections in a range of blade rows can be deduced. It is found that secondary losses can in many instances be large, the loss being generally found to be great when the blading has low reaction.

N-38719*

Aeronautical Research Council (Gt. Brit.)
FLUTTER AND RESONANCE CHARACTERISTICS OF A MODEL CANTILEVER WING CARRYING LOCALISED MASSES. N. C. Lambourne. 1955. 25p. diagrs., tabs. (ARC R & M 2866. Supersedes: ARC 13,910; 0.939; ARC 11,008; 0.687)

Resonance tests on a model cantilever wing carrying concentrated masses were made in conjunction with flutter tests. Measurements were made with masses up to approximately five times the mass of the bare wing added at two positions. Flutter and resonance characteristics are placed in juxtaposition. An attempt is made to correlate the two sets of phenomena by means of the Küssner criterion. Distortion modes of flutter are analyzed into normal mode components. Results suggest that for a wing rigidly fixed at the root and carrying a single concentrated mass the first three normal modes are sufficient to define the flutter mode.
Copies obtainable from NACA, Washington

N-38720*

Aeronautical Research Council (Gt. Brit.)
SOME APPLICATIONS OF THE LAMÉ FUNCTION SOLUTIONS OF THE LINEARISED SUPERSONIC FLOW EQUATIONS. PART I - FINITE SWEPTBACK WINGS WITH SYMMETRICAL SECTIONS AND ROUNDED LEADING EDGES. PART II - CAMBERED AND TWISTED WINGS. G. M. Roper. 1955. 42p. diagrs. (ARC R & M 2865; ARC 14,473; ARC 14,475; ARC 14,476. Supersedes RAE Aero 2436; RAE Aero 2437)

In the present paper some special solutions are found. Some of these solutions are combined with previous solutions to give (a) pressure distribution and wave drag at zero lift on some finite unyawed sweptback wings having symmetrical sections with rounded leading edges and wing tips perpendicular to the wind direction, and (b) the change in pressure distribution and wave drag at zero lift on the surface of a Squire wing when the thickness chord ratio is modified. Some additional solutions applicable to cambered and twisted wings are also given.

N-38721*

Aeronautical Research Council (Gt. Brit.)
THE APPLICATION OF THE EXACT METHOD OF AEROFOIL DESIGN. M. B. Glauert. 1955. 45p. diagrs., tabs. (ARC R & M 2683. Supersedes ARC 10,933; FM 1161)

This report considers in detail the design of airfoils by Lighthill's exact method, in which the velocity over the airfoil surface is prescribed as a function of the angular coordinate on the circle into which the airfoil may be transformed. The mathematical basis of the method is set out, means for obtaining desired characteristics for the airfoil are developed, and the procedure to be followed in the actual design is fully discussed. Various special functions are introduced to increase the range and practical utility of the velocity distributions obtainable, and these and other functions are fully tabulated. The calculations for the design of a particular thick suction airfoil are set out in detail.
Copies obtainable from NACA, Washington

N-38722*

Aeronautical Research Council (Gt. Brit.)
AN EXPERIMENTAL INVESTIGATION OF THE BOUNDARY LAYER ON A POROUS CIRCULAR CYLINDER. D. G. Hurley and B(rian) Thwaites. 1955. 14p. diagrs., photos. (ARC R & M 2829. Supersedes ARC 14,158; FM 1584)

The report describes an experimental investigation of the boundary layer on the surface of a porous circular cylinder at which there is a normal inward velocity. The primary object of the experiments was to test the approximate theory of reference 1 for calculating the development of a laminar boundary layer under conditions of continuous suction. The formula given in that reference for calculating the momentum thickness of the layer gave results in accord with the experimental determinations. Owing to practical difficulties in the exploration of the very thin boundary layers and in the determination of the velocity gradient around the surface, other comparisons with the theory were difficult.

N-38723*

Aeronautical Research Council (Gt. Brit.)
FORMULAE FOR ESTIMATING THE FORCES IN SEAPLANE-WATER IMPACTS WITHOUT ROTATION OR CHINE IMMERSION. R. J. Monaghan and P. R. Crewe. 1955. 28p. diagrs., tabs. (ARC R & M 2804; ARC 12,399. Supersedes RAE Aero 2308)

This report contains design formulas for estimating the maximum forces, together with the times and drafts associated with these forces, in main-step landings of seaplanes provided there is neither rotation nor chine immersion. Good agreement is formed with the results of model tests made under controlled conditions at NACA. The basic formulas and curves presented are considered to be the most satisfactory and accurate of the many proposed in recent years. They involve the use of a new basic parameter which is a measure of the effect of forward velocity; a new formula for associated mass, and a new method of plotting which is considered to be the most useful for the analysis of experimental data.

N-38724*

Aeronautical Research Council (Gt. Brit.)
WIND-TUNNEL TESTS ON THE NACA 63A009 AEROFOIL WITH DISTRIBUTED SUCTION OVER THE NOSE. N. Gregory and W. S. Walker. 1955. 17p. diagrs., tabs. (ARC R & M 2900. Supersedes ARC 15,184; Perf. 987; FM 1787)

The effects of distributed suction on the stalling characteristics of the airfoil are described. The most economical extent of suction was from the leading edge for 2.75 percent chord round the upper surface. At a $R = 1.15 \times 10^6$, a suction-quantity coefficient of 0.0034 increased $C_{L_{max}}$ from 0.86 to 1.50 by delaying the stall from $\alpha = 11^o$ to $\alpha = 20^o$. Scale effect on the flow was investigated at $\alpha = 14^o$. The airfoil was also tested with a 20-percent split flap at 60° deflection. Suction gave half the increase on the flapped airfoil that it gave on the plain airfoil. The airfoil was modified for further testing by reducing the chord and blunting the nose.

N-38725*

Aeronautical Research Council (Gt. Brit.)
DETAILED OBSERVATIONS MADE AT HIGH INCIDENCES AND AT HIGH-SUBSONIC MACH NUMBERS ON GOLDSTEIN 1442/1547 AEROFOIL. H. H. Pearcey and M. E. Faber. 1954. 52p. diagrs., photos., tabs. (ARC R & M 2849. Supersedes ARC 13,531; FM 1498; Perf. 714)

Surface-pressure distribution, shock-wave photographs, and observations of boundary-layer separation have been made over a wide range of angle of attack. The observations enable the effects of compressibility on $C_{L_{max}}$ and on the nature of the stall to be studied in detail for the two-dimensional case. The pitching-moment coefficients, also, can be integrated from the pressure distributions. Certain features of the results are thought to be of fairly general interest and application.

N-38728*

Royal Aircraft Establishment (Gt. Brit.)
TECHNIQUES FOR THE MEASUREMENT OF THE AERODYNAMIC FORCES ON OSCILLATING AEROFOILS. W. G. Molyneux. June 1955. 30p. diagrs. (RAE Tech. Note Structures 161)

The various techniques for oscillatory force measurements are considered in relation to their application to the measurement of the aerodynamic coefficients for a rectangular wing oscillating in modes of vertical translation and uniform pitch. It is shown that the eight relevant coefficients L_z, $L_{\dot{z}}$, L_α, $L_{\dot{\alpha}}$, M_z, $M_{\dot{z}}$, M_α and $M_{\dot{\alpha}}$ are obtainable by any of the techniques described. The survey is not exhaustive, but it provides a basis for comparison of the various techniques and should be of assistance to investigators in this field in indicating the particular technique most likely to meet their requirements.

N-38729*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF WATER ON THE POROSITY OF PARACHUTE FABRICS. J. E. Swallow. May 1955. 18p. diagrs., tabs. (RAE Tech. Note Chem. 1248)

Air flow through parachute fabrics was found to be seriously affected by water. The porosity of the nylon, cotton, Fortisan and Terylene fabrics examined was decreased and became negligible for the closer weaves. This was mainly a surface tension effect, but swelling was a contributory factor for cellulosic fabrics. Mock-leno weave nylon fabrics were least affected.

N-38730*

Royal Aircraft Establishment (Gt. Brit.)
ON THE INTEGRAL EQUATIONS OF TWO DIMENSIONAL SUBSONIC FLUTTER DERIVATIVE THEORY. D. E. Williams. June 1955. 39p. (RAE Structures 181)

This note gives the result of an attempt to find an analytical solution of Possio's integral equation - the equation which connects the downwash and the pressure distribution on an airfoil oscillating in two-dimensional subsonic compressible flow. A method is given for solving this problem and for solving the corresponding problem in incompressible flow - the solution of Birnbaum's integral equation.

N-38732*

Royal Aircraft Establishment (Gt. Brit.)
THE DETERMINATION OF FLUORINE IN ORGANIC COMPOUNDS CONTAINING FLUORINE AND PHOSPHORUS. T. R. F. W. Fennell. May 1955. 11p. diagr., tabs. (RAE Tech. Note Chem. 1251)

A published method for the determination of fluoride in the presence of phosphate ion has been found to yield erroneous results. The method has been modified to overcome this fault.

N-38759*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) THE EFFECT OF THE GROUND ON A HELICOPTER ROTOR IN FORWARD FLIGHT. I. C. Cheeseman and W. E. Bennett. July 11, 1955. 13p. diagrs. (AAEE/Res/288)

An approximate method of estimating the effect of the ground on the lift of a rotor at any forward speed is described. Flight tests on several different aircraft show reasonable agreement with the theory. Curves are given showing the relation between thrust, height, speed, and power. The theory has been extended to include the effect of a variation in blade loading and shows that within the range that this parameter takes on present single rotor helicopters the effect is small.

N-38761*

Royal Aircraft Establishment (Gt. Brit.)
A UNIFIED THEORY OF PERFECTLY PLASTIC PLATES. E. H. Mansfield. May 1955. 53p. diagrs. (RAE Structures 170)

A theory is developed for determining the collapse load and the collapse mechanism for perfectly plastic plates under normal loading. A number of solutions to simple problems is first presented and the theory is extended to deal with plates of arbitrary plan carrying a concentrated load, and to plates of rectangular or regular polygonal plan carrying a uniformly distributed load.

N-38781*

Forest Products Research Lab. (Gt. Brit.)
INVESTIGATIONS INTO GLUES AND GLUING. PROGRESS REPORT EIGHTY-FIVE - JUNE 1955. BEHAVIOR OF GLUED WOOD PRODUCTS IN LIGHT NAVAL CRAFT. PART I - SYNOPTIC REPORT. FIFTH YEAR'S ANALYSIS. R. J. Newall and L. S. Doman. 6p. (Forest Products Research Lab. Supersedes corresponding part of Progress Report 71)

This investigation consists in storing samples of plywood and other glued wood products in selected locations for periods up to 10 years. At intervals, samples are removed and systematically tested for deterioration of the glue lines, fungal attack, etc. Inspections have been made at six-monthly intervals over the past 5 years and a summary of the observations is presented.

N-38782*

Forest Products Research Lab. (Gt. Brit.)
COMPOSITE WOOD SECTION. TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. ANINGUERIA - ANINGUERIS ALTISSIMA - UGANDA. (NO RELIABLE WEIGHT FIGURES AVAILABLE BUT PROBABLY BETWEEN 35 AND 40 LB. PER CUBIC FOOT AT 15 PER CENT MOISTURE CONTENT). (PROGRESS REPORT TWENTY-EIGHT). June 1955. 12p. tabs. (Forest Products Research Lab.)

N-38783*

Forest Products Research Lab. (Gt. Brit.)
COMPOSITE WOOD SECTION. TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. ABURA (NZINGU)-MITRAGYNA STIPULOSA - UGANDA. (36 POUNDS PER CUBIC FOOT AT 15 PER CENT MOISTURE CONTENT). (PROGRESS REPORT TWENTY-SEVEN). June 1955. 14p. tabs. (Forest Products Research Lab.)

N-38784*

Forest Products Research Lab. (Gt. Brit.)
COMPOSITE WOOD SECTION. TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. DAHOMA - PIPTADENIA AFRICANA - UGANDA. (47 POUNDS PER CUBIC FOOT AT 15 PER CENT CONTENT). MUCHENCHE - PIPTADENIA BUCHANANII - UGANDA. (35 POUNDS PER CUBIC FOOT AT 15 PER CENT MOISTURE CONTENT). (PROGRESS REPORT TWENTY-SIX). June 1955. 11p. tabs. (Forest Products Research Lab.)

N-38785*

Forest Products Research Lab. (Gt. Brit.)
MOISTURE RELATIONS OF COMPOSITE WOOD PRODUCTS. PROGRESS REPORT TWENTY-SEVEN - JUNE 1955. THE FURROWING OF VENEERED BLOCKBOARD. J. F. S. Carruthers. 9p. diagrs., tabs. (Forest Products Research Lab. Supersedes Progress Report 26, May, 1954)

The purpose of this investigation was to determine the cause of the furrowing which sometimes occurs on the surface of veneered blockboard after polishing. Three different core constructions were employed and an explanation of the furrowing is given for each type.

N-38807*

Royal Aircraft Establishment (Gt. Brit.)
VELOCITY CALCULATIONS BY CONFORMAL MAPPING FOR TWO-DIMENSIONAL AEROFOILS.
D. A. Spence and N. A. Routledge. February 1955. 48p. diagrs., tabs. (RAE Aero 2539)

A method is derived for computing the conformal transformation between the plane of an airfoil of arbitrary shape (symmetrical or cambered), and the plane of its velocity potential at zero lift (in which the airfoil contour becomes a slit), in order to permit calculations of the velocity at points off the surface. The integral equation which relates the contours is derived by an application of Cauchy's theorem, and solved to the order of the square of thickness ratio. The solution is found by representing the ordinate distribution by a Fourier series. The rapid tailing-off of the Fourier coefficients for all smooth airfoil shapes then leads to high accuracy being achieved with a comparatively small amount of effort. The method is straightforward and has proved easy to use.

N-38808*

Royal Aircraft Establishment (Gt. Brit.)
THE CHARACTERISTIC FREQUENCIES OF SMALL OSCILLATIONS IN THE FLOW PAST BLUFF BODIES. D. A. Spence. May 1955. 23p. diagrs. (RAE Aero 2532)

Summary: When a bluff body is placed in a steady stream it experiences buffeting, the periodicity of which can be explained in terms of interactions between external and boundary layer regions. It is shown that the frequency must satisfy a characteristic equation in order for the oscillations induced in the boundary layer to be compatible with those in the outside stream. The equation is derived formally for Lighthill's step case and for that of the circular cylinder. The Karman vortices which are observed in the latter case appear to be a consequence of the oscillatory character of the circulation around the cylinder.

DECLASSIFIED NACA REPORTS

NACA RM A54F28

ON THE RANGE OF APPLICABILITY OF THE TRANSONIC AREA RULE. John R. Spreiter. August 1954. 21p. (NACA RM A54F28) (Declassified from Confidential, 9/7/55)

Some insight into the range of applicability of the transonic area rule has been gained by comparison with the appropriate similarity rule of transonic flow theory and with experimental data for a large family of rectangular wings having NACA 63AXXX profiles.

NACA RM A54J07

THEORETICAL PRESSURE DISTRIBUTIONS FOR SOME SLENDER WING-BODY COMBINATIONS AT ZERO LIFT. Paul F. Byrd. January 1955. 39p. diagrs. (NACA RM A54J07) (Declassified from Confidential, 9/7/55)

Theoretical calculations are made of the pressure distributions for some slender, symmetrical wing-body combinations in subsonic and supersonic flow. The combinations consist first of nonlifting, swept-back wings mounted on a circular cylinder and second of such wings mounted on a body indented so that the local cross-sectional area of the combination is constant. The results indicate that indentation straightens out the isobars along the wing and diminishes the maximum perturbation velocities.

NACA RM L52H08

A STUDY OF THE ZERO-LIFT DRAG-RISE CHARACTERISTICS OF WING-BODY COMBINATIONS NEAR THE SPEED OF SOUND. Richard T. Whitcomb. September 1952. 41p. diagrs., photos., 3 tabs. (NACA RM L52H08) (Declassified from Confidential, 7/26/55)

Results are presented which indicate that near the speed of sound the zero-lift drag rise of a thin low-aspect-ratio wing-body combination is primarily dependent on the axial distribution of the cross-sectional areas normal to the airstream. Results of an investigation of applications of this concept to the reduction of the drag-rise increments of representative wing-body combinations are also presented.

NACA RM L54A29a

ON SLENDER-BODY THEORY AT TRANSONIC SPEEDS. Keith C. Harder and E. B. Klunker. March 1954. 12p. (NACA RM L54A29a) (Declassified from Confidential, 9/7/55)

The basic ideas of the slender-body approximation have been applied to the nonlinear transonic-flow equation for the velocity potential in order to obtain some of the essential features of slender-body theory at transonic speeds. The results of the investigation are presented from a unified point of view which demonstrates the similarity of slender-body solutions in the various Mach number ranges. The transonic area rule and some conditions concerning its validity follow from the analysis.

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Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1191

ON THE DEVELOPMENT OF TURBULENT WAKES FROM VORTEX STREETS. Anatol Roshko, California Institute of Technology. 1954. ii, 25p. diagrs., photos., 3 tabs. (NACA Rept. 1191. Formerly TN 2913)

Wake development behind circular cylinders at Reynolds numbers from 40 to 10,000 was investigated by hot-wire techniques in a low-speed wind tunnel. The Reynolds number range of periodic vortex shedding is divided into two distinct subranges. In the stable range, R = 40 to 150, regular vortex streets are formed and no turbulent motion develops, the vortices decaying by viscous diffusion. The range R = 150 to 300 is a transition region to the irregular range in which turbulent velocity fluctuations accompany the periodic formation of vortices. The diffusion is turbulent and the wake becomes fully turbulent in 40 to 50 diameters. The turbulence is initiated by laminar-turbulent transition in the free layers which spring from the separation points on the cylinder. An annular vortex street was observed in the wake of a ring.

NACA RM E55E18

PERFORMANCE CHARACTERISTICS OF HEMISPHERICAL TARGET-TYPE THRUST REVERSERS. Fred W. Steffen, Jack G. McArdle, and James W. Coats. September 1955. 39p. diagrs., photos., tab. (NACA RM E55E18)

Reverse-thrust performance of hemispherical target-type thrust reversers was obtained. The value of reverse-thrust ratio was found to be primarily a function of hemisphere diameter. Slight improvements in performance were obtained with some size reversers by operating with the exhaust nozzle opened slightly. When high values of reverse-thrust ratio were obtained, the reversed flow attached to the boattail and the pressures on the boattail fell below atmospheric. This pressure reduction amounted to about 20 percent of the resultant reverse force. Various boattail shapes had little effect on reverse-thrust ratio for most hemisphere sizes.

NACA RM E55G27a

IDEAL TEMPERATURE RISE DUE TO CONSTANT-PRESSURE COMBUSTION OF A JP-4 FUEL. S(idney) C. Huntley. September 1955. 53p. diagrs., tabs. (NACA RM E55G27a)

Charts are presented from which ideal temperature rise or the ideal quantity of fuel required to obtain a specified combustion temperature may be obtained. The charts are applicable only to a fuel having a hydrogen-carbon mass ratio of 0.168 (CH_2) and include a range of fuel-air ratios from 0 to 1.2 fractions of stoichiometric fuel-air ratio with dissociation taken into account, inlet-air temperatures from 400° to 1600° R, and combustion pressures from 1/16 to 64 atmospheres.

NACA RM L55G21

NOTE ON HOVERING TURNS WITH TANDEM HELICOPTERS. John P. Reeder and Robert J. Tapscott. September 1955. 5p. photo. (NACA RM L55G21)

The source of an appreciable pitching-moment difference between left and right hovering turns for a tandem helicopter is described. The difference in pitching moment results from the difference in rotational speed of the counterrotating rotors with respect to the air while the helicopter is turning.

NACA TM 1377

THE THEORIES OF TURBULENCE. (Les Théories de la Turbulence). L. Agostini and J. Bass. October 1955. 163p. diagrs. (NACA TM 1377. Trans. from Ministère de l'Air, Publications Scientifiques et Techniques 237, 1950)

The report includes a discussion of the kinematics of statistical mediums, particularly those which are isotropic. A mathematical study is made of the applications of Navier's equations to turbulent motion. Physical theories involving similarity are dealt with. Review is made of much of the work in turbulence. The theoretical discussions are illustrated by some correlation and spectrum curves based on measurements taken in the wind tunnel at the laboratory of the mechanics of the atmosphere at Marseille.

*AVAILABLE ON LOAN ONLY.

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NACA TM 1389

OPTIMUM FLIGHT PATHS OF TURBOJET AIRCRAFT. (Traiettorie Ottime Di Volo Degli Aeroplani Azionati Da Turboreattori). Angelo Miele. September 1955. 47p. diagrs., tabs. (NACA TM 1389. Trans. from L'Aerotecnica, v. 32, no. 4, 1952, p. 206-219)

The climb of turbojet aircraft is analyzed and discussed including the effects of tangential accelerations. Three flight performances are examined: minimum time of climb, climb with minimum fuel consumption, and steepest climb. Diagrams for quick calculation of the optimum Mach numbers and the effect of acceleration on the rate of climb in tropospheric and stratospheric flight are given.

NACA TM 1396

FROM LINEAR MECHANICS TO NONLINEAR MECHANICS. (De la mécanique linéaire a la mécanique non linéaire). Julien Loeb. October 1955. 18p. diagrs. (NACA TM 1396. Trans. from Annales des Télécommunications, v.5, no. 2, Feb., 1950, p. 65-71)

Consideration is first given to the technique used in telecommunication where a nonlinear system (the modulator) results in a linear transposition of a signal. It is then shown that a similar method permits linearization of electromechanical devices or nonlinear mechanical devices. A sweep function plays the same role as the carrier wave in radioelectricity. The linearizations of certain nonlinear functionals are presented.

NACA TN 3463

INVESTIGATION OF THE VIBRATIONS OF A HOLLOW THIN-WALLED RECTANGULAR BEAM. Eldon E. Kordes and Edwin T. Kruszewski. October 1955. 24p. diagrs., photos., 2 tabs. (NACA TN 3463)

Experimental modes and frequencies of an unstiffened hollow beam of rectangular cross section are presented, and comparisons are made between experimental and theoretical frequencies. Theories based on rigid cross sections were found to be sufficiently accurate to predict the frequencies of only the lowest three bending modes. For the higher bending modes and all the torsional modes, it was necessary to include the effects of cross-sectional distortions in the calculations.

NACA TN 3464

INFLUENCE OF SHEAR DEFORMATION ON THE CROSS SECTION ON TORSIONAL FREQUENCIES OF BOX BEAMS. Edwin T. Kruszewski and William W. Davenport. October 1955. 23p. diagrs. (NACA TN 3464)

An exact analysis has been carried out on the torsional vibrations of a four-flange box beam with cross sections which can change shape because the stiffness of the bulkheads is finite. The effect of shear deformation of the cross section on the torsional frequencies is illustrated by numerical calculations. An approximate method for quickly estimating the effects of bulkhead shear stiffness on the torsional frequencies of box beams has been devised.

NACA TN 3475

AN ANALYSIS OF ACCELERATION, AIRSPEED, AND GUST-VELOCITY DATA FROM ONE TYPE OF FOUR-ENGINE TRANSPORT AIRPLANE OPERATED OVER TWO DOMESTIC ROUTES. Martin R. Copp and Thomas L. Coleman. October 1955. 29p. diagrs., tabs. (NACA TN 3475)

Time-history data obtained by the NACA VGH recorder from one type of four-engine commercial transport airplane during operations on two domestic routes indicated that the number of gust accelerations experienced per mile of flight by the two operations differed by a factor of roughly 3. The number of gusts per mile of flight differed by a factor of roughly 4. A general decrease in the frequency of occurrence of gust velocities with increasing altitude was noted for both operations. For acceleration values above 0.8g, maneuver accelerations formed a substantial part of the total-flight load histories. A comparison of the average overall airspeeds and the corresponding average airspeeds in rough air (with accelerations equal to or greater than 0.3g) indicated very little slowdown by either operation upon encountering turbulence.

NACA TN 3481

WIND-TUNNEL INVESTIGATION AT LOW SPEED OF EFFECT OF SIZE AND POSITION OF CLOSED AIR DUCTS ON STATIC LONGITUDINAL AND STATIC LATERAL STABILITY CHARACTERISTICS OF UNSWEPT-MIDWING MODELS HAVING WINGS OF ASPECT RATIO 2, 4, AND 6. Byron M. Jaquet and James L. Williams. September 1955. 45p. diagrs., photos., tabs. (NACA TN 3481)

Results are presented of tests made at a Mach number of 0.13 in the Langley stability tunnel to determine the effects of closed wing-root air ducts on the static longitudinal and static lateral stability characteristics of models having unswept wing and tail surfaces with wings of aspect ratio 2, 4, and 6. In addition, for model configurations employing the wing of aspect ratio 2 the effects of top and bottom fuselage ducts on the static longitudinal and static lateral characteristics were determined. The effect of the wing-root ducts on the aerodynamic hysteresis in sideslip of the model employing the wing of aspect ratio 2 was also determined.

NACA TN 3485

AN APPROXIMATE SOLUTION FOR AXIALLY SYMMETRIC FLOW OVER A CONE WITH AN ATTACHED SHOCK WAVE. Richard A. Hord. October 1955. 32p. diagrs. (NACA TN 3485)

It is shown that the streamlines in an angular neighborhood of the surface of an unyawed circular cone with an attached shock wave are, to a first approximation, portions of hyperbolas. This fact is used as a basis for the development of an approximate solution in which shock-wave orientation and flow field behind the shock wave are given explicitly in terms of free-stream Mach number, vertex angle of the body cone, and the ratio of specific heats of the gas. The approximate solution is compared with other approximate solutions for the cone.

NACA TN 3497

SUMMARY OF RESULTS OF A WIND-TUNNEL INVESTIGATION OF NINE RELATED HORIZONTAL TAILS. Jules B. Dods, Jr. and Bruce E. Tinling. July 1955. 105p. diagrs., 2 tabs. (NACA TN 3497. Formerly RM A51G31a)

A compilation of data is presented for models of nine related horizontal tails. The majority of the results were obtained at a Mach number of approximately 0.20. Three of the models were tested throughout the subsonic Mach number range to a maximum of 0.94. The Reynolds number range was from 2 to 4 million. The models had aspect ratios from 2 to 6, angles of sweepback from 5.7° to 45°, and had 30-percent-chord, sealed, plain flaps. The lift coefficient, hinge-moment coefficient, and pressure coefficients across the elevator nose seal are presented. The effects of sweepback, aspect ratio, and Mach number on the lift and hinge-moment parameters are summarized. Comparisons of the experimental results with theoretical calculations are presented.

NACA TN 3519

VISUALIZATION STUDY OF SECONDARY FLOWS IN TURBINE ROTOR TIP REGIONS. Hubert W. Allen and Milton G. Kofskey. September 1955. 33p. diagrs., photos., tab. (NACA TN 3519)

A low-speed visualization study of turbine rotor tip secondary flows was made. Results include qualitative information on tip-clearance flow, cross-passage flow, and scraping flow, and on a range of rotor speeds for which a transition condition appeared with minimum flow disturbance. Rotor speed required for this transition flow condition depended upon blade configuration, angle of incidence, tip clearance, and air-flow rate. Results should aid in extending the study to higher airspeeds.

NACA TN 3532

LOW-SPEED STATIC LATERAL AND ROLLING STABILITY CHARACTERISTICS OF A SERIES OF CONFIGURATIONS COMPOSED OF INTERSECTING TRIANGULAR PLAN-FORM SURFACES. David F. Thomas, Jr. October 1955. 29p. diagrs., photos. (NACA TN 3532)

The static lateral and rolling stability derivatives of a series of cruciform, inverted T-, V-, and Y-configurations composed of low-aspect-ratio triangular surfaces have been obtained at low speed in the 6-foot-diameter rolling-flow test section of the Langley stability tunnel. These derivatives are presented as functions of the geometry of the models, and for two configurations (a planar wing and an inverted T), as functions of angle of attack. Where possible, comparisons have been made to indicate the extent of agreement between experiment and existing theory. In general, the sideslip derivatives showed better agreement between theory and experiment than the rolling derivatives.

NACA TN 3533

THE PROPER COMBINATION OF LIFT LOADING FOR LEAST DRAG ON A SUPERSONIC WING. Frederick C. Grant. October 1955. 21p. diagrs. (NACA TN 3533)

Lagrange's method of undetermined multipliers is applied to the problem of properly combining lift loadings for the least drag at a given lift on supersonic wings. The interference drag between the optimum loading and any loading at the same lift coefficient is found to be constant on a given plan form. This is an integral form of a criterion established by Robert T. Jones for optimum loadings. The best combination of four loadings on a delta wing with subsonic leading edges is calculated for several Mach numbers as a numerical example.

NACA TN 3535

FLIGHT INVESTIGATION OF THE SURFACE-PRESSURE DISTRIBUTION AND THE FLOW FIELD AROUND A CONICAL AND TWO SPHERICAL NONROTATING FULL-SCALE PROPELLER SPINNERS. Jerome B. Hammack, Milton L. Windler, and Elwood F. Scheithauer. September 1955. 36p. diagrs., photos. (NACA TN 3535)

The surface-pressure distribution and the flow field around a conical and two spherical nonrotating full-scale propeller spinners were determined in flight at Mach numbers of 0.70 to 0.96. The local-surface Mach numbers between the cone-sphere tangency and the maximum thickness stations were approximately 0.4 higher than those at a free-stream Mach number of 0.95. The departure from free-stream conditions of the larger spherical spinner extends beyond the 1.3-spinner-radius station; whereas, with the smaller spherical spinner, free-stream conditions were reached at the 1.3-spinner-radius station.

NACA TN 3536

A LIMITED FLIGHT INVESTIGATION OF THE EFFECT OF THREE VORTEX-GENERATOR CONFIGURATIONS ON THE EFFECTIVENESS OF A PLAIN FLAP ON AN UNSWEPT WING. Garland J. Morris and Lindsay J(ohn) Lina. September 1955. 20p. diagrs., photos., tabs. (NACA TN 3536)

An exploratory flight investigation was made to determine the effect of three vortex-generator configurations on the effectiveness of the plain flap of a fighter airplane. Tests were made with flaps deflected 19° and 45° at several indicated airspeeds in the range from stall to 140 miles per hour. No improvement in flap effectiveness was obtained with the flaps deflected full down. With flaps deflected 19°, the vortex-generator configuration which produced the largest increase in lift coefficient had about the same effect as increasing the flap deflection to about 27°. Another configuration produced some increase in lift coefficient with no apparent increase in drag.

NACA TN 3538

SUMMARY OF DERIVED GUST VELOCITIES OBTAINED FROM MEASUREMENTS WITHIN THUNDERSTORMS. H(arold) B. Tolefson. October 1955. 19p. diagrs., tabs. (NACA TN 3538)

Available measurements of the derived gust velocities within thunderstorms are summarized for altitudes from 5,000 to 34,000 feet. The results indicate that the intensity of the derived gust velocity is essentially constant up to altitudes of 20,000 feet and that an approximate 10-percent reduction in the gust intensity occurs for altitudes from 20,000 to 30,000 feet.

NACA TN 3561

INTENSITY, SCALE, AND SPECTRA OF TURBULENCE IN MIXING REGION OF FREE SUBSONIC JET. James C. Laurence. September 1955. 58p. diagrs., photo., tab. (NACA TN 3561)

Hot-wire anemometer measurements of the turbulence parameters were made in a 3.5-inch-diameter free jet at exit Mach numbers between 0.2 and 0.7 and Reynolds numbers (based on jet rad.) between 37,500 and 350,000. The results of these measurements show that (1) the intensity of turbulence is a max. at a distance of approximately 1 jet rad. from the jet center line and decreases with increasing Mach and/or Reynolds number, and (2) the lateral and longitudinal scales of turbulence are nearly independent of Mach and/or Reynolds number and vary proportionally with distance from the jet nozzle. The lateral scale is much smaller than the longitudinal and does not vary with distance from the center line, while the longitudinal scale is a max. at a distance from the center line of about 0.7 to 0.8 of the jet rad.

NACA TN 3568

AVERAGING OF PERIODIC PRESSURE PULSATIONS BY A TOTAL-PRESSURE PROBE. R. C. Johnson. October 1955. 30p. diagrs., photo., tabs. (NACA TN 3568)

Information is presented on the average pressure indicated by a total-pressure probe subjected to a stagnation pressure that alternates periodically between two constant values. Calculated and experimental data are in good agreement, and errors are reduced when the probe design is such as to ensure laminar-flow pulsations in the probe at all times. The averaging error is minimized when the inside diameter of the probe entrance tube is made as small as possible, and its length as great as possible, consistent with an acceptable time lag.

NACA TN 3570

AN EXPERIMENTAL COMPARISON OF THE LAGRANGIAN AND EULERIAN CORRELATION COEFFICIENTS IN HOMOGENEOUS ISOTROPIC TURBULENCE. William R. Mickelsen. October 1955. 42p. diagrs. (NACA TN 3570)

The Lagrangian and Eulerian correlation coefficients were compared in a field of homogeneous, isotropic turbulence. The Lagrangian correlation coefficient was characterized by diffusion measurements, and the Eulerian coefficient was measured by hot-wire anemometry. The Lagrangian and Eulerian correlation coefficients had similar shapes connected by a linear relation between their coordinates. The proportionality factor in the linear relation was roughly constant over a range of turbulence intensities from 1.8 to 14 feet per second. The linear relation permits solution of mixing problems from the Eulerian turbulence parameters.

BRITISH REPORTS

N-38869*

Royal Aircraft Establishment (Gt. Brit.)
A SIMPLIFIED MODEL OF THE INCOMPRESSIBLE FLOW PAST TWO-DIMENSIONAL AEROFOILS WITH A LONG BUBBLE TYPE OF FLOW SEPARATION. J. F. Norbury and L. F. Crabtree. June 1955. 17p. diagrs., tabs. (RAE Tech. Note Aero 2352)

This problem may be divided into two parts. The first part concerns the external inviscid flow, and the other is related to the details of the flow inside the viscous region formed by the bubble, the boundary layer, and the wake. Although much information can be obtained by considering only the external stream (as in the hodograph method developed by Maskell), a complete and unique solution for the pressure distribution can only be found by attacking the second part of the problem as well. This has been attempted here and it is shown how the pressure recovery ratio at the end of a long bubble may be found by the analysis of a simplified model of the flow; the complete pressure distribution may then be uniquely determined.

MISCELLANEOUS

N-39013*

AIRCRAFT STRUCTURES RESEARCH AT ELEVATED TEMPERATURES. John E. Duberg. (Presented to Structures and Materials Panel of Advisory Group for Aeronautical Research and Development (NATO) London, England, September 5-9, 1955). 36p. diagrs., photos.

A review is made of the test techniques that have been developed and used by the NACA for experimental research in aircraft structures at elevated temperatures. Some experimental results are presented. Remarks are included on the problem of model scaling for testing of structures at high temperatures.

UNPUBLISHED PAPERS

N-37996*

THE BUCKLING OF PLATES AND BARS IN THE PLASTIC RANGE. I. THEORY. (Over het knitvraagstuk in het plastische gebied bij staven en platen. I. Theorie). J. F. Besseling. July 1955. 97p. diagrs., tabs. (Trans. from Nationaal Luchtvaartlaboratorium, Amsterdam, S.407, Oct. 14, 1952)

The topics treated include the plastic buckling of bars and plates; application of plasticity theories to the determination of stiffness quantities needed for computing the buckling; and the effect of plasticity on the buckling load for a number of fundamental buckling cases when the buckling stress condition is reached through a uniform increase of loading. This report is limited to the theoretical side of the buckling problem and gives the basis for comparing theoretical and experimental results.

DECLASSIFIED NACA REPORTS

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NACA RM A8I17

INVESTIGATION OF A THIN WING OF ASPECT RATIO 4 IN THE AMES 12-FOOT PRESSURE WIND TUNNEL. III - THE EFFECTIVENESS OF A CONSTANT-CHORD AILERON. Ben H. Johnson, Jr., and Fred A. Demele. November 19, 1948. 26p. diagrs., photo. (NACA RM A8I17) (Declassified from Confidential, 9/15/55)

Presented in the report are results of tests at Mach numbers from 0.27 to 0.94 of a thin, unswept wing having a modified diamond airfoil section of thickness ratio 0.042 and equipped with a constant-chord aileron. The tests were conducted at a constant Reynolds number of 2,730,000. The effects of compressibility on the aileron effectiveness were negligible at Mach numbers up to 0.85, but at higher Mach numbers erratic effects of compressibility were evident, especially at lift coefficients greater than 0.5.

NACA RM A9I01

INVESTIGATION OF A THIN WING OF ASPECT RATIO 4 IN THE AMES 12-FOOT PRESSURE WIND TUNNEL. V - STATIC LONGITUDINAL STABILITY AND CONTROL THROUGHOUT THE SUBSONIC SPEED RANGE OF A SEMISPAN MODEL OF A SUPERSONIC AIRPLANE. Ben H. Johnson, Jr., and Francis W. Rollins. December 8, 1949. 130p. diagrs., photos. (NACA RM A9I01) (Declassified from Confidential, 9/15/55)

Presented in this report are results of tests at Mach numbers from 0.20 to 0.94 of a model of a hypothetical supersonic airplane equipped with a thin, sharp-edged wing and tail without sweep. The static longitudinal-stability characteristics of the model have been measured for two different vertical locations of the horizontal tail. The longitudinal control afforded by an all-movable stabilizer and by an elevator has been investigated. The downwash at the tail has been computed and the dynamic-pressure ratio at the tail has been evaluated from pressure measurements in the wake of the wing.

✓ NACA RM A51I07

THE STATIC LONGITUDINAL CHARACTERISTICS AT MACH NUMBERS UP TO 0.95 OF A TRIANGULAR-WING CANARD MODEL HAVING A TRIANGULAR CONTROL. Jack D. Stephenson and Ralph Selan. December 1951. 72p. diagrs., photo. (NACA RM A51I07) (Declassified from Confidential, 9/15/55)

Presents and analyzes results of tests to assess the longitudinal characteristics of a canard-type model having a triangular wing of aspect ratio 2 and NACA 0008-63 sections. The horizontal canard surface had a plan form identical to the wing and an NACA 0005-63 section. The Mach number range of the investigation varied from 0.25 to 0.95 at Reynolds numbers of 8 million and 3 million, respectively. The model was tested with the horizontal control surface at various fixed angles of incidence and with the surface unrestrained so that it could pivot about an axis at 30 percent of its mean aerodynamic chord.

NACA RM A52F18

THE LONGITUDINAL CHARACTERISTICS AT MACH NUMBERS UP TO 0.92 OF A CAMBERED AND TWISTED WING HAVING 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10. George G. Edwards, Bruce E. Tinling, and Arthur C. Ackerman. September 1952. 71p. diagrs., photos., tab. (NACA RM A52F18) **(Declassified from Confidential, 9/15/55)**

A sweptback wing, in combination with a fuselage, of a type considered suitable for long-range, high-speed airplanes, has been tested in the Ames 12-foot pressure wind tunnel. The wing had 40° of sweepback, an aspect ratio of 10, a taper ratio of 0.4, and 5° of washout at the tip. The sections normal to the sweep reference line had NACA four-digit profiles, design lift coefficients of 0.40, and varied in thickness ratio from 14 percent at the root to 11 percent at the tip. The lift, drag, and pitching moment of a semispan model were measured at Reynolds numbers from 2,000,000 to 8,000,000 at low Mach numbers, and at Mach numbers from 0.25 to 0.92 at a Reynolds number of 2,000,000. The changes in boundary-layer flow on the upper surface were studied with tufts.

NACA RM A52I19

THE LONGITUDINAL CHARACTERISTICS AT MACH NUMBERS UP TO 0.9 OF A WING-FUSELAGE-TAIL COMBINATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10. Bruce E. Tinling. December 1952. 41p. diagrs., photo., tab. (NACA RM A52I19) **(Declassified from Confidential, 9/15/55)**

Wind-tunnel tests were made of a wing-fuselage horizontal tail combination suitable for long-range high-speed airplanes. The cambered and twisted wing had an aspect ratio of 10, taper ratio of 0.4, and 40° sweepback. The all-movable horizontal tail had an aspect ratio of 4.5, taper ratio of 0.4, and 40° sweepback. Included are data on longitudinal stability and control, wing fence and tail effect, and isolated horizontal tail data. Data were obtained at a Reynolds number of 8,000,000 at low Mach numbers, and at a Reynolds number of 2,000,000 at Mach numbers up to 0.9.

NACA RM A52K20

PRESSURE DISTRIBUTION AT MACH NUMBERS UP TO 0.90 ON A CAMBERED AND TWISTED WING HAVING 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10, INCLUDING THE EFFECTS OF FENCES. Frederick W. Boltz and Harry H. Shibata. March 1953. 133p. diagrs., photos., tabs. (NACA RM A52K20) **(Declassified from Confidential, 9/15/55)**

Pressure-distribution measurements have been made on a semispan model of a cambered and twisted wing, alone and in combination with a fuselage. The wing had 40° of sweepback, an aspect ratio of 10, a taper ratio of 0.4, and 5° of washout at the tip. The wing thickness distribution in sections normal to the reference sweep line was the NACA 4-digit series with the maximum thickness varying from 14-percent chord at the root to 11-percent chord at the tip. The chordwise distributions of pressure coefficient at nine semispan stations are presented for Mach numbers of 0.165 and 0.25 at a Reynolds number of 8,000,000, and for Mach numbers from 0.25 to 0.90 at a Reynolds number of 2,000,000. Tabulated pressure data are presented for the wing without fences and with four fences.

NACA RM A53D06

THE EFFECTS OF NACELLES AND OF EXTENDED SPLIT FLAPS ON THE LONGITUDINAL CHARACTERISTICS OF A WING-FUSELAGE-TAIL COMBINATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10. Bruce E. Tinling and Armando E. Lopez. June 1953. 47p. diagrs., tab. (NACA RM A53D06) **(Declassified from Confidential, 9/15/55)**

Wind-tunnel tests were made to evaluate the effects of nacelles and of extended split flaps on the longitudinal characteristics of a wing-fuselage-tail combination suitable for long-range high-speed airplanes. The cambered and twisted wing had an aspect ratio of 10, a taper ratio of 0.4, and 40° of sweepback. The nacelles were at 25 and 50 percent of the semispan. Data were obtained to evaluate the effects of nacelles at Mach numbers up to 0.90 at a Reynolds number of 2,000,000. The effects of the flaps were evaluated from data obtained at a Reynolds number of 4,000,000 and a Mach number of 0.082. A limited number of data were also obtained to evaluate the effects of increasing the tail height.

NACA RM A53I23

DOWNWASH BEHIND A TRIANGULAR WING OF ASPECT RATIO 3 - TRANSONIC BUMP METHOD. John A. Axelson. December 1953. 37p. diagrs., photo., tab. (NACA RM A53I23) **(Declassified from Confidential, 9/15/55)**

Downwash measured by means of an all-movable horizontal tail in several different locations is presented for a triangular wing having an aspect ratio of 3 and the NACA 63A006 section. The lift, drag, and pitching-moment characteristics of the wing and the downwash are presented for angles of attack up to 28° over a Mach number range from 0.6 to 1.1, corresponding to a Reynolds number range from 1.8 million to 2.4 million. The effects of tail location on the tail contribution to the static longitudinal stability of the wing-tail combination are discussed.

NACA RM A53I28

THE RESULTS OF WIND-TUNNEL TESTS AT LOW SPEEDS OF A FOUR-ENGINE PROPELLER-DRIVEN AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10. George G. Edwards, Donald A. Buell, and Jerald K. Dickson. December 1953. 121p. diagrs., photo., tabs. (NACA RM A53I28) **(Declassified from Confidential, 9/15/55)**

The effects of operating propellers on the low-speed longitudinal characteristics of a four-engine tractor airplane configuration having a sweptback wing have been investigated in the Ames 12-foot pressure wind tunnel at thrust coefficients up to 0.9 per propeller and at Reynolds numbers from 4,000,000 to 8,000,000. Variations in the model included different heights and incidences of the horizontal tail as well as tail removed, two arrangements of extended split flaps, several propeller-blade angles, and independent as well as simultaneous operation of the inboard and outboard propellers. Coefficients of lift, longitudinal force, pitching moment, propeller thrust, and propeller power are presented in tabular form for various values of advance ratio at constant angles of attack. Selected portions of the data are presented in plotted form for various constant thrust coefficients.

NACA RM A53I29

THE TRANSONIC CHARACTERISTICS OF 36 SYMMETRICAL WINGS OF VARYING TAPER, ASPECT RATIO, AND THICKNESS AS DETERMINED BY THE TRANSONIC-BUMP TECHNIQUE. Warren H. Nelson, Edwin C. Allen, and Walter J. Krumm. December 1953. 131p. diagrs., photo. (NACA RM A53I29) **(Declassified from Confidential, 9/15/55)**

An investigation was made in the Ames 16-foot high-speed wind tunnel, utilizing the transonic-bump technique to determine the effects of plan-form taper on a series of wings having aspect ratios of 4, 3, and 2, and NACA 63A00X sections with thickness-to-chord ratios of 8, 6, 4, and 2 percent. The Mach number range was 0.6 to 1.1 with a corresponding Reynolds number range of about 1.4 million to 2.0 million. The results indicate that increasing the taper ratio caused only small increases in lift-curve slope except for the wings of highest aspect ratio and thinnest sections. Increasing taper ratio generally increased the overall center-of-pressure travel in going from subsonic to supersonic speeds.

NACA RM E8I01

EFFECT OF THREE FLAME-HOLDER CONFIGURATIONS ON SUBSONIC FLIGHT PERFORMANCE OF RECTANGULAR RAM JET OVER RANGE OF ALTITUDES. Dugald O. Black and Wesley E. Messing. November 24, 1948. 28p. diagrs., photo., tab. (NACA RM E8I01)
(Declassified from Confidential, 9/15/55)

A flight investigation is reported that was conducted on a rectangular ram jet incorporating various flame-holder configurations over a range of fuel-air ratios from 0.017 to 0.120, combustion-chamber-inlet velocities from 50 to 125 feet per second, and pressure altitudes from 1500 to 28,000 feet. Highest combustion efficiencies, which varied from a maximum of 82 percent at 1500 feet to 39 percent at 26,000 feet, were obtained at all altitudes with the three-V gutter-type flame holder. However, at any given altitude and fuel-air ratio slightly higher net-thrust coefficients occurred with the two-V flame holder as a result of its lower value of pressure drop.

NACA RM E8I28

EFFECT OF VARIATION IN FUEL PRESSURE ON COMBUSTION PERFORMANCE OF RECTANGULAR RAM JET. Wesley E. Messing and Dugald O. Black. November 24, 1948. 26p. diagrs., photo., tab. (NACA RM E8I28)
(Declassified from Confidential, 9/15/55)

Reports effect of variation in fuel pressure on starting characteristics, minimum blow-out limits, combustion efficiencies, gas total-temperature ratio, and net-thrust coefficient of rectangular ram jet operated over range of pressure altitudes from 1500 to 26,300 feet, indicated airspeeds from 100 to 200 miles per hour, and fuel-air ratios from 0.017 to 0.120. In general, increasing the degree of fuel atomization and distribution by utilization of small orifice fuel nozzles that operated at high fuel pressures resulted in higher values of combustion efficiency, gas total-temperature ratio, and net-thrust coefficient at a given fuel-air ratio.

NACA RM E50D28

AERODYNAMIC CHARACTERISTICS OF NACA RM-10 MISSILE IN 8- BY 6-FOOT SUPERSONIC WIND TUNNEL AT MACH NUMBERS FROM 1.49 TO 1.98. II - PRESENTATION AND ANALYSIS OF FORCE MEASUREMENTS. Fred T. Esenwein, Leonard J. Obery, and Carl F. Schueller. July 21, 1950. 34p. diagrs., photo. (NACA RM E50D28)
(Declassified from Confidential, 9/15/55)

Experimental investigation of aerodynamic forces acting on body of revolution (NACA RM-10 missile) with and without stabilizing fins was conducted at Mach numbers from 1.49 to 1.98 at angles of attack from 0° to 9° and at Reynolds number of approximately 30,000,000. Comparison of experimental lift, drag, and pitching-moment coefficients and center-of-pressure location for body alone is made with linearized potential theory and a semiempirical method. Results indicate that aerodynamic characteristics were predicted more accurately by semi-empirical method than by potential theory. Breakdown of measured drag coefficients into components of friction, pressure, and base-pressure drag is presented for body alone at zero angle of attack.

NACA RM E50I19

AERODYNAMIC CHARACTERISTICS OF NACA RM-10 MISSILE IN 8- BY 6-FOOT SUPERSONIC WIND TUNNEL AT MACH NUMBERS FROM 1.49 TO 1.98. III - ANALYSIS OF FORCE DISTRIBUTION AT ANGLE OF ATTACK (STABILIZING FINS REMOVED). Roger W. Luidens and Paul C. Simon. December 12, 1950. 26p. diagrs. (NACA RM E50I19)
(Declassified from Confidential 9/15/55)

Analysis of force distribution on slender pointed body of revolution at angle of attack was made utilizing pressure-distribution data and balance measurements obtained in NACA Lewis 8- by 6-foot supersonic tunnel. Comparison of experimental station normal force with those predicted by linearized potential theory (on which radius of body assumed to approach zero) shows that inaccurate prediction by theory of normal force acting on slender body of revolution with curved profiles at angle-of-attack results from inaccurate prediction of potential flow pressure distribution due to angle of attack, and from neglecting effect of cross-flow separation. Increase in total axial force with angle of attack was primarily due to increase in base pressure force.

NACA RM E51H23

WIRE CLOTH AS POROUS MATERIAL FOR TRANSPIRATION-COOLED WALLS. E. R. G. Eckert, Martin R. Kinsler, and Reeves P. Cochran. November 1951. 38p. diagrs., photos., tab. (NACA RM E51H23) **(Declassified from Confidential, 9/15/55)**

The permeability characteristics and tensile strength of a porous material developed from stainless-steel corduroy wire cloth for use in transpiration-cooled walls where the primary stresses are in one direction were investigated. The results of this investigation are presented and compared with similar results obtained with porous sintered metal compacts. A much wider range of permeabilities is obtainable with the wire cloth than with the porous metal compacts considered and the ultimate tensile strength in the direction of the primary stresses for porous materials produced from three mesh sizes of wire cloth is from two to three times the ultimate tensile strengths of the porous metal compacts.

NACA RM E52I12

INTERSTAGE SURVEYS AND ANALYSIS OF VISCOUS ACTION IN LATTER STAGES OF A MULTISTAGE AXIAL-FLOW COMPRESSOR. William B. Briggs and Charles C. Giamati. March 1953. 51p. diagrs., photo., tab. (NACA RM E52I12)
(Declassified from Confidential, 9/15/55)

The overall performance of an eight-stage axial-flow compressor having a design stage pressure ratio of 1.23 was determined and radial interstage surveys were made for four weight flows at both 50 percent and 100 percent design speed. The survey data, from behind the guide vanes and each row of the fifth to eighth stages, were presented as axial and tangential velocity components from which boundary-layer parameters of displacement and momentum thickness were calculated. An analysis related current qualitative ideas of flows which are imposed upon the through flow and the quantitative status of theory to the observed variation of these parameters. Midchannel velocity peaks in excess of design value were not found.

NACA RM E51I25

FLOW SEPARATION AHEAD OF A BLUNT AXIALLY SYMMETRIC BODY AT MACH NUMBERS 1.76 TO 2.10. W. E. Moeckel. December 1951. 12p. diagrs., photos. (NACA RM E51I25) **(Declassified from Confidential, 9/15/55)**

The pressure distribution and drag were determined for a spherical-nosed axially symmetric body with thin projecting rods at Mach numbers of 1.76, 1.93, and 2.10. The upstream projection distance of the rods was varied over a wide range to study changes in the character of the flow separation and to determine the variation of drag and pressure distribution with tip projection. Drag coefficients between 0.18 and 0.30 were obtained for most tip projections at each Mach number.

NACA RM L8I08

LONGITUDINAL-STABILITY INVESTIGATION OF HIGH-LIFT AND STALL-CONTROL DEVICES ON A 52° SWEPTBACK WING WITH AND WITHOUT FUSELAGE AND HORIZONTAL TAIL AT A REYNOLDS NUMBER OF 6.8×10^6. Gerald V. Foster and James E. Fitzpatrick. December 20, 1948. 41p. diagrs., photos., tabs. (NACA RM L8I08)
(Declassified from Confidential, 9/15/55)

Contains low-speed longitudinal stability characteristics of a 52° sweptback wing of aspect ratio 2.88, taper ratio 0.625, and NACA 64_1-112 airfoil sections normal to the 0.282-chord line, in combination with split flaps, leading-edge flaps, and upper-surface fences. Low-wing and midwing-fuselage aerodynamic characteristics are presented with and without a horizontal tail at various vertical locations. Tests were conducted at a Reynolds number of 6.8×10^6.

NACA RM L8I30a

EFFECTS OF A SWEPTBACK HYDROFOIL ON THE FORCE AND LONGITUDINAL STABILITY CHARACTERISTICS OF A TYPICAL HIGH-SPEED AIRPLANE. Raymond B. Wood. December 2, 1948. 19p. diagrs., photo., tabs. (NACA RM L8I30a)
(Declassified from Confidential, 9/15/55)

An investigation was conducted in the Langley 8-foot high-speed tunnel to determine the effects of a sweptback hydrofoil on the force and longitudinal stability

characteristics of a typical high-speed airplane. The Mach number range for this investigation was from 0.60 to 0.95 and at M = 1.20. The effects of the hydrofoil on the lift, drag, and pitching-moment characteristics are presented.

NACA RM L9I30

FLIGHT INVESTIGATIONS AT HIGH-SUBSONIC, TRANSONIC, AND SUPERSONIC SPEEDS TO DETERMINE ZERO-LIFT DRAG OF FIN-STABILIZED BODIES OF REVOLUTION HAVING FINENESS RATIOS OF 12.5, 8.91, AND 6.04 AND VARYING POSITIONS OF MAXIMUM DIAMETER. Roger G. Hart and Ellis R. Katz. November 30, 1949. 36p. diagrs., photos. (NACA RM L9I30)
(Declassified from Confidential, 9/15/55)

Rocket-powered models were flown at transonic and supersonic speeds to determine the zero-lift drag of fin-stabilized bodies of revolution differing in fineness ratio and in position of maximum diameter. The bodies were of fineness ratio 12.5, 8.91, and 6.04 and all had cut-off sterns with equal base and frontal areas.

NACA RM L50I27

THE LONGITUDINAL STABILITY, CONTROL EFFECTIVENESS, AND CONTROL HINGE-MOMENT CHARACTERISTICS OBTAINED FROM A FLIGHT INVESTIGATION OF A CANARD MISSILE CONFIGURATION AT TRANSONIC AND SUPERSONIC SPEEDS. Roy J. Niewald and Martin T. Moul. November 24, 1950. 43p. diagrs., photos. (NACA RM L50I27)
(Declassified from Confidential, 9/15/55)

A 60° delta-wing canard missile configuration was flight-tested at the Langley Pilotless Aircraft Research Station at Wallops Island, Va. Longitudinal stability derivatives, control hinge-moment, and drag characteristics were obtained at transonic and supersonic velocities by utilizing a continuous step control disturbance of $\pm 5^{\circ}$.

NACA RM L51G31

SYSTEMATIC TWO-DIMENSIONAL CASCADE TESTS OF NACA 65-SERIES COMPRESSOR BLADES AT LOW SPEEDS. L. Joseph Herrig, James C. Emery, and John R. Erwin. September 1951. 223p. diagrs., photo., tabs. (NACA RM L51G31)
(Declassified from Confidential, 9/15/55)

A two-dimensional low-speed porous-wall cascade tunnel investigation has been conducted to establish the performance of the NACA 65-series compressor blade sections over the useful range of inlet angle, solidity, and section camber. Design points for optimum high-speed operation are presented. The loading limitation is determined for some conditions. Trends of section operating range with increasing section camber are determined for the four inlet angles tested.

NACA RM L51H03

ROLLING EFFECTIVENESS OF ALL-MOVABLE WINGS AT SMALL ANGLES OF INCIDENCE AT MACH NUMBERS FROM 0.6 TO 1.6. H. Kurt Strass and Edward T. Marley. October 1951. 16p. diagrs., photo., tab. (NACA RM L51H03)
(Declassified from Confidential, 9/15/55)

An investigation of the rolling effectiveness of several all-movable wing configurations has been conducted throughout a Mach number range from 0.6 to 1.6 in order to check a simplified wing incidence correction theory which states that for all-movable wing $\frac{pb}{2V} = \frac{2i_w}{57.3}\left(\frac{1+2\lambda}{1+3\lambda}\right)$. In addition, a comparison was made with two other more complex methods of estimation. The results showed that the simplified theory gave accurate agreement with experiment at Mach numbers from 0.6 to 1.6 and suggest the use of this simplified equation as a means of predicting the rolling effectiveness of all-movable wings throughout this speed range.

NACA RM L52I16

SOME EXPERIMENTAL STUDIES OF PANEL FLUTTER AT MACH NUMBER 1.3. Maurice A. Sylvester and John E. Baker. December 1952. 25p. diagrs., photos., tab. (NACA RM L52I16)
(Declassified from Confidential, 9/15/55)

Experimental studies of panel flutter using thin metal plates were conducted at a Mach number of 1.3 to verify its existence and to study the effects of some structural parameters on the flutter characteristics. The effects of tensile forces and buckling were studied on panels clamped front and rear, in addition to initially buckled panels clamped on all four edges. Panel flutter was obtained under these laboratory conditions and it was found that tensile forces, shortening the panels, and increasing the bending stiffness were effective means for eliminating flutter. Buckled panels were more susceptible to flutter than unbuckled panels. No apparent systematic trends in the flutter modes or frequencies could be observed.

NACA RM L53F17

METHOD OF ESTIMATING THE INCOMPRESSIBLE-FLOW PRESSURE DISTRIBUTION OF COMPRESSOR BLADE SECTIONS AT DESIGN ANGLE OF ATTACK. John R. Erwin and Laura A. Yacobi. December 1953. 41p. diagrs., tab. (NACA RM L53F17)
(Declassified from Confidential, 9/15/55)

A method was devised for estimating the incompressible flow pressure distribution over compressor blade sections at design angle of attack. The theoretical incremental velocities due to camber and thickness of the section as an isolated airfoil are assumed proportional to the average passage velocity and are modified by empirically determined interference factors. Comparisons were made between estimated and test pressure distributions of NACA 65-series sections for typical conditions. Good agreement was obtained.

NACA RM L53I11

FREE-FLIGHT-TUNNEL INVESTIGATION OF THE LOW-SPEED STABILITY AND CONTROL CHARACTERISTICS OF A CANARD AIRPLANE MODEL. Joseph L. Johnson, Jr., and John W. Paulson. October 1953. 37p. diagrs., photo., 2 tabs. (NACA RM L53I11) **(Declassified from Confidential, 9/15/55)**

Results are presented of an experimental investigation in the Langley free-flight tunnel to determine the dynamic lateral stability and control characteristics of a model of a canard-type airplane. Tests were made with several vertical-tail configurations for the model with a triangular horizontal tail and with a sweptback horizontal tail having a leading-edge flap.

NACA RM L53I25a

FLIGHT DETERMINATION OF DRAG OF NORMAL-SHOCK NOSE INLETS WITH VARIOUS COWLING PROFILES AT MACH NUMBERS FROM 0.9 TO 1.5. R. I. Sears, C. F. Merlet, and L. W. Putland. October 1953. 36p. diagrs., photos., tabs. (NACA RM L53I25a) **(Declassified from Confidential, 9/15/55)**

External-drag data are presented for normal-shock nose inlets with 1-series, parabolic, and conic cowling profiles. The tests were made at an angle of attack of 0° by using rocket-propelled models in free flight at Mach numbers from 0.9 to 1.5. The Reynolds number based on body maximum diameter varied from 2.5×10^6 to 5.5×10^6. At maximum flow rate, the inlet models had about the same external drag at a Mach number of approximately 1.1, but at higher Mach numbers the sharp-lip conic cowl had the least drag. Blunting or beveling the lip of the conic cowl while keeping the fineness ratio constant resulted in drag coefficients slightly higher than for the sharp-lip conic cowl at maximum flow rate. At a mass-flow ratio of about 0.8, the conic cowls with sharp, blunt, or beveled lips and the parabolic cowl all gave about the same drag.

NACA RM L53I29b

INVESTIGATION AT SUPERSONIC SPEEDS OF THE VARIATION WITH REYNOLDS NUMBER AND MACH NUMBER OF THE TOTAL, BASE, AND SKIN-FRICTION DRAG OF SEVEN BOATTAIL BODIES OF REVOLUTION DESIGNED FOR MINIMUM WAVE DRAG. August F. Bromm, Jr., and Julia M. Goodwin. December 1953. 20p. diagrs., photo. (NACA RM L53I29b) **(Declassified from Confidential, 9/15/55)**

Results are presented from an investigation of the variation with Reynolds number and Mach number of the total, base, and skin-friction drag of seven boattail bodies of revolution designed for minimum wave drag according to the theory of NACA TN 2550. The tests covered a Reynolds number range from approximately 1.0×10^6 to 10.0×10^6 at Mach numbers of 1.62, 1.93, and 2.41, respectively.

NACA RM L53I30b

TWO-DIMENSIONAL LOW-SPEED CASCADE INVESTIGATION OF NACA COMPRESSOR BLADE SECTIONS HAVING A SYSTEMATIC VARIATION IN MEAN-LINE LOADING. John R. Erwin, Melvyn Savage, and James C. Emery. November 1953. 129p. diagrs., tabs. (NACA RM L53I30b) **(Declassified from Confidential, 9/15/55)**

The low-speed cascade performance of the high-speed NACA 65-$\left(C_{l_o} A_2 I_{8b}\right)$10 compressor blade sections has been systematically investigated. When used in conjunction with published cascade data, the results will provide design information for all inlet angle and solidity conditions within the usual range of application. Summary curves have been prepared to facilitate the selection of blade sections and settings to fulfill the conditions dictated by compressor design velocity diagrams. Comparative tests of blade sections having widely different loading distributions indicated that these data, in conjunction with previously published cascade data, permit a fairly accurate prediction of design performance for most compressor blade sections since the mean lines tested probably encompass the practical range of compressor-blade mean-line loading distributions. A comparative evaluation of the high-speed performance capabilities of the blade sections investigated was made.

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Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1175

EFFECT OF VARIABLE VISCOSITY AND THERMAL CONDUCTIVITY ON HIGH-SPEED SLIP FLOW BETWEEN CONCENTRIC CYLINDERS. T. C. Lin and R. E. Street, University of Washington. 1954. ii, 36p. diagrs. (NACA Rept. 1175. Formerly TN 2895)

The differential equations of slip flow, including the Burnett terms, were first solved by Schamberg assuming that the coefficients of viscosity and heat conduction of the gas were constants. The problem is solved herein for variable coefficients of viscosity and thermal conductivity by applying a transformation leading to an iteration method. The method, starting with the solution for constant coefficients, enables one to approximate the solution for variable coefficients very closely after one or two steps. Satisfactory results are shown to follow from Schamberg's solution by using his values of the constant coefficients multiplied by a constant factor η, leading to what are denoted as the effective coefficients of viscosity and thermal conductivity.

NACA Rept. 1189

THEORETICAL AND EXPERIMENTAL ANALYSIS OF LOW-DRAG SUPERSONIC INLETS HAVING A CIRCULAR CROSS SECTION AND A CENTRAL BODY AT MACH NUMBERS OF 3.30, 2.75, AND 2.45. Antonio Ferri and Louis M. Nucci. 1954. ii, 37p. diagrs., photos. (NACA Rept. 1189. Supersedes RM L8H13)

Contains theoretical and experimental analysis of circular inlets having a central body at Mach numbers of 3.30, 2.75, and 2.45. The inlets have been designed in order to have low drag and high pressure recovery. The pressure recoveries obtained are of the same order of magnitude as those previously obtained by inlets having very large external drag.

NACA Rept. 1198

A THEORETICAL STUDY OF THE EFFECT OF FORWARD SPEED ON THE FREE-SPACE SOUND-PRESSURE FIELD AROUND PROPELLERS. I. E. Garrick and Charles E. Watkins. 1954. ii, 16p. diagrs., tab. (NACA Rept. 1198. Supersedes TN 3018)

The sound-pressure field due to thrust and torque of a propeller in flight at uniform subsonic speed is analyzed by use of a distribution of acoustic doublets located at the propeller disk. The basic element used to synthesize the field is the pressure field of a concentrated force moving uniformly at subsonic speeds, for which an expression generalizing one of Lamb's for the fixed concentrated force is given. The results can be regarded as an extension of the work for the static propeller given by Gutin (NACA TM 1195) for the far pressure field and given by Hubbard and Regier (NACA Rep. 996) for the field near the tips of the rotating propeller. The extended formulas are used to calculate the sound field for a specific two-blade propeller operating at constant torque for various forward-speed Mach numbers.

NACA Rept. 1209

DEVELOPMENT OF TURBULENCE-MEASURING EQUIPMENT. Leslie S. G. Kovásznay, John Hopkins University. 1954. ii, 30p. diagrs., photos., tab. (NACA Rept. 1209. Supersedes TN 2839)

Hot-wire turbulence-measuring equipment has been developed to meet the more-stringent requirements involved in the measurement of fluctuations in flow parameters at supersonic velocities. The higher mean speed necessitates the resolution of higher frequency components than at low speed, and the relatively low turbulence level present at supersonic speed makes necessary an improved noise level for the equipment. The equipment covers the frequency range from 2 to 70,000 cycles per second. The equipment is adaptable to all-purpose turbulence work with improved utility and accuracy over that of older types of equipment. Sample measurements are given to demonstrate the performance.

NACA RM E55I16

SPARK IGNITION OF FLOWING GASES. V - APPLICATION OF FUEL-AIR-RATIO AND INITIAL-TEMPERATURE DATA TO IGNITION THEORY. Clyde C. Swett, Jr. November 1955. 19p. diagrs. (NACA RM E55I16)

Data showing the effect of fuel-air ratio and initial temperature on spark-ignition energy are presented and applied to a previously developed theory of ignition. The initial-temperature data are consistent with the theory; fuel-air-ratio data are only partially consistent. Probable reasons for the discrepancy are discussed.

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NACA TM 1388

GENERAL SOLUTIONS OF OPTIMUM PROBLEMS IN NONSTATIONARY FLIGHT. (Soluzioni Generali di Problemi di Ottimo in Volo Non-Stazionario). Angelo Miele. October 1955. 25p. diagrs., tab. (NACA TM 1388. Trans. from L'Aerotecnica, v.32, no.3, 1952, p.135-142)

A general method concerning optimum problems in nonstationary flight is developed and discussed. Various conditions of flight in a vertical plane (climb with minimum time, climb with minimum fuel consumption, steepest climb, descending and gliding flight with maximum time of space) are studied; the corresponding best techniques of flight, that is, the optimum speed-height relationships, are determined.

NACA TN 3415

A UNIVERSAL COLUMN FORMULA FOR LOAD AT WHICH YIELDING STARTS. L. H. Donnell and V. C. Tsien, Illinois Institute of Technology. October 1955. 48p. diagrs., photos., tab. (NACA TN 3415)

An analysis is presented of the load at which yielding first occurs in actual columns, taking adequately into account all the factors which have an important effect upon this load. The results are expressed as a formula or chart applicable to all cases.

NACA TN 3476

CALCULATED SPANWISE LIFT DISTRIBUTIONS AND AERODYNAMIC INFLUENCE COEFFICIENTS FOR SWEPT WINGS IN SUBSONIC FLOW. Franklin W. Diederich and Martin Zlotnick. October 1955. 173p. diagrs., tabs. (NACA TN 3476)

Spanwise lift distributions have been calculated for 61 swept wings with various aspect ratios and taper ratios and with a variety of angle-of-attack or twist distributions, including flap and aileron deflections, by means of the Weissinger method with eight control points on the semispan. Also calculated were aerodynamic influence coefficients which pertain to a certain definite set of stations along the span.

NACA TN 3494

SOUND PROPAGATION INTO THE SHADOW ZONE IN A TEMPERATURE-STRATIFIED ATMOSPHERE ABOVE A PLANE BOUNDARY. David C. Pridmore-Brown and Uno Ingard, Massachusetts Institute of Technology. October 1955. 57p. diagrs., photo. (NACA TN 3494)

A theoretical and experimental study of the sound field about a point source over a plane boundary in the presence of a vertical temperature gradient has been made. Methods are presented for analyzing the effects of temperature gradients on the attenuation of sound in the shadow zone of a sound field.

NACA TN 3495

FAILURE OF MATERIALS UNDER COMBINED REPEATED STRESSES WITH SUPERIMPOSED STATIC STRESSES. George Sines, University of California at Los Angeles. November 1955. 69p. diagrs., photos., tabs. (NACA TN 3495)

Experiments on biaxial alternating stresses and simple combinations of static stress with alternating stress are reviewed. A general criterion for the effect of static stress on the permissible amplitude of alternating stress is proposed and compared with results of tests performed under more complex stress states. Tests were performed to determine the effect of static compression on alternating torsion and the results are compared with the general criterion. A modification of Orowan's theory of fatigue to include the effect of static stress is presented.

NACA TN 3531

PILOT'S LOSS OF ORIENTATION IN INVERTED SPINS. Stanley H. Scher. October 1955. 10p. diagrs., photos. (NACA TN 3531)

The rising problem of pilot orientation during spins, especially during unintentional inverted spins, is discussed. The free-spinning-tunnel results and reported airplane experiences concerning inverted spins and recoveries are reviewed. Information is provided regarding the nature of inverted spins, optimum control technique for recovery, and some of the factors which apparently contribute to the pilot's loss of orientation. A spin-simulator rig which was recently constructed at the Langley Laboratory for use in an attempt to understand better the problems confronting the pilot of a spinning airplane is described.

NACA TN 3537

HELICOPTER INSTRUMENT FLIGHT AND PRECISION MANEUVERS AS AFFECTED BY CHANGES IN DAMPING IN ROLL, PITCH, AND YAW. James B. Whitten, John P. Reeder, and Almer D. Crim. November 1955. 14p. diagrs., photos. (NACA TN 3537)

The damping in roll, pitch, and yaw of a single-rotor helicopter was varied by means of electronic components, and these variations were evaluated by performing instrument approaches and other precision maneuvers. Increased damping in roll was found to be particularly beneficial, whereas corresponding changes in yaw and pitch were less effective. Some operational aspects of helicopter instrument approaches are also included in the discussion.

NACA TN 3539

SOME EFFECTS OF SYSTEM NONLINEARITIES IN THE PROBLEM OF AIRCRAFT FLUTTER. Donald S. Woolston, Harry L. Runyan, and Thomas A. Byrdsong. October 1955. 20p. diagrs., tabs. (NACA TN 3539)

This paper presents the results of a preliminary investigation of the effect of nonlinear structural terms on the flutter of a two-degree-of-freedom system. The three types of nonlinearities investigated were a flat spot, hysteresis, and a cubic spring. Calculations were made on an analog computer. For one case, the flat spot, an experimental investigation was also made and good correlation with theory was found.

NACA TN 3542

ANALYSIS OF STRESSES IN THE PLASTIC RANGE AROUND A CIRCULAR HOLE IN A PLATE SUBJECTED TO UNIAXIAL TENSION. Bernard Budiansky and Robert J. Vidensek. October 1955. 39p. diagrs., tabs. (NACA TN 3542)

An approximate theoretical solution is presented for the stresses in the plastic range around a circular hole in an infinite sheet subjected to uniaxial tension. The solution is based on the simple deformation theory of plasticity and is found by application of a variational principle in conjunction with the Rayleigh-Ritz procedure and the use of a high-speed computing machine (SEAC). Numerical results are obtained for four different materials, which are characterized by four distinct uniaxial stress-strain curves. The results for stress concentration factor in the plastic range are compared with those obtained from a formula due to Stowell.

NACA TN 3544

COMPARISON BETWEEN THEORETICAL AND EXPERIMENTAL STRESSES IN CIRCULAR SEMIMONOCOQUE CYLINDERS WITH RECTANGULAR CUTOUTS. Harvey G. McComb, Jr., and Emmet F. Low, Jr. October 1955. 20p. diagrs. (NACA TN 3544)

Comparisons are made between a theory for calculating stresses about rectangular cutouts in circular cylinders of semimonocoque construction published in NACA TN 3200 and previously published NACA experimental data. The comparisons include stresses in the stringers and shear stresses in the center of the shear panels in the neighborhood of the cutout. The theory takes into account the bending flexibility of the rings in the structure, and this factor is found to be important in the calculation of stresses about cutouts. In general, when the ring flexibility is considered, good agreement is exhibited between the calculated and experimental results.

NACA TN 3550

MEASUREMENTS OF THE EFFECT OF TRAILING-EDGE THICKNESS ON THE ZERO-LIFT DRAG OF THIN LOW-ASPECT-RATIO WINGS. John D. Morrow. November 1955. 11p. diagrs., photo. (NACA TN 3550. Supersedes RM L50F26)

Results of an exploratory free-flight investigation at zero lift of several rocket-powered drag-research models having 4-percent-thick wings of taper ratio 0.423 are presented for a Mach number range of 0.7 to 1.6. Four wings having trailing edges of different thicknesses were tested. The drag of all the models was measured and is compared with calculated values.

NACA TN 3557

A THEORETICAL ANALYSIS OF THE FIELD OF A RANDOM NOISE SOURCE ABOVE AN INFINITE PLANE. Peter A. Franken, Massachusetts Institute of Technology. November 1955. 20p. diagrs. (NACA TN 3557)

The sound field about a random noise source above a plane as measured by a receiver with finite band width is studied theoretically. For simplicity, only the far field is considered. The special case of a perfectly reflecting plane is discussed first and the analysis is then extended to include the case of a plane of arbitrary impedance.

NACA TN 3567

STUDY OF SCREECHING COMBUSTION IN A 6-INCH SIMULATED AFTERBURNER. Perry L. Blackshear, Warren D. Rayle, and Leonard K. Tower. October 1955. 58p. diagrs., photos., tab. (NACA TN 3567)

The mode of oscillation in a screeching 6-inch-diameter simulated afterburner is identified through axial, circumferential, and diametric surveys of sound amplitude and phase. This mode is found to be the first transverse (sloshing) mode in the hot gases downstream of the flame-holder. The development of a microphone probe suitable for use in screeching combustors is described. This development includes a theoretical and experimental treatment of the attenuation of high-amplitude sound in tubes.

NACA TN 3572

AMPLITUDE OF SUPERSONIC DIFFUSER FLOW PULSATIONS. William H. Sterbentz and Joseph Davids. October 1955. 23p. diagrs. (NACA TN 3572. Supersedes RM E52I24)

A theoretical method for evaluating the stability characteristics and the amplitude and frequency of pulsation of ram-jet engines without heat addition is presented. Theory and experiment show that the pulsation amplitude of a high-mass-flow-ratio diffuser increases with decreasing mass flow. The theoretical trends for changes in amplitude, frequency, and mean pressure recovery with changes in plenum-chamber volume were experimentally confirmed. For perforated, convergent-divergent-type diffusers, theory and experiment show the existence of a stability hysteresis loop on the pressure-recovery, mass-flow-ratio curve.

NACA TN 3573

EFFECT OF EXHAUST-NOZZLE EJECTORS ON TURBOJET NOISE GENERATION. Warren J. North and Willard D. Coles. October 1955. 26p. diagrs., photo. (NACA TN 3573)

Engine noise levels and jet velocity profiles have been obtained with several turbojet exhaust-nozzle ejectors. An insignificant reduction in total sound power was realized. At subsonic nozzle pressure ratios, total sound power from exhaust-nozzle ejectors or bypass exit configurations can be calculated from primary-jet parameters only.

NACA TN 3575

BURNING VELOCITIES OF VARIOUS PREMIXED TURBULENT PROPANE FLAMES ON OPEN BURNERS. Paul Wagner. October 1955. 32p. diagrs., photos., tab. (NACA TN 3575)

Turbulent burning velocities were measured as a function of Reynolds number for open propane flames. Flames of propane and oxygen diluted with nitrogen, argon, or helium were studied in a variety of burners up to a maximum pipe Reynolds number of 26,000. The ratio of turbulent to laminar burning velocity correlates with the cold-flow Reynolds number for systems of a given diluent. This ratio also correlates with a Reynolds number calculated from values of the turbulent intensity measured at the burner exit.

BRITISH REPORTS

N-40036*

Royal Aircraft Establishment (Gt. Brit.)
LOW SPEED WIND TUNNEL CALIBRATION OF A Mk. 9A PITOT-STATIC HEAD. J. E. Nethaway. March 1955. 8p. diagrs., tab. (RAE Tech. Note Aero 2364)

This note describes the calibration of a Mark 9A pitot-static head in the No. 2 11-1/2 foot wind tunnel. The results show the variation of pitot and static-pressure error coefficients with incidence, at constant tunnel speed.

N-40039*

Royal Aircraft Establishment (Gt. Brit.)
THE DETERMINATION OF THE RELATIVE REACTIVITIES OF BIFUNCTIONAL MONOMERS. PART I - THE NATURE OF THE PROBLEM. G. M. Bristow. July 1955. 6p. tab. (RAE Tech. Note Chem. 1256)

An account is given of the use of bifunctional monomers in the production of cross-linked polymers, and of some methods by which the relative reactivities of the two unsaturated groups can be determined.

N-40042*

Royal Aircraft Establishment (Gt. Brit.)
A LOW-PRESSURE MICRO-ANALYTICAL METHOD FOR DETERMINING OXYGEN, HYDROGEN AND NITROGEN IN METALS. H. C. Davis and J. A. Gray. March 1955. 14p. diagrs., tabs. (RAE Met. 86)

A low-pressure microanalytical method for the determination of oxygen, hydrogen, and nitrogen in metals is described. Gases evolved by vacuum-fusion are analyzed physically. The results obtained for oxygen and hydrogen are closely reproducible, but those for nitrogen are less so.

N-40044*

Royal Aircraft Establishment (Gt. Brit.)
THE THEORETICAL WAVE DRAG OF OPEN NOSE AXISYMMETRICAL FOREBODIES WITH VARYING FINENESS RATIO, AREA RATIO AND NOSE ANGLE. J. H. Willis and D. G. Randall. February 1955. 33p. diagrs., tab. (RAE Tech. Note Aero 2360)

Existing results for the wave drag of open-nose axisymmetrical forebodies are for bodies whose profiles are straight lines or parabolic arcs. These results are here extended to a family of profiles which includes the straight line and the parabolic arc as special cases. Slender body theory is employed throughout.

UNPUBLISHED PAPERS

N-40045*

Royal Aircraft Establishment (Gt. Brit.)
TESTS ON HEAT AND CORROSION RESISTING COATINGS FOR MAGNESIUM ALLOYS. J. Mackay and H. G. Cole. June 1955. 9p. tabs. (RAE Tech. Note Chem. 1254)

In tests on painted magnesium alloy specimens heated to 200° C at three-monthly intervals during an intermittent seawater spray test, the best combinations of protective efficiency with hardness and flexibility were given by an epoxy base scheme and by a standard stoving scheme to D. T. D. 235. Other epoxy schemes gave good protection but were relatively inflexible. A standard air-drying scheme to D. T. D. 260A gave very good protection. Butyl titanate paints and a silicone paint gave poor protection. A zinc chrome sealed anodic treatment gave better results as a protective pretreatment than chromate bath iii of D. T. D. 911A. Butyl titanate paints broke down on pure aluminum exposed to the same test.

N-26685*

EXPERIMENTAL DETERMINATION OF THE EFFECTIVE WIDTH OF FLAT PLATES IN THE ELASTIC AND PLASTIC RANGE. (De experimentele bepaling van de meedragende breedte van vlakke platen in het elastische en het plastische gebied). J. F. Besseling. September 1955. 100p. diagrs., photos., tab. (Trans. from Nationaal Luchtvaartlaboratorium, Amsterdam, S. 414, February 1953)

Influence of boundary conditions and transverse stiffeners on the effective width of a plate are discussed. The testing apparatus, measuring equipment, and test program are reviewed and test results are presented for aluminum alloy 24ST.

N-39572*

HEAT-RESISTANT SINTER MATERIALS. (Hochwarmfeste Sinterwerkstoffe). F. Benesovsky. (1955). 6p. diagrs., photo., tab. (Trans. from Werkstoffe und Korrosion, Jour., no. 8/9, Aug. - Sept. 1954, p. 288-290)

Ceramal materials, produced by powder metallurgy from a titanium carbide base, are suggested for use in turbine and rocket drives. Other ceramal materials suggested for high temperature use are alloys with boride, silicide, and oxide bases. Titanium boride and zirconium boride show high melting points, are generally brittle, and have poor thermal shock properties. It is believed that metal additions may improve these properties.

MISCELLANEOUS

NACA Rept. 1135

Errata No. 2 on "EQUATIONS, TABLES, AND CHARTS FOR COMPRESSIBLE FLOW." Ames Research Staff. 1953.

NACA Rept. 1175

Errata on "EFFECT OF VARIABLE VISCOSITY AND THERMAL CONDUCTIVITY ON HIGH-SPEED SLIP FLOW BETWEEN CONCENTRIC CYLINDERS." T. C. Lin and R. E. Street. 1954.

NACA TN 3454

Errata on "EFFECT OF A DISCONTINUITY ON TURBULENT BOUNDARY-LAYER-THICKNESS PARAMETERS WITH APPLICATION TO SHOCK-INDUCED SEPARATION." Eli Reshotko and Maurice Tucker. May 1955.

NACA TN 3483

Errata on "AN ANALYSIS OF ACCELERATION, AIRSPEED, AND GUST-VELOCITY DATA FROM A FOUR-ENGINE TRANSPORT AIRPLANE IN OPERATIONS ON AN EASTERN UNITED STATES ROUTE." Thomas L. Coleman and Mary W. Fetner. September 1955.

NACA TN 3514

Errata on "RESPONSE OF HOMOGENEOUS AND TWO-MATERIAL LAMINATED CYLINDERS TO SINUSOIDAL ENVIRONMENTAL TEMPERATURE CHANGE, WITH APPLICATIONS TO HOT-WIRE ANEMOMETRY AND THERMOCOUPLE PYROMETRY." Herman H. Lowell and Norman Patton. September 1955.

N-37765*

SOME ELEVATED TEMPERATURE STRUCTURAL PROBLEMS OF HIGH-SPEED AIRCRAFT. Richard R. Heldenfels. (Presented to SAE Golden Anniversary National Aeronautic Meeting, Los Angeles, California, October 11-15, 1955) 29p. diagrs.

This paper contains a discussion of the problems of structural design, such as creep, thermal buckling, thermal stresses, and stiffness reduction, as related to the aerodynamic heating of high-speed aircraft.

DECLASSIFIED NACA REPORTS

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THE FOLLOWING REPORTS HAVE BEEN DECLASSIFIED FROM CONFIDENTIAL, 10/14/55

NACA RM A7J02

THE HIGH-SPEED AERODYNAMIC EFFECTS OF MODIFICATIONS TO THE WING AND WING-FUSELAGE INTERSECTION OF AN AIRPLANE MODEL WITH THE WING SWEPT BACK 35°. Lee E. Boddy and Charles P. Morrill, Jr. February 18, 1948. 34p. diagrs., photos. (NACA RM A7J02)

Wind-tunnel tests at high subsonic Mach numbers were conducted on an airplane model having sweptback wings. Attempts were made to reduce the interference at the plane of symmetry of the sweptback wing and thus increase its divergence Mach number. Also, tests were made with the wing trailing-edge angle decreased, in an effort to eliminate the reversal of aileron hinge moment and wing pitching moment suffered by the true-contour wing at high Mach numbers.

NACA RM A7J03

THE AERODYNAMIC EFFECTS OF ROCKETS AND FUEL TANKS MOUNTED UNDER THE SWEPTBACK WING OF AN AIRPLANE MODEL. Lee E. Boddy and Charles P. Morrill, Jr. April 23, 1948. 19p. diagrs. (NACA RM A7J03)

The effects of externally mounted rockets and fuel tanks on the aerodynamic characteristics of an airplane model with sweptback wings are presented in this report. Wind-tunnel tests were made at high subsonic Mach numbers to determine the effect of the external equipment on the drag, the longitudinal stability and control, and the lateral control of the model.

NACA RM A50J26

EXPERIMENTAL DAMPING IN PITCH OF 45° TRIANGULAR WINGS. Murray Tobak, David E. Reese, Jr., and Benjamin H. Beam. December 1, 1950. 63p. diagrs., photo. (NACA RM A50J26)

Results are presented of a wind-tunnel investigation of the variation of the damping-in-pitch parameter $C_{m_q} + C_{m_{\dot{\alpha}}}$ with Mach number and axis of rotation position for two triangular wings having leading edges swept back 45°, with and without a body. Tests were conducted at subsonic speeds over a Mach number range of 0.23 to 0.94 and at supersonic speeds from 1.15 to 1.70. The measured damping coefficients are compared with theoretical results at both subsonic and supersonic speeds.

✓ NACA RM A53J02

PRELIMINARY RESULTS OF AN INVESTIGATION OF THE EFFECTS OF SPINNER SHAPE ON THE CHARACTERISTICS OF AN NACA D-TYPE COWL BEHIND A THREE-BLADE PROPELLER, INCLUDING THE CHARACTERISTICS OF THE PROPELLER AT NEGATIVE THRUST. Robert M. Reynolds. November 1953. 15p. diagrs., photo., tab. (NACA RM A53J02)

Preliminary results of measurements of the ram-recovery ratio at the inlet of an NACA D-type cowl behind an operating propeller in combination with a 1-series and a modified-conical spinner, maximum efficiency of the propeller with the 1-series spinner and the spinner-cowling combinations, and the negative thrust characteristics of the propeller at low speeds are summarized. Tests were conducted at Mach numbers from 0.2 to 0.8, for propeller blade angles from 33° to 63°, and for various inlet-velocity and advance ratios. Negative-thrust characteristics of the propeller were measured at a Mach number of 0.15 for blade angles from 25° to -20°. All tests were made with the model at an angle of attack of 0° and at a Reynolds number of 1.0 million per foot.

NACA RM A53J07

THE EFFECTS OF HORIZONTAL-TAIL HEIGHT AND A PARTIAL-SPAN LEADING-EDGE EXTENSION ON THE STATIC LONGITUDINAL STABILITY OF A WING-FUSELAGE-TAIL COMBINATION HAVING A SWEPTBACK WING. Angelo Bandettini and Ralph Selan. March 1954. 54p. diagrs., photos., 2 tabs. (NACA RM A53J07)

Test results are presented to show the effects of horizontal-tail height (22- and 8-percent semispan above wing chord plane extended) on the static longitudinal stability of a model having a wing with 35° sweepback, an aspect ratio 4.5, and a taper ratio 0.5. The model was also modified by a wing-leading-edge chord extension and tested with the tail in the low position. Tests were conducted at various Mach numbers up to 0.92 at a Reynolds number of 2,000,000 and at a Mach number of 0.20 at a Reynolds number of 11,000,000. The results of airstream surveys in the region of the tail are also presented.

NACA RM E50J24

DYNAMIC INVESTIGATION OF TURBINE-PROPELLER ENGINE UNDER ALTITUDE CONDITIONS. Richard P. Krebs, Seymour C. Himmel, Darnold Blivas, and Harold Shames. December 6, 1950. 55p diagrs., photo. (NACA RM E50J24)

An altitude-wind-tunnel investigation of the dynamics of a turbine-propeller engine employing the frequency-response technique was conducted over a range of pressure altitudes from 10,000 to 30,000 feet. The dynamic responses generalized for pressure altitudes over the range of frequencies investigated. The generalized time constants were found to be approximately 1.0 second for the engine-propeller combination, 0.36 second for the propeller alone, and 2.4 seconds for the engine alone. These values were in good agreement with those predicted from steady-state-performance data.

NACA RM E51J11

IGNITION-DELAY CHARACTERISTICS IN MODIFIED OPEN-CUP APPARATUS OF SEVERAL FUELS WITH NITRIC ACID OXIDANTS WITHIN TEMPERATURE RANGE 70° TO -105° F. Riley O. Miller. December 1951. 30p. diagrs., 4 tabs. (NACA RM E51J11)

Fluid properties and low-temperature ignition delays were obtained for approximately 90 fuel-oxidant combinations. A red fuming nitric acid containing approximately 3 percent water and 19 percent nitrogen tetroxide froze at approximately -87° F and ignited several low-viscosity fuel blends of aromatic amines in triethylamine at -76° F and lower. With this acid, the following average ignition delays were obtained with a blend of 30 percent o-toluidine in triethylamine:

Temperature, °F	70	-40	-76	-87	-105
Delay, milliseconds	19	24	38	61	210

NACA RM E52J27

PRELIMINARY INVESTIGATION OF A PERFORATED AXIALLY SYMMETRIC NOZZLE FOR VARYING NOZZLE PRESSURE RATIOS. Eli Reshotko. January 1953. 43p. diagrs., photo., 2 tabs. (NACA RM E52J27)

The performance characteristics of a perforated axially symmetric convergent-divergent nozzle were investigated in an attempt to achieve improved convergent-divergent nozzle thrust performance at below design pressure ratios. The purpose of the perforations was to allow inflow of air into the overexpanded portion of the nozzle, thus advancing separation of the flow. The flow through the perforations was found to advance separation only when the perforations were liberally placed over the entire divergent portion of the nozzle. A local concentration of perforations caused separation only in the local region of perforation. The use of low energy atmospheric bleed air reduced thrust losses by as much as 50 percent at appreciably overexpanded operation. For underexpanded flow, air flowing out through the perforations caused significant thrust loss. With shrouding to prevent this outbleed, thrusts 5 to 10 percent less than those of the unperforated nozzle were obtained. The use of high energy bleed was unsatisfactory since the inlet momentum penalty of the bleed air was in many cases greater than the additional thrust obtained.

NACA RM L8I29

PRELIMINARY RESULTS OF NACA TRANSONIC FLIGHTS OF THE XS-1 AIRPLANE WITH 10-PERCENT-THICK WING AND 8-PERCENT-THICK HORIZONTAL TAIL. Hubert M. Drake, Harold R. Goodman, and Herbert H. Hoover. October 13, 1948. 18p. diagrs., photos. (NACA RM L8I29)

Contains results of exploratory flights at altitudes of about 40,000 feet to a maximum Mach number of 1.06. Data are presented showing the longitudinal trim changes, elevator effectiveness in producing acceleration, and rudder effectiveness as a function of Mach number. Data on lateral oscillations are also presented.

NACA RM L8J12

HIGH-SPEED WIND-TUNNEL INVESTIGATION OF A SWEPTBACK WING WITH AN ADDED TRIANGULAR AREA AT THE CENTER. Beverly Z. Henry, Jr. January 14, 1949. 24p. diagrs., tabs. (NACA RM L8J12)

Results are presented of an investigation in the Langley 8-foot high-speed tunnel of two sweptback wings of different plan form. The purpose of the investigation was to determine the effects of the addition of a triangular area to the inboard section of a conventional sweptback wing in order to produce a wing employing two stages of sweepback. Lift, drag, and pitching-moment characteristics are presented to illustrate these effects for a Mach number range of 0.40 through 0.935.

NACA RM L8K23

FREE-FLIGHT INVESTIGATION AT TRANSONIC AND SUPERSONIC SPEEDS OF THE ROLLING EFFECTIVENESS OF SEVERAL AILERON CONFIGURATIONS ON A TAPERED WING HAVING 42.7° SWEEPBACK. Carl A. Sandahl. January 11, 1949. 23p. diagrs., photos., tab. (NACA RM L8K23)

An investigation was made of several aileron modifications in conjunction with a tapered, sweptback wing having circular-arc airfoil sections of relatively large thickness ratio. The modified ailerons eliminated the reversal of rolling effectiveness at transonic speeds obtained with the true-contour ailerons at small deflections.

NACA RM L9F07

PRELIMINARY THEORETICAL AND FLIGHT INVESTIGATION OF THE LATERAL OSCILLATION OF THE X-1 AIRPLANE. Hubert M. Drake and Helen L. Wall. July 19, 1949. 24p. diagrs., photo., tab. (NACA RM L9F07)

A small-amplitude, undamped, lateral oscillation has been encountered in flight tests of the X-1 airplane. The oscillation occurs in subsonic and supersonic flight, in maneuvers, and power on and off. The calculations indicate that a change, in the positive direction, of the inclination of the principal axis with respect to the flight path should have a considerable stabilizing effect.

NACA RM L9G19a

MEASUREMENTS OF AILERON EFFECTIVENESS OF THE BELL X-1 AIRPLANE AT MACH NUMBERS BETWEEN 0.9 AND 1.06. Hubert M. Drake. August 4, 1949. 5p. diagrs. (NACA RM L9G19a)

Presents results of flight measurements of aileron effectiveness of the X-1 airplane up to a Mach number of 0.94. The data indicate a 75 percent loss of aileron effectiveness between $M = 0.82$ and $M = 0.94$.

NACA RM L50G20

ELEVATOR-STABILIZER EFFECTIVENESS AND TRIM OF THE X-1 AIRPLANE TO A MACH NUMBER OF 1.06. Hubert M. Drake and John R. Carden. November 1, 1950. 12p. diagrs. (NACA RM L50G20)

The relative elevator-stabilizer effectiveness of the X-1 has been determined to decrease from a value of 0.25 at a Mach number of 0.78 to a value of 0.05 at a Mach number of 1.0. At supersonic speeds the effectiveness increases. The variation between the trim curves at various stabilizer settings is caused by the variation in effectiveness and the fact that the effectiveness is nonlinear at Mach numbers between 0.94 and 0.97. It was found that, with the elevator fixed at zero, only about 0.5° of stabilizer movement would be required to trim through the Mach number range from 0.78 to 1.02.

NACA RM L50J25

A TRANSONIC-WING INVESTIGATION IN THE LANGLEY 8-FOOT HIGH-SPEED TUNNEL AT HIGH SUBSONIC MACH NUMBERS AND AT A MACH NUMBER OF 1.2. WING-FUSELAGE CONFIGURATION HAVING A WING OF 60° SWEEPBACK, ASPECT RATIO 4, TAPER RATIO 0.6, AND NACA 65A006 AIRFOIL SECTION. Raymond B. Wood and Frank F. Fleming. January 24, 1951. 43p. diagrs., photo. (NACA RM L50J25)

An investigation was conducted in the Langley 8-foot high-speed tunnel of the aerodynamic characteristics of a wing swept back 60° at the quarter chord, with aspect ratio 4, taper ratio 0.6, and an NACA 65A006 airfoil section. The tests were conducted through a Mach number range from 0.6 to 0.96 and at a Mach number of 1.2. Data are presented for a wing fuselage and for a wing with wing-fuselage interference. Wake-survey-study results and the measurements of the angle of downwash for a probable tail location, approximately 38 percent of the wing semispan above the wing-chord plane, are included.

NACA RM L51D17

AN INVESTIGATION OF FOUR WINGS OF SQUARE PLAN FORM AT A MACH NUMBER OF 6.86 IN THE LANGLEY 11-INCH HYPERSONIC TUNNEL. Charles H. McLellan, Mitchel H. Bertram, and John A. Moore. June 1951. 47p. diagrs., photos. (NACA RM L51D17)

The results of tests of four wings at a Mach number of 6.86 in the Langley 11-inch hypersonic tunnel are presented. The wings tested had 4-inch square plan forms with 5-percent-thick diamond, half-diamond, wedge, and half-circular-arc sections. The boundary layer has been found to have a large effect on the wing pressure distributions. Reasonable agreement was indicated between the aerodynamic coefficients from experimental pressure data and inviscid theory. Total drag measurements showed good agreement with the theory at low angles of attack when the effects of surface friction were included. At the higher angles of attack, both lift coefficient and drag coefficient were found to be slightly below the values predicted by the two-dimensional theory.

NACA RM L51J10

INVESTIGATION BY THE TRANSONIC-BUMP METHOD OF A 35° SWEPTBACK SEMISPAN MODEL EQUIPPED WITH A FLAP OPERATED BY A SERIES OF SERVOVANES LOCATED AHEAD OF AND GEARED TO THE FLAP. William H. Phillips and Robert F. Thompson. December 1951. 39p. diagrs., photo. (NACA RM L51J10)

Lift, drag, pitching-moment, rolling-moment, and yawing-moment data in the Mach number range from 0.6 to 1.0 obtained from wind-tunnel tests of a low-aspect-ratio sweptback airfoil model with a servovane control are presented. The control utilizes the drag force and spoiler action of a set of vanes to deflect a flap-type control. Comparison of lift increment and center-of-pressure location is made with previously published data from tests of a conventional flap-type control.

NACA RM L51J30

SUMMARY OF FLUTTER EXPERIENCES AS A GUIDE TO THE PRELIMINARY DESIGN OF LIFTING SURFACES ON MISSILES. Dennis J. Martin. November 1951. 16p. diagrs. (NACA RM L51J30)

This report presents a limited review of some experiences in flight testing of missiles and of wing flutter investigations that may be of interest in missile design. Several types of flutter which may be of concern in missile studies are briefly described. Crude criteria are presented for two of the most common types of flutter to permit a rapid estimate to be made of the probability of the occurrence of flutter. Many of the details of the flutter picture have been omitted, and only the broader elements have been retained so as to give the designer an overall view of the subject.

NACA RM L52D01

A STUDY OF THE FLOW OVER A 45° SWEPTBACK WING-FUSELAGE COMBINATION AT TRANSONIC MACH NUMBERS. Richard T. Whitcomb and Thomas C. Kelly. June 1952. 60p. diagrs., photos. (NACA RM L52D01)

Pressure distributions, tuft patterns, and schlieren surveys have been obtained for a 45° sweptback wing-fuselage combination in the Langley 8-foot transonic tunnel at transonic Mach numbers to 1.11 and angles of attack to 20°. The results provide an indication at transonic Mach numbers of the nature of the formation of shock waves on the wing and fuselage, wing-fuselage interference, and the development of separation and the separation vortex.

NACA RM L52J21a

INVESTIGATIONS AT SUPERSONIC SPEEDS OF THE BASE PRESSURE ON BODIES OF REVOLUTION WITH AND WITHOUT SWEPTBACK STABILIZING FINS. Eugene S. Love and Robert M. O'Donnell. December 1952. 66p. diagrs., photos. (NACA RM L52J21a)

Results are presented from an investigation at Mach numbers of 1.62, 1.93, and 2.41 of the variation with Reynolds number of the base pressure on bodies of revolution at zero lift, with and without sweptback stabilizing fins. Included are the effects of varying nose and base shapes and cutoff length, the effects of the presence of sting supports of varying diameter, and the effects of disturbances entering the wake. The overall Reynolds number range was approximately from 1×10^6 to 10×10^6.

NACA RM L52J23a

INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS OF THE NACA RM-10 MISSILE (WITH FINS) AT A MACH NUMBER OF 1.62 IN THE LANGLEY 9-INCH SUPERSONIC TUNNEL. Donald E. Coletti. December 1952. 21p. diagrs. (NACA RM L52J23a)

An investigation was made of a 0.050-scale model of the RM-10 missile at a Mach number of 1.62 and a Reynolds number of 2.66×10^6. Measurements were made of lift, drag, and pitching moment over an angle-of-attack range of $\pm 5°$. The effects of the ratio of sting-shield diameter to base diameter were also investigated. Comparisons are made with results of tests in other facilities at widely different Reynolds numbers.

NACA RM L52K06

PRESSURE DISTRIBUTION AND PRESSURE DRAG FOR A HEMISPHERICAL NOSE AT MACH NUMBERS 2.05, 2.54, AND 3.04. Leo T. Chauvin. December 1952. 14p. diagrs., photos. (NACA RM L52K06)

An experimental investigation of the pressure distributions on a hemispherical nose 3.98 inches in diameter, mounted on a cylindrical support, has been made at Mach numbers of 2.05, 2.54, and 3.04 and for Reynolds numbers of 4.44×10^6, 4.57×10^6, and 4.16×10^6, respectively. The Reynolds number was based on body diameter and free-stream conditions. Pressure-drag coefficients were calculated and good agreement was obtained between these tests and other investigations.

NACA RM L53E04

AILERON AND ELEVATOR HINGE MOMENTS OF THE BELL X-1 AIRPLANE MEASURED IN TRANSONIC FLIGHT. Hubert M. Drake and John B. McKay. June 1953. 27p. diagrs. (NACA RM L53E04)

Hinge moments have been measured on the aileron and elevator of the Bell X-1 airplane having the 10-percent-thick wing and 8-percent-thick tail. The aileron measurements were made by means of strain gages and pressure distributions while the elevator measurements were made by means of the wheel-force strain gages. The elevator hinge-moment characteristics were determined to a Mach number of 1.18 and the aileron hinge moments to a Mach number of 1.13.

NACA RM L53F08

FLIGHT MEASUREMENTS OF LIFT AND DRAG FOR THE BELL X-1 RESEARCH AIRPLANE HAVING A 10-PERCENT-THICK WING. Edwin J. Saltzman. September 1953. 37p. diagrs., tab. (NACA RM L53F08)

Lift and drag results have been obtained from power-off flight tests of the Bell X-1 (10-percent-thick wing) airplane for Mach numbers 0.68 to 1.01. Comparisons of drag are made with 8-percent-thick-wing flight tests and 10-percent-thick-wing wind-tunnel results.

NACA RM L53I09a

LOW-SPEED WIND-TUNNEL INVESTIGATION OF A JET CONTROL ON A 35° SWEPT WING. John G. Lowry and Thomas R. Turner. October 1953. 9p. diagrs. (NACA RM L53I09a)

A low-speed wind-tunnel investigation was made of a jet control that obtains its effectiveness from both the jet reaction and from the change in circulation around the wing due to the jet's acting as a spoiler. The jet control was investigated as an aileron on a 35° sweptback wing of aspect ratio 4.76. The investigation was of exploratory nature and was limited to the case where the jet was supplied with air at stagnation pressure. The results indicated that such a jet could be used as an emergency control.

NACA RM L53J01a

WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF STEADY ROLLING ON THE AERODYNAMIC LOADING CHARACTERISTICS OF A 45° SWEPTBACK WING AT HIGH SUBSONIC SPEEDS. James W. Wiggins and Richard E. Kuhn. November 1953. 22p. diagrs., photos. (NACA RM L53J01a)

The aerodynamic loading characteristics of a 45° sweptback wing of aspect ratio 4 in combination with a fuselage during steady roll are presented. The tests covered Mach numbers of 0.70, 0.85, and 0.91, and angles of attack up to 13°. The effects of fences at a Mach number of 0.85 and a comparison of measured and calculated load distribution are included.

NACA RM L53J09a

WIND-TUNNEL INVESTIGATION AT LOW SPEED OF THE EFFECT OF VARYING THE RATIO OF BODY DIAMETER TO WING SPAN FROM 0.1 TO 0.8 ON THE AERODYNAMIC CHARACTERISTICS IN PITCH OF A 45° SWEPTBACK-WING—BODY COMBINATION. Harold S. Johnson. November 1953. 32p. diagrs., photo., tab. (NACA RM L53J09a)

Low-speed lift, drag, and pitching-moment data were obtained for a family of bodies and wing-body combinations to determine the effect of varying the ratio of body diameter to wing span from 0.1 to 0.8. The bodies had ogival noses and cylindrical afterbodies. The untapered 6-percent-thick wings had aspect ratios of 3 and 45° of sweepback. The lift data of the bodies alone and the wing-body combinations are compared with several existing theories.

NACA RM L53J19

AN EXPERIMENTAL AND THEORETICAL INVESTIGATION AT HIGH SUBSONIC SPEEDS OF THE EFFECTS OF HORIZONTAL-TAIL HEIGHT ON THE AERODYNAMIC CHARACTERISTICS IN SIDESLIP OF AN UNSWEPT, UNTAPERED TAIL ASSEMBLY. Harleth G. Wiley and Donald R. Riley. December 1953. 71p. diagrs., tab. (NACA RM L53J19)

This paper presents the effects at high subsonic speeds of horizontal-tail height on the aerodynamic characteristics in sideslip at 0° angle of attack of an unswept, untapered empennage. Configurations investigated included the fuselage alone, fuselage plus vertical tail, fuselage plus horizontal tail, and the fuselage plus vertical tail with the horizontal tail located at 0, 26, 59, and 100 percent vertical-surface span. Tests were made at 0° angle of attack through a sideslip range of -2° to 20° over a Mach number range of 0.50 to 0.94.

NACA RM L53J29

WIND-TUNNEL INVESTIGATION AT HIGH AND LOW SUBSONIC MACH NUMBERS OF TWO UNSWEPT WINGS HAVING NACA 2-006 AND NACA 65A006 AIRFOIL SECTIONS. Stanley F. Racisz. December 1953. 40p. diagrs., photo., tab. (NACA RM L53J29)

An investigation has been made of two unswept wings with aspect ratios of 4 and taper ratios of 0.2. One wing had airfoil sections designed for high maximum lift at low speeds (NACA 2-006), and the other wing had NACA 65A006 airfoil sections. Each wing was mounted on a slender body of revolution. The lift, drag, and pitching-moment characteristics were determined at Reynolds numbers from 1×10^6 to 7.5×10^6 for Mach numbers below 0.2 for the wings with and without split flaps and for the wings with and without leading-edge roughness. The characteristics of the plain wings were also determined for several values of Reynolds number at Mach numbers up to about 0.92. Gains obtainable by the use of the NACA 2-006 airfoil section are evident for Mach numbers up to 0.65 from the comparisons of the results for the two wings.

NACA RM L53L08a

EXPERIMENTAL CONVECTIVE HEAT TRANSFER TO A 4-INCH AND 6-INCH HEMISPHERE AT MACH NUMBERS FROM 1.62 TO 3.04. Leo T. Chauvin and Joseph P. Maloney. February 1954. 18p. diagrs., photos. (NACA RM L53L08a)

Equilibrium temperatures and heat-transfer coefficients for a hemispherical nose have been measured for Mach numbers from 1.62 to 3.04. Heat transfer to the surface of the hemisphere was presented as Stanton number against Reynolds number for various surface heating conditions. Heat transfer at the stagnation point has been measured and correlated with theory. Transition from a laminar to a turbulent boundary layer was obtained at Reynolds numbers of approximately 1×10^6 corresponding to a region on the body located between 45° and 60° from the stagnation point.

NACA RM L53L15

INVESTIGATION OF A PULSE-JET-POWERED HELICOPTER ROTOR ON THE LANGLEY HELICOPTER TEST TOWER. Edward J. Radin and Paul J. Carpenter. February 1954. 23p. diagrs., photos. (NACA RM L53L15)

A helicopter rotor powered by tip-located pulse-jet engines has been investigated on the Langley helicopter test tower to determine its basic hovering characteristics as well as the power-off drag and propulsive characteristics of the engines. The noise intensity in the vicinity of the pulse-jet engines was also determined.

NACA - Langley Field, Va.

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Research Abstracts

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CURRENT NACA REPORTS

NACA RM E55B11

FULL-SCALE PERFORMANCE STUDY OF A PROTOTYPE CRASH-FIRE PROTECTION SYSTEM FOR RECIPROCATING-ENGINE-POWERED AIRPLANES. Dugald O. Black and Jacob C. Moser. November 1955. 36p. diagrs., photos. (NACA RM E55B11)

An airplane was experimentally crashed to study the performance of a prototype crash-fire inerting system for reciprocating-engine-powered airplanes. The results of previous experimental crashes indicate that the crash conditions imposed almost always result in fire. The inerting system was therefore exposed to conditions that would adequately test its ability to inert and de-energize the various ignition sources known to cause crash fires. The fact that fire did not occur during this crash indicated that the crash-fire inerting system functioned satisfactorily as a complete unit. The prototype inerting system functioned with a rapidity equal to or greater than that of the experimental system used in the NACA crash-fire studies.

NACA RM E55H11

A SURVEY OF UNCLASSIFIED AXIAL-FLOW-COMPRESSOR LITERATURE. Howard Z. Herzig and Arthur G. Hansen. November 1955. i, 88p. (NACA RM E55H11)

A survey of unclassified axial-flow-compressor literature is presented in the form of brief reviews of the methods, results, and conclusions of selected reports. The reports are organized into several main categories with subdivisions, and frequent references are made within the individual reviews to pertinent material elsewhere in the survey.

NACA RM E55I27a

AVERAGE BOND ENERGIES BETWEEN BORON AND ELEMENTS OF THE FOURTH, FIFTH, SIXTH, AND SEVENTH GROUPS OF THE PERIODIC TABLE. Aubrey P. Altshuller. November 1955. 7p. tab. (NACA RM E55I27a)

The average bond energies $\bar{D}_{gm}(B\text{-}Z)$ for boron-containing molecules have been calculated by the Pauling geometric-mean equation. These calculated bond energies are compared with the average bond energies $\bar{D}_{exp}(B\text{-}Z)$ obtained from experimental data. The higher values of $\bar{D}_{exp}(B\text{-}Z)$ in comparison with $\bar{D}_{gm}(B\text{-}Z)$ when Z is an element in the fifth, sixth, or seventh periodic group may be attributed to resonance stabilization or double-bond character.

NACA TM 1384

METALLOGRAPHY OF ALUMINUM AND ITS ALLOYS. USE OF ELECTROLYTIC POLISHING. (Métallographie de l'aluminium et de ses alliages. Emploi du polissage électrolytique). P. A. Jacquet. November 1955. ii, 80p. diagrs., photos., tabs. (NACA TM 1384. Trans. from Office National d'Études et de Recherches Aéronautiques, Pub.51, 1952)

Recent methods are described for electropolishing aluminum and aluminum alloys. Numerous references are included of electrolytic micrographic investigations carried out during the period 1948 to 1952. A detailed description of a commercial electrolytic polishing unit, suitable for micrographic examination of aluminum and its alloys, is included.

NACA TN 3413

INVESTIGATION OF THE USE OF A RUBBER ANALOG IN THE STUDY OF STRESS DISTRIBUTION IN RIVETED AND CEMENTED JOINTS. Louis R. Demarkles, Massachusetts Institute of Technology. November 1955. 97p. diagrs., tabs. (NACA TN 3413)

Results are presented of an investigation made to study the stress distribution within cemented and riveted joints by use of an analogous joint constructed of a highly flexible material. Displacement measurements obtained from foam-rubber analogs, and rational though not rigorously sound formulas for shear stress distribution in joints, are given.

NACA TN 3469

SUMMARY OF RESULTS OBTAINED BY TRANSONIC-BUMP METHOD ON EFFECTS OF PLAN FORM AND THICKNESS ON LIFT AND DRAG CHARACTERISTICS OF WINGS AT TRANSONIC SPEEDS. Edward C. Polhamus. November 1955. 33p. diagrs., tab. (NACA TN 3469. Supersedes RM L51H30)

This paper presents a summary of the effects of plan form and thickness on the lift and drag characteristics of wings at transonic speeds and comparisons with subsonic, transonic, and supersonic theories. The data considered in this summary were obtained during a transonic research program conducted in the Langley high-speed 7- by 10-foot tunnel by the transonic-bump method. The Reynolds numbers of the tests were generally less than 1×10^6.

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NACA TN 3492

DETERMINATION OF INFLOW DISTRIBUTIONS FROM EXPERIMENTAL AERODYNAMIC LOADING AND BLADE-MOTION DATA ON A MODEL HELICOPTER ROTOR IN HOVERING AND FORWARD FLIGHT. Gaetano Falabella, Jr., and John R. Meyer, Jr., Massachusetts Institute of Technology. November 1955. 184p. diagrs., photos., tab. (NACA TN 3492)

Inflow distributions, azimuth and spanwise, were determined analytically from measured pressure distributions and blade-motion data on a model helicopter rotor blade under hovering and simulated forward-flight conditions. Pressures and corresponding blade flapping were recorded for various rotor conditions at tip-speed ratios of 0.10 to 1.00. Supplementary information concerning reverse-flow effects on offset-blade motion, measured forces and moments on a typical offset model rotor, and additional recorded pressure data are also included.

NACA TN 3524

THE EFFECT OF REYNOLDS NUMBER ON THE STALLING CHARACTERISTICS AND PRESSURE DISTRIBUTIONS OF FOUR MODERATELY THIN AIRFOIL SECTIONS. George B. McCullough. November 1955. 24p. diagrs., tabs. (NACA TN 3524)

Low-speed measurements of the lift, drag, pitching moment, and pressure distribution of the NACA 0008, 0007.5, 0007, and 0006 airfoil sections are presented for Reynolds numbers from 1.5 to 6 million. It is shown that the flow over these sections underwent a change at some value of the lift coefficient which depended on the airfoil thickness ratio and Reynolds number. The effect of the flow change on maximum lift was small.

NACA TN 3525

VORTEX INTERFERENCE ON SLENDER AIRPLANES. Alvin H. Sacks. November 1955. 19p. diagr. (NACA TN 3525)

Formulas are developed for the forces and moments due to vortex interference on a slender wing-body-tail combination of general cross section performing quasi-stationary maneuvers. It is found that in steady straight flight the interference lift depends only on the impulse of each shed vortex and its image vortex in a transformed circle plane, this quantity to be determined at the wing trailing edge and at the base of the configuration.

NACA TN 3526

FLIGHT CALIBRATION OF FOUR AIRSPEED SYSTEMS ON A SWEPT-WING AIRPLANE AT MACH NUMBERS UP TO 1.04 BY THE NACA RADAR-PHOTOTHEODOLITE METHOD. Jim Rogers Thompson, Richard S. Bray, and George E. Cooper. November 1955. 41p. diagrs., photos., tab. (NACA TN 3526. Supersedes RM A50H24)

The characteristics of four different airspeed systems installed in a swept-wing airplane have been investigated in flight up to 1.04 Mach number by the NACA radar-phototheodolite method of airspeed calibration. The variations of static-pressure defect per unit indicated impact pressure with Mach number and a limited amount of information on the effect of airplane normal-force coefficient are presented for each system. The results are compared with available theory and wind-tunnel tests of the isolated heads.

NACA TN 3547

AERODYNAMIC CHARACTERISTICS OF A SMALL-SCALE SHROUDED PROPELLER AT ANGLES OF ATTACK FROM 0° TO 90°. Lysle P. Parlett. November 1955. 12p. diagrs. (NACA TN 3547)

Tests have been performed to determine the effects of airspeed and angle of attack on the lift, drag, and pitching moment of a shrouded-propeller model, having a shroud length of about two-thirds of the propeller diameter, over an angle-of-attack range from 0° to 90°. Tests were made of the complete model with the propeller operating and also of the shroud alone with the propeller removed. The effect of inlet-lip cross-sectional radius on the static-thrust characteristics was also studied.

NACA TN 3548

FLIGHT INVESTIGATION AT MACH NUMBERS FROM 0.6 TO 1.7 TO DETERMINE DRAG AND BASE PRESSURES ON A BLUNT-TRAILING-EDGE AIRFOIL AND DRAG OF DIAMOND AND CIRCULAR-ARC AIRFOILS AT ZERO LIFT. John D. Morrow and Ellis Katz. November 1955. 19p. diagrs., photos. (NACA TN 3548. Supersedes RM L50E19a)

Results of an exploratory free-flight investigation at zero lift of several rocket-powered drag-research models having rectangular 6-percent-thick wings are presented for a Mach number range of 0.6 to 1.7. Wings having diamond, circular-arc, and blunt-trailing-edge airfoil sections were tested. Pressures over the base of the blunt-trailing-edge airfoil were measured. The drags of all the models were measured and are compared with theory in this paper.

NACA TN 3569

COMPRESSIBLE LAMINAR BOUNDARY LAYER AND HEAT TRANSFER FOR UNSTEADY MOTIONS OF A FLAT PLATE. Simon Ostrach. November 1955. 26p. diagrs., tab. (NACA TN 3569)

The laminar compressible boundary layer and heat transfer over an isothermal semi-infinite flat plate moving with a time-dependent velocity has been analyzed. First-order deviations from the quasi-steady velocity and temperature profiles and boundary-layer characteristics have been computed. A plate oscillating about a steady velocity is considered as an example.

NACA TN 3574

ACOUSTIC ANALYSIS OF RAM-JET BUZZ. Harold Mirels. November 1955. 33p diagrs. (NACA TN 3574)

A one-dimensional analysis of ram-jet buzz is presented. It is assumed that the buzz has a linear instability origin and that the combustion chamber is of constant area. The configuration is shown to be unstable when the real part of the acoustic impedance of the inlet is greater than a term of the order of the combustion-chamber Mach number. Computations indicate that burning with a fixed planar flame front and constant heat release per unit mass increases the stable operating range.

NACA TN 3583

CHARTS OF BOUNDARY-LAYER MASS FLOW AND MOMENTUM FOR INLET PERFORMANCE ANALYSIS MACH NUMBER RANGE, 0.2 TO 5.0. Paul C. Simon and Kenneth L. Kowalski. November 1955. 32p. diagrs., tab. (NACA TN 3583)

Significant flow parameters for various fractions of a turbulent boundary layer are presented in chart form for a number of power-law velocity profiles and a range of Mach numbers up to 5.0. Estimates of auxiliary inlet mass flow or momentum may easily be made. Application of the charts to inlets of arbitrary shape and to the determination of the pressure recovery of rectangular normal-shock inlets immersed in boundary layer is described.

NACA TN 3586

IMPINGEMENT OF WATER DROPLETS ON NACA 65A004 AIRFOIL AT 0° ANGLE OF ATTACK. Rinaldo J. Brun and Dorothea E. Vogt. November 1955. 28p. diagrs. (NACA TN 3586)

The trajectories of droplets in the air flowing past an NACA 65A004 airfoil at an angle of attack of 0° were determined. The amount of water in droplet form impinging on the airfoil, the area of droplet impingement, and the rate of droplet impingement per unit area on the airfoil surface were calculated from the trajectories and presented to cover a large range of flight and atmospheric conditions. These impingement characteristics are compared briefly with those previously reported for the same airfoil at angles of attack of 4° and 8°.

BRITISH REPORTS

N-40040*

National Gas Turbine Establishment (Gt. Brit.)
AN EXPERIMENTAL INTRODUCTION TO THE JET FLAP. N. A. Dimmock. July 1955. 68p. diagrs., photos., tabs. (NGTE R. 175)

Results are given of two airfoils, each having 12.5-percent-thick elliptical cross section with a narrow full-span jet slot at the trailing edge, the jet deflections being, respectively, 90° and 31.4°. The values of the force and moment coefficients and derivatives agree with those suggested by theory in a previous report. Support is given to the thrust hypothesis in that the measured thrust was greater, under appropriate conditions, than the reaction component from the deflected jet. The losses in the system are considered and some are investigated, those due to Reynolds number and jet entrainment effects being included. Influence of ground on lift and center of lift was measured and found not to be prohibitive.

N-40048*

Royal Aircraft Establishment (Gt. Brit.)
TESTS OF HUMIDITY EFFECTS ON FLOW IN A WIND TUNNEL AT MACH NUMBERS BETWEEN 2.48 AND 4. R. J. Monaghan. January 1955. 33p. diagrs. (RAE Tech. Note Aero 2358)

Static and pitot pressure distributions were measured in the working section of a 5-in. by 5-in. supersonic wind tunnel at nominal Mach numbers of 2.48, 3.25, and 4, over ranges of absolute humidity at the inlet from 5×10^{-5} to 3×10^{-3}. Previous work indicates that a condensation shock would occur in the nozzle. For a stagnation pressure of 1 atmosphere and stagnation temperatures giving zero heat-transfer conditions at the walls, no humidity effects were discernible if the absolute humidity was less than 2×10^{-4} at $M = 2.48$, 3×10^{-4} at $M = 3.12$, and about 5×10^{-4} at $M = 3.8$.

N-40068*

Aeronautical Research Council (Gt. Brit.)
TESTS ON A SWEPT-BACK WING AND BODY WITH ENDPLATES AND WING TIP TANKS IN THE COMPRESSED AIR TUNNEL. C. Salter and R. Jones. APPENDIX - COMPARISON BETWEEN THE MEASURED LIFT AND DRAG AND CALCULATED VALUES FOR THE WING WITH TIP TANKS. J. Weber. 1954. 26p. diagrs., tabs. (ARC CP 196)

Results are given of experiments to determine the effect on lift, drag and pitching moment, of wing tip tanks and of two sizes of end plates on a tapered swept wing model. The tests were undertaken primarily to extend the range of Reynolds number for checks on previous theoretical work. As regards lift and pitching moment, the effects are found to be fairly well defined. The drag characteristics are less consistent, but it seems that end plates have the effect of reducing the drag of the model over quite a large range of C_L. This does not apply in the case of the wing tip tanks.

N-40069*

Aeronautical Research Council (Gt. Brit.)
WIDE RANGE AMPLIFIER FOR TURBULENCE MEASUREMENTS WITH ADJUSTABLE UPPER FREQUENCY LIMIT. H. Schuh and D. Walker. 1955. 42p. diagrs. (ARC CP 198)

Requirements are discussed for an amplifier suitable for subsonic and supersonic turbulence work with hot wires. An amplifier is described which has a frequency range from 1.4 c/s to 50 kc/s, dealing with a range of thermal time lag from 0.1 m. s. to 5 m. s. An iron dust-cored inductance is used to give the required compensation for thermal lag, the circuit being a modification of Dryden's circuit. The upper frequency cutoff is adjustable in six steps from 1.5 kc/s to 50 kc/s. The output can be applied to a thermocouple meter and to an oscilloscope.

N-40080*

Aeronautical Research Council (Gt. Brit.)
FLIGHT TESTS AT TRANSONIC SPEEDS ON FREELY FALLING MODELS. PARTS I TO V. Edited by C. Kell. PART I - HISTORICAL. C. Kell. PART II - EQUIPMENT AND TECHNIQUE. C. Kell and J. Swan. PART III - DRAG EXPERIMENTS. C. Kell and F. Smith. PART IV - FLUTTER EXPERIMENTS. W. G. Molyneux and E. W. Chapple. PART V - NOTES ON THE ACCURACY OF THE FREELY FALLING MODEL EXPERIMENT. T. F. C. Lawrence. 1955. 32p. diagrs., photos., tab. (ARC R & M 2902. Supersedes RAE Tech. Memo. Aero 308)

Basic bodies carrying the airfoils to be tested were released from an aircraft flying at height, and accelerated under the influence of gravity through the transonic speed range. Radar recorded the flight path and telemetering equipment carried within the body transmitted information to a ground station during the free fall. This work started in 1943 and was brought to a close in 1949.

N-40082*

Aeronautical Research Council (Gt. Brit.)
OBSERVATIONS OF THE FLOW ROUND A TWO-DIMENSIONAL AEROFOIL OSCILLATING IN A HIGH-SPEED AIR STREAM. A. Chinneck, D. W. Holder, and C. J. Berry. 1955. 18p. diagrs., photos., tab. (ARC R & M 2931. Supersedes ARC 15, 141; FM 1779 & 0.1006)

Photographs have been taken of the flow around a 10-percent-thick RAE 104 airfoil performing pitching oscillations at low values of the frequency parameter in subsonic and supersonic airstreams. Apart from a difference of phase, the general flow pattern appeared to be similar to those observed in steady motion, the pattern for a particular instantaneous incidence of the oscillation resembling that for steady motion at a different incidence. It is suggested that, for the range of frequency parameter covered, the observed phase lag of the flow pattern corresponds to the lag in the circulation.

N-40084*

Aeronautical Research Council (Gt. Brit.)
THE AERODYNAMIC EFFECTS OF ASPECT RATIO ON FLUTTER OF UNSWEPT WINGS. W. G. Molyneux and E. W. Chapple. 1955. 12p. diagrs., tab. (ARC R & M 2942; 15,609. Supersedes RAE Structures 135)

A method is described for the direct measurement of the aerodynamic effects of aspect ratio on wing flutter. The method requires the use of stiff (virtually rigid) wings flexibly mounted at the root. Details are given of tests on untapered, unswept wings with freedoms in modes of linear flexure and uniform pitch. A comparison is made between measured values of the flutter characteristics and the values calculated using an aerodynamic theory for oscillating wings of finite aspect ratio, and reasonable agreement for flutter speeds and frequencies is obtained.

N-40186*

Royal Aircraft Establishment (Gt. Brit.)
MEASUREMENTS OF PITCHING MOMENT DERIVATIVES FOR A SERIES OF RECTANGULAR WINGS AT LOW WIND SPEEDS. P. R. Guyett and D. E. G. Poulter. June 1955. 52p. diagrs., tabs. (RAE Structures 185)

The direct aerodynamic moments for pitching oscillations have been measured on a series of rectangular wings having aspect ratios between 2 and 8 for axis positions at the wing leading edges and trailing edges. Two of the wings were also tested with single end plates which were aerodynamically effective in doubling the wing geometric aspect ratio. The measurements were made at low speeds in an open jet wind tunnel and covered the range of frequency parameter (based on wing chord) 0.13 to 0.39. The results are in general agreement with theoretical results due to Lawrence and Gerber. Similar tests were also made on a wing fitted with two end plates in an attempt to obtain results for two-dimensional flow. The results do not agree with other experimental results and two-dimensional theoretical values and indicate that wind-tunnel interference is important for this test configuration.

N-40187*

Royal Aircraft Establishment (Gt. Brit.)
THE MECHANICAL PROPERTIES AND STRUCTURE OF CONTINUOUSLY CAST A.C.9 ALUMINIUM ALLOY TUBES. P. C. Bradley and D. Bunting. June 1955. 10p. diagr., photos., tabs. (RAE Tech. Note RPD 122)

The mechanical properties of a large diameter tube continuously cast in aluminum alloy A.C. 9 have been investigated at room and at elevated temperature, in connection with the use of such tubes as fuel or oxidant tanks for rocket motors. The variation in structure of the alloy across a section is described and discussed with reference to the possible detrimental effect of primary silicon crystals on the mechanical properties. The operating temperature should not be allowed to exceed about 180° C if tanks of this material are to be used more than once.

N-40188*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECTS OF TAPER ON THE SUPERVELOCITIES ON THREE-DIMENSIONAL WINGS AT ZERO INCIDENCE. K. W. Newby. June 1955. 120p. diagrs., tab. (RAE Aero 2544)

Relationships have been derived for expressing the velocities on three-dimensional tapered wings at zero incidence in terms of the velocities on untapered infinite swept wings. The theoretical investigation of the effects of taper is confined to simple wings having airfoil sections formed by cubic or parabolic arcs; some experimental evidence is given to show that the results of this investigation can probably be applied quantitatively to wings having conventional airfoil sections. The results given in this report show that plan form and thickness taper have a marked effect on the velocities near the center of a wing, but that these effects decrease with increase of sweepback. A calculation method is outlined in section 4.26 of the text for applying the results obtained for wings having parabolic arc airfoil sections, to wings having arbitrary section shapes.

N-40189*

Royal Aircraft Establishment (Gt. Brit.)
RECORDING AND PROCESSING FLIGHT TEST DATA BY DIGITAL METHODS. E. J. Petherick. (Prepared for AGARD Flight Test Panel). April 1955. 12p. photos. (RAE Tech. Note MS 20)

This note reviews current developments in the recording and processing of flight test data by digital methods. It first describes four assessors which facilitate conversion of strip chart and kinetheodolite records to typewritten or punched card form. It then details some coded scales which can be read automatically, and finally it describes the incorporation and use of such scales in a digital recording system intended for airborne use.

N-40190*

Royal Aircraft Establishment (Gt. Brit.)
WIND TUNNEL TESTS ON A 6 FT DIAMETER HELICOPTER ROTOR. T. B. Owen, R. A. Fail, and R. C. W. Eyre. May 1955. 33p. diagrs., tabs. (RAE Tech. Note Aero 2378)

Thrust, torque, and flapping angle have been measured on a 6-foot diameter rotor over a range of blade angle, shaft inclination, and tip speed ratio for comparison with the 12-foot diameter rotor previously tested in the 24-foot tunnel. In addition to tests in the 24-foot tunnel, the 6-foot diameter rotor was also tested in the No. 2 11-1/2 foot tunnel to investigate tunnel constraint. Brief investigations were made of support interference and blade twisting. There are small discrepancies both as regards tunnel corrections and as regards the comparison of the 6-foot and 12-foot diameter rotors in the unstalled operating range. Possible reasons are discussed but small unexplained discrepancies remain. Blade stalling has larger effects on the 6-foot diameter rotor but owing to the progressive nature of the phenomenon it is not possible to define any precise limits to the ranges of validity of the results on the two rotors.

N-40191*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) AN EXPERIMENTAL INVESTIGATION INTO THE PERFORMANCE OF A HELICOPTER FOLLOWING SUDDEN REDUCTION IN POWER. G. W. Langdon. August 4, 1955. 12p. diagrs. (AAEE/Res/289).

The performance of a single rotor helicopter fitted with a throttle override has been measured under conditions simulating the failure of one engine of a multiengined helicopter during take-off. Records of the motion are included and the experimental results are compared with theoretical predictions.

N-40192*

Royal Aircraft Establishment (Gt. Brit.)
INVESTIGATION OF THE FATIGUE OF EXTRUDED TUBULAR BOOMS. W. A. P. Fisher and H. Yeomans. June 1955. 15p. diagrs., photos., tabs. (RAE Tech. Note Structures 162).

The presence of the unmachined extruded surface of the bore in the tubes, as used for the "Viking" and "Valetta" spar booms, has a marked adverse effect on the basic fatigue strength of the tube. The failures of the necked specimens show that the flaws at the inner surface are a source of fatigue. Scatter in the endurance of tubular spar booms is probably largely due to the chances of such flaws occurring at the side of a transverse hole. The specimens were made from aluminum alloy extruded tube DTD 364.

N-40193*

Marine Aircraft Experimental Establishment. (Gt. Brit.) INVESTIGATION OF HIGH LENGTH/BEAM RATIO SEAPLANE HULLS WITH HIGH BEAM LOADINGS - HYDRODYNAMIC STABILITY. PART 17 - THE STABILITY AND SPRAY CHARACTERISTICS OF MODEL M. J. K. Friswell, D. M. Ridland, and A. G. Kurn. April 1955. 24p. diagrs., photos., tabs. (MAEE F/Res/253)

In this report results are presented of limited tests on the hydrodynamic characteristics of model M of the series, these tests being designed solely to provide information on the interactions of the different relevant parameters. The model has a length-to-beam ratio of 13 (the forebody being 6 beams in length and the afterbody 7 beams), no forebody warp, an afterbody to forebody keel angle of 8°, and a straight transverse step with a step depth of 0.15 beams. The tests comprised the determination of longitudinal stability limits without slipstream at $C_{\Delta_0} = 2.75$ and an investigation of spray at this loading. A short discussion of the results is also included.

N-40197*

Royal Aircraft Establishment (Gt. Brit.)
CORRELATED FATIGUE DATA FOR AIRCRAFT STRUCTURAL JOINTS. R. B. Heywood. June 1955. 16p. diagrs., tab. (RAE Structures 184)

Results of fatigue tests carried out at RAE on typical aircraft wing structural joints are correlated to give an indication of general fatigue behavior. The results are plotted in the form of S - Log N curves, and these indicate that the mode of behavior cannot be attributed to any single factor, such as the type of aluminum alloy, the ultimate tensile strength, or the mean stress of the fatigue cycle. The detailed method of design undoubtedly has a predominant influence on behavior, but this quality is not revealed by a broad classification according to the proportion of load transmitted at holes.

N-40198*

Royal Aircraft Establishment (Gt. Brit.)
A TECHNIQUE FOR THE MEASUREMENT OF PRESSURE DISTRIBUTION ON OSCILLATING AEROFOILS, WITH RESULTS FOR A RECTANGULAR WING OF ASPECT RATIO 3.3. W. G. Molyneux and F. Ruddlesden. June 1955. 24p. diagrs., tabs. (RAE Tech. Note Structures 164)

Details are given of a strain-gage pressure transducer that has been developed for measurements of pressure distribution on oscillating airfoils in low speed wind tunnels. The transducer characteristics are shown to be well suited to oscillatory measurements, and in particular the transducer output can be measured directly on a sensitive galvanometer without the need for preamplification. As an illustration of the use of the transducer, pressure measurements have been made in the RAE 5-foot diameter open jet wind tunnel on a rectangular wing of aspect ratio 3.3 oscillating in modes of pitch and roll. Values for the aerodynamic derivatives have been obtained from the integrated pressure distributions, and are compared with those derived from overall force measurements and with theoretical values. The measured values are in close agreement but there are some discrepancies with theory that are thought to be due to a wind-tunnel interference effect.

N-40199*

Royal Aircraft Establishment (Gt. Brit.)
THE INFLUENCE OF PRE-LOADING ON THE FATIGUE LIFE OF AIRCRAFT COMPONENTS AND STRUCTURES. R. B. Heywood. June 1955. 27p. diagrs., photos., tabs. (RAE Structures 182)

Tests on aircraft components and structures are described which show that preloading can have a marked influence on fatigue behavior. Tensile preloading may increase the life - in one instance a hundredfold improvement was obtained - and compressive preloading may reduce the life. The effect is attributed to residual stresses and to load redistributions induced by preloading.

N-40205*

Ministry of Supply (Gt. Brit.)
AN ABSORPTIOMETRIC METHOD FOR THE DETERMINATION OF CHROMIUM IN METHACRYLATO-CHROMIUM TREATED GLASS FABRIC. E. J. McLauchlan. August 1955. 4p. diagr. (MOS AID Chem. 6)

An absorptiometric method for the determination of chromium in methacrylato-chromium treated glass fabric is described. A wet-oxidation attack is utilized to remove the chromium from the glass fibers and to oxidize the tervalent chromium to sexavalent chromium for subsequent absorptiometric determination as the diphenylcarbazide complex.

N-40207*

Royal Aircraft Establishment (Gt. Brit.)
OPTIMUM DESIGNS FOR REINFORCED CIRCULAR HOLES. E. H. Mansfield. June 1955. 26p. diagrs. (RAE Structures 183)

The design of reinforced circular holes in an infinite sheet is considered theoretically. The stress system in the main body of the sheet is assumed to be one in which the principal stresses are in the ratio 1:-1 (that is, shear), 1:0 (that is, tension), 1:1 or 1:1/2. The reinforcement may vary round the hole and families of such reinforcements with constant total weight are considered; the peak stresses in the sheet are evaluated so that optimum weight-strength designs are determined.

N-40209*

Royal Aircraft Establishment (Gt. Brit.)
STATIC ELECTRICITY IN AIRCRAFT FUEL TANKS. F. L. Holmes and D. T. Sharwood. May 1955. 10p. diagrs., tab. (RAE Tech. Note EL.82; Tech. Note Mech. Eng. 201)

Tests were made to measure the static field strength generated in aircraft fuel tanks by foaming of the fuel. A type of apparatus for measuring static field strength is described with details of its application to these tests. The results show that the field strength is less than 1 volt per centimeter which is many times less than that required for flashover and the ignition of a fuel vapor/air mixture.

UNPUBLISHED PAPERS

N-22024*

FLOW NEAR A HEATED SOLID BODY IN A STANDING ACOUSTIC WAVE. P. N. Kubanskii. October 1955. 11p. diagrs. (Trans. of Zhurnal Tekhnicheskoi Fiziki, v. 22, no. 4, April 1952, p. 585-592)

Results of experiments carried out in standing waves generated by vibrations of finite amplitude are presented. Two types of waves are considered: (1) forced standing waves, formed when the frequency of outside vibrations does not correspond with the natural frequency of vibration of the radiating system, and (2) standing waves which form as the result of coincidence of frequency of outside vibration with natural frequency of vibration of the radiating system. Optical methods are used in the examination of the flow and the presence of higher harmonics in the standing acoustical wave is observed. The deformation of the waves is also studied.

N-34452*

SOFT ROT. DESTRUCTION OF WOOD THROUGH COMMON FUNGI. (Moderfaule. Die Zersetzung von Holz durch niedere Pilze). W. P. K. Findlay and J. G. Savory. October 1955. 12p. photos., tab. (Trans. from Holz als Roh- und Werkstoff, v.12, no.8, August 1954, p.293-296).

If wood is exposed to humid weather for some length of time, a softening of the surface takes place which is due to a fungus attack. This phenomenon is of minor significance except in the case of cooling towers and similar industrial water-cooling plants. Soft rot, as this fungus is generally called, was produced according to a method by Abrams. The fungi causing soft rot are reviewed and preservatives for protection of wood are discussed, but further investigations are required in order to indicate effective methods of protection of wood from soft rot.

N-39717*

EFFECT OF ACOUSTICAL VIBRATIONS OF FINITE AMPLITUDE ON THE BOUNDARY LAYER. P. N. Kubanskii. October 1955. 11p. diagrs. (Trans. of Zhurnal Tekhnicheskoi Fiziki, v.22, no.4, April 1952, p.593-601)

It is concluded that acoustical standing waves of finite amplitude can produce currents near the wall of a solid body, even when the body is located in a stream. A considerable intensity of acoustical vibration is necessary in order to produce acoustical flow near the walls of a solid body in a stream. The acoustical streams produced near the walls of solid bodies exert an influence on the boundary layer which surrounds the body. There is a possibility of using acoustical vibrations to control phenomena which occur in the boundary layer. Such phenomena could be directed toward the desired side of a physical body, depending upon the condition of the boundary layer.

DECLASSIFIED NACA REPORTS

We have

NACA RM A50J26a

AERODYNAMIC CHARACTERISTICS INCLUDING PRESSURE DISTRIBUTIONS OF A FUSELAGE AND THREE COMBINATIONS OF THE FUSELAGE WITH SWEPT-BACK WINGS AT HIGH SUBSONIC SPEEDS. Fred B. Sutton and Andrew Martin. February 6, 1951. 117p. diagrs., photos., tabs. (NACA RM A50J26a) (Declassified from Confidential, 10/14/55)

As part of an NACA transonic research program, three sweptback wings with a fuselage were investigated over a Mach number range from 0.40 to 0.94. These model wings had NACA 65A006 sections parallel to the plane of symmetry. One of the model wings was swept back 35° and had an aspect ratio of 6; the other two were swept back 45° and had aspect ratios of 4 and 6. Force and pitching-moment data, tabulated pressure measurements, downwash and dynamic-pressure characteristics, and tuft studies are presented. The approximate effects of wing elasticity on lift and moment data are also shown.

THE FOLLOWING REPORTS HAVE BEEN DECLASSIFIED FROM CONFIDENTIAL 11/14/55, AND ARE UNAVAILABLE:

RM L8K18a
RM L52K24a

THE FOLLOWING REPORTS HAVE BEEN DECLASSIFIED FROM CONFIDENTIAL, 11/14/55

NACA RM A7K28

HIGH-SPEED STABILITY AND CONTROL CHARACTERISTICS OF A FIGHTER AIRPLANE MODEL WITH A SWEPT-BACK WING AND TAIL. Charles P. Morrill, Jr., and Lee E. Boddy. April 14, 1948. 47p. diagrs., photos. (NACA RM A7K28)

Wind-tunnel tests were made at high subsonic Mach numbers of a model of a pursuit airplane with a 35° sweptback wing and tail. Data are included in the report which show the basic characteristics of the model; the control and hinge-moment characteristics of the horizontal tail, elevator, and aileron; the effect of a wing leading-edge slat; and the effect of a fuselage-side dive brake.

NACA RM A9K02

INVESTIGATION OF DOWNWASH AND WAKE CHARACTERISTICS AT A MACH NUMBER OF 1.53. III - SWEPT WINGS. Edward W. Perkins and Thomas N. Canning. February 23, 1950. 41p. diagrs., tab. (NACA RM A9K02)

The results of an experimental investigation of the downwash and wake characteristics behind two highly swept wings in a supersonic stream are presented. The leading-edge sweep angles of the two wings were 63° and $63^{\circ}45'$, the aspect ratios were 3.50 and 1.66, and the corresponding taper ratios were 0.25 and 1.00. The tests were made at a Mach number of 1.53 and Reynolds numbers of 1.4 million and 2.6 million, respectively. A comparison between experimental and theoretical values of the rate of change of downwash angle with angle of attack at zero lift is made.

NACA RM A52K12

TECHNIQUES FOR DETERMINING THRUST IN FLIGHT FOR AIRPLANES EQUIPPED WITH AFTERBURNERS. L. Stewart Rolls, C. Dewey Havill, and George R. Holden. January 1953. 27p. diagrs., photos. (NACA RM A52K12)

An experimental technique has been developed which enables a determination of the net thrust for an afterburner-equipped airplane in flight. Measurements from a swinging pitot-static pressure and total temperature probe are used to determine the gross thrust, total air-flow rate, and net thrust. Details are also presented for an air-cooled fixed-pressure probe for the determination of basic engine thrust.

NACA RM A52K13

TESTS IN THE AMES 40- BY 80-FOOT WIND TUNNEL OF AN AIRPLANE MODEL WITH AN ASPECT RATIO 4 TRIANGULAR WING AND AN ALL-MOVABLE HORIZONTAL TAIL - HIGH-LIFT DEVICES AND LATERAL CONTROLS. Ralph W. Franks. February 1953. 45p. diagrs., photo., 2 tabs. (NACA RM A52K13)

Tests have been made of a model consisting of a triangular wing in combination with a fuselage of fineness ratio 12.5; a thin, triangular, vertical tail with a constant-chord rudder; and a thin, unswept, all-movable horizontal tail. The wing had an NACA 0005 modified section and was equipped with slotted inboard and plain outboard flaps. Tests were made with the wing-fuselage-vertical-tail configuration in addition to the tests of the complete model. The results of tests of lateral and directional controls, the inboard flaps as a high-lift device, and the outboard flaps as a high-lift device are presented. The Reynolds number, based on the wing mean aerodynamic chord, was approximately 10.9 million and the Mach number was about 0.13.

NACA RM A53C19

EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF PLAN-FORM TAPER ON THE AERODYNAMIC CHARACTERISTICS OF SYMMETRICAL UNSWEPT WINGS OF VARYING ASPECT RATIO. Edwin C. Allen. May 1953. 53p. diagrs., photos., tab. (NACA RM A53C19)

This report presents results of tests of a series of symmetrical, unswept, 8-percent-thick wings of varying aspect ratio and taper ratio. The wings were tested in combination with four different bodies of revolution over a Mach number range from 0.40 to 0.94 with a corresponding Reynolds number range from 2.58 million to 5.90 million. The lift, drag, and pitching-moment data are presented for wings of aspect ratios 2, 3, and 4 and for taper ratios of 0.20 to 1.00.

NACA RM E51K15

COMPARISON OF LOCKED-ROTOR AND WINDMILLING DRAG CHARACTERISTICS OF AN AXIAL-FLOW-COMPRESSOR TYPE TURBOJET ENGINE. K. R. Vincent, S. C. Huntley, and H. D. Wilsted. January 1952. 10p. diagrs. (NACA RM E51K15)

The internal drag of an axial-flow turbojet engine with the rotor locked in place to prevent windmilling and with the engine windmilling was obtained over a range of simulated Mach numbers. The corrected internal drag of the engine with the locked rotor was 210 pounds or only 46 percent of the windmilling drag at a flight Mach number of 0.8.

NACA RM E53K06

ANALYTICAL STUDY OF LOSSES AT OFF-DESIGN CONDITIONS FOR A FIXED-GEOMETRY TURBINE. Warner L. Stewart and David G. Evans. February 1954. 48p. diagrs., tab. (NACA RM E53K06)

An analytical investigation was made to determine the off-design loss characteristics of a fixed-geometry turbine of which the experimental performance was known. The method of analysis utilized an effective loss parameter and assumed that the velocity normal to the blade entrance angle was lost as a total-pressure loss. The method also assumed constant tangential component of velocity between the station just upstream and just downstream of the stator and rotor trailing edge. Good correlation between the analytically and experimentally obtained performance was found over the entire map until limiting loading was approached. The large decrease in efficiency at low-speed high pressure ratios and at high-speed low pressure ratios was found in the analysis to be almost entirely due to the rotor incidence and turbine exit whirl losses. From the results of the investigation it was concluded that for turbines designed to operate efficiently at more than one point, the design must compromise rotor incidence angle and exit whirl losses.

NACA RM L8K12a

HINGE-MOMENT MEASUREMENTS OF A WING WITH LEADING-EDGE AND TRAILING-EDGE FLAPS AT A MACH NUMBER OF 1.93. William B. Boatright and Robert W. Rainey. January 14, 1949. 12p. diagrs., tab. (NACA RM L8K12a)

Hinge-moment data for a wing with leading-edge and trailing-edge flaps of wedge section were obtained in the Langley 9-inch supersonic tunnel at a Mach number of 1.93 and a Reynolds number of 1.31×10^6. Curves of hinge moment against angle of attack and against flap deflection are shown, and the results are compared with theory. The possibility of a linkage system to reduce control forces is discussed.

NACA RM L8K17a

CONTROL EFFECTIVENESS AND HINGE-MOMENT MEASUREMENTS AT A MACH NUMBER OF 1.9 OF A NOSE FLAP AND TRAILING-EDGE FLAP ON A HIGHLY TAPERED LOW-ASPECT-RATIO WING. D. William Conner and Meade H. Mitchell, Jr. January 10, 1949. 26p. diagrs., photo. (NACA RM L8K17a)

Nose flaps and trailing-edge flaps were tested on a low-aspect-ratio, highly tapered, half-span wing model in the Langley 9- by 12-inch supersonic blowdown tunnel at a Mach number of 1.9 and a Reynolds number of 3,000,000. Lift, drag, pitching- and rolling-moment data for the wing and hinge-moment data for the flaps were obtained. All tests were made in the presence of a fuselage.

NACA RM L8K24a

EXPERIMENTAL AND CALCULATED HINGE MOMENTS OF TWO AILERONS ON A 42.7° SWEPTBACK WING AT A MACH NUMBER OF 1.9. James C. Sivells and Kennith L. Goin. January 19, 1949. 23p. diagrs., photos., tabs. (NACA RM L8K24a)

A 42.7° sweptback wing was tested with two types of ailerons in the Langley 9- by 12-inch supersonic blowdown tunnel at a Mach number of 1.9 and a Reynolds number of 2.2×10^6. The wing had an aspect ratio of 4, a taper ratio of 0.5, and an 8-percent-thick biconvex airfoil section. The contour of one aileron was formed by the basic airfoil contour, and the other aileron had flat sides and a trailing-edge thickness of one-half the hinge-line thickness.

NACA RM L9K01a

ROCKET-POWERED FLIGHT TEST OF A ROLL-STABILIZED SUPERSONIC MISSILE CONFIGURATION. Robert A. Gardiner and Jacob Zarovsky. January 12, 1950. 32p. diagrs., photos., tab. (NACA RM L9K01a)

A missile research model incorporating wing-tip ailerons and a gyro-actuated automatic roll control was flight tested at supersonic speed. The aerodynamic rolling derivatives for zero-lift flight were determined from the flight record. It was concluded that the method used in the preflight system analysis is valid and that the gyro-actuated tip-aileron control system provided a satisfactory means of obtaining roll stabilization in zero-lift supersonic flight.

NACA RM L9K09

AERODYNAMIC INVESTIGATION OF A PARABOLIC BODY OF REVOLUTION AT MACH NUMBER OF 1.92 AND SOME EFFECTS OF AN ANNULAR JET EXHAUSTING FROM THE BASE. Eugene S. Love. February 8, 1950. 75p. diagrs., photos., tab. (NACA RM L9K09)

An aerodynamic investigation of a slender pointed parabolic body of revolution was conducted at a Mach number of 1.92 with and without the effects of an annular supersonic jet exhausting from the base. Measurements without the jet in operation were made of lift, drag, pitching moment, base pressures, and radial and axial pressures. With the jet in operation, pressure measurements were made over the rear of the body with the primary variables being angle of attack, ratio of jet velocity to stream velocity, and ratio of pressure at jet exit to stream pressure.

NACA RM L50K06

HORIZONTAL-TAIL EFFECTIVENESS AND DOWNWASH SURVEYS FOR TWO 47.7° SWEPTBACK WING-FUSELAGE COMBINATIONS WITH ASPECT RATIOS OF 5.1 AND 6.0 AT A REYNOLDS NUMBER OF 6.0×10^6. Reino J. Salmi. January 12, 1951. 65p. diagrs., photos., 2 tabs. (NACA RM L50K06)

Results of wind-tunnel tests on two 47.7° sweptback wing-fuselage combinations of aspect ratios 5.1 and 6.0 to determine the effects of the vertical location of a horizontal sweptback tail on tail effectiveness and the static longitudinal stability were presented. The tests were made at a Reynolds number of about 6.0×10^6 (Mach number of 0.14) for various combinations of leading-edge and trailing-edge flaps. The results of airstream surveys in the region of the tail are also presented.

NACA RM L50K29

LOW-SPEED LONGITUDINAL AND WAKE AIR-FLOW CHARACTERISTICS AT A REYNOLDS NUMBER OF 6.0 x 10^6 OF A 52° SWEPTBACK WING EQUIPPED WITH VARIOUS SPANS OF LEADING-EDGE AND TRAILING-EDGE FLAPS, A FUSELAGE, AND A HORIZONTAL TAIL AT VARIOUS VERTICAL POSITIONS. Roland F. Griner and Gerald V. Foster. February 28, 1951. 66p. diagrs., photo., 3 tabs. (NACA RM L50K29)

The results are presented of an investigation conducted in the Langley 19-foot pressure tunnel at a Reynolds number of 6.0 x 10^6 to determine the effects of leading-edge-flap spans on an NACA 64-series wing swept back 52°. Several of the more satisfactory spans of leading-edge flaps were investigated with various combinations of trailing-edge flaps, fences, a fuselage, and a horizontal tail. Surveys of downwash angle, sidewash angle, and dynamic pressure ratio behind the wing at approximately the location of a horizontal tail are presented.

NACA RM L51I05

EFFECT OF FORMATION POSITION ON LOAD FACTORS OBTAINED ON F2H AIRPLANES. Carl R. Huss and Harold A. Hamer. December 1951. 15p. diagrs., 3 tabs. (NACA RM L51I05)

Plots of load factor against airplane position are presented for three combinations of four airplanes flying in formation. The plots show that the load-factor trend was to increase toward the end of the formation. Typical time histories are presented.

NACA RM L51K30

TIME HISTORIES OF MANEUVERS PERFORMED WITH AN F-86A AIRPLANE DURING SQUADRON OPERATIONS. Harold A. Hamer and Campbell Henderson. February 1952. 90p. diagrs., 3 tabs. (NACA RM L51K30)

Some preliminary results of maneuvers performed during U. S. Air Force squadron operations with an F-86A jet-fighter airplane are presented in time-history form. The maneuvers cover a speed range from the stall to 530-mile-per-hour indicated airspeed and pressure altitudes varying from sea level to approximately 25,000 feet. Variation of the maximum airplane linear and angular accelerations experienced during the investigation are also presented.

NACA RM L52K07

FREE-FLIGHT INVESTIGATION AT ZERO LIFT IN THE MACH NUMBER RANGE BETWEEN 0.7 AND 1.4 TO DETERMINE THE EFFECTIVENESS OF AN INSET TAB AS A MEANS OF AERODYNAMICALLY RELIEVING AILERON HINGE MOMENTS. William M. Bland, Jr., and Edward T. Marley. January 1953. 19p. diagrs., photos. (NACA RM L52K07)

An experimental investigation employing a technique which utilized a zero-lift rocket-propelled model in free flight has been made to determine some of the characteristics of an inset tab as an aerodynamic balance in the Mach number range between 0.7 and 1.4. The fixed, 0.09-chord, full-span, inset tab that was investigated was attached to a 0.3-chord full-span aileron on a wing of aspect ratio 3 and taper ratio 0.6 that had the quarter-chord line swept back 45° and NACA 65A006 airfoil sections parallel to the model center line. Results of this investigation show that the tab was capable of balancing (trimming) the aileron hinge moments throughout the Mach number range investigated even though the effectiveness of the tab decreased with increasing Mach number. It was shown that the aileron rolling effectiveness was decreased considerably when the tab was used to reduce the aileron hinge moments. The tab when considered as a servotab was an effective aerodynamic balance for Mach numbers less than 1.1. At no time during the investigation did the mass-balanced aileron show any evidence of buzz or flutter. It was also shown that the tab effectiveness could be estimated with reasonable accuracy from experimental data and from thin-airfoil theory.

NACA RM L52K25

INVESTIGATION OF THE EFFECT OF CHORDWISE POSITIONING AND SHAPE OF AN UNDERWING NACELLE ON THE HIGH-SPEED AERODYNAMIC CHARACTERISTICS OF A 45° SWEPTBACK TAPERED-IN-THICKNESS-RATIO WING OF ASPECT RATIO 6. H. Norman Silvers and Thomas J. King, Jr. January 1953. 50p. diagrs. (NACA RM L52K25)

An investigation at high speeds of chordwise positioning of underwing nacelles at a spanwise location of 0.46 semispan with an ogive-cylinder shape (fineness ratio = 9.34), an NACA 65A-series airfoil of revolution shape (fineness ratio = 10.68), and a modified NACA 0-series airfoil of revolution shape reversed in direction (fineness ratio = 10.04) was made on a small-size 45° sweptback tapered-in-thickness-ratio wing of aspect ratio 6.

NACA RM L53K16

AN AIR-FLOW-DIRECTION PICKUP SUITABLE FOR TELEMETERING USE ON PILOTLESS AIRCRAFT. Wallace L. Ikard. March 1954. 25p. diagrs., photos. (NACA RM L53K16)

A vane-type air-flow-direction pickup is described which is suitable for telemetering angle-of-attack and angle-of-sideslip data from rocket-propelled pilotless aircraft models. Test results which are presented show that the device performs well under high accelerations and is stable throughout a Mach number range from subsonic to above a Mach number of 2.5.

NACA RM L53K18

EXPERIMENTAL INVESTIGATION OF THE OSCILLATING FORCES AND MOMENTS ON A TWO-DIMENSIONAL WING EQUIPPED WITH AN OSCILLATING CIRCULAR-ARC SPOILER. Sherman A. Clevenson and John E. Tomassoni. January 1954. 20p. diagrs., photos. (NACA RM L53K18)

Results of a wind-tunnel investigation of the forces, moments, and phase angles on a two-dimensional wing equipped with an oscillating circular-arc spoiler are presented. Schlieren photographs are presented which show the flow over and behind the spoiler. Data for Reynolds numbers from 1.3×10^6 to 6.3×10^6, Mach numbers from 0.2 to 0.82, and reduced frequencies from 0 to 0.92 on the normal-force and pitching-moment coefficients and their respective phase angles referred to spoiler position are indicated.

NACA RM L53K30

PRELIMINARY INVESTIGATION OF THE FLOW IN AN ANNULAR-DIFFUSER—TAILPIPE COMBINATION WITH AN ABRUPT AREA EXPANSION AND SUCTION, INJECTION, AND VORTEX-GENERATOR FLOW CONTROLS. John R. Henry and Stafford W. Wilbur. February 1954. 27p. diagrs. (NACA RM L53K30)

The performance of an annular-diffuser—tailpipe combination with an abrupt area expansion was investigated with and without flow controls in the form of suction, injection, and vortex generators. The diffuser had a 21-inch-diameter straight outer wall, an area ratio of 1.9 to 1, and fully developed pipe flow at the inlet. Inlet Mach number was varied between 0.18 and 0.43. The ratio of the auxiliary air flow to the flow of the main stream was varied from 0 to approximately 4 percent. (Both suction and injection flow controls were effective in producing improved diffuser performance.)

National Advisory Committee for Aeronautics
Research Abstracts
and
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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1195

FORMULAS FOR THE ELASTIC CONSTANTS OF PLATES WITH INTEGRAL WAFFLE-LIKE STIFFENING. Norris F. Dow, Charles Libove, and Ralph E. Hubka. 1954. ii, 24p. diagrs., tab. (NACA Rept. 1195. Supersedes RM L53E13a)

Formulas are derived for the elastic constants of plates with integral ribbing. The constants, which include the effectiveness of the ribs for resisting deformations other than bending and stretching in their longitudinal directions, are defined in terms of four coefficients, and methods for the evaluation of these coefficients are discussed. Four of the more important elastic constants are predicted by these formulas and are compared with test results.

NACA Rept. 1199

A STUDY OF THE PROBLEM OF DESIGNING AIRPLANES WITH SATISFACTORY INHERENT DAMPING OF THE DUTCH ROLL OSCILLATION. John P. Campbell and Marion O. McKinney, Jr. 1954. ii, 18p. diagrs., tabs. (NACA Rept. 1199. Supersedes TN 3035)

This paper presents some preliminary results of a theoretical investigation to determine what design features appear most important in designing modern high-performance airplanes to have the greatest possible inherent stability of the Dutch roll oscillation in order that the need for artificial stabilizing devices can be minimized. These preliminary results cover the case of fighter airplanes at subsonic speeds.

NACA Rept. 1200

METHOD FOR STUDYING HELICOPTER LONGITUDINAL MANEUVER STABILITY. Kenneth B. Amer. 1954, ii, 17p. diagrs., photos., tabs. (NACA Rept. 1200. Supersedes TN 3022)

A theoretical analysis of helicopter maneuver stability is made and the results are compared with experimental results for both a single- and a tandem-rotor helicopter. Techniques are described for measuring in flight the significant stability derivatives for use with the theory to aid in design studies of means for achieving marginal maneuver stability for a prototype helicopter.

NACA Rept. 1201

PERFORMANCE AND BOUNDARY-LAYER DATA FROM 12° AND 23° CONICAL DIFFUSERS OF AREA RATIO 2.0 AT MACH NUMBERS UP TO CHOKING AND REYNOLDS NUMBERS UP TO 7.5×10^6. B. H. Little, Jr., and Stafford W. Wilbur. 1954. ii, 23p. diagrs., tabs. (NACA Rept. 1201. Supersedes RM L9H10; RM L9K10; RM L50C02a)

For each of two inlet-boundary-layer thicknesses, performance and boundary-layer characteristics have been determined for a 12°, 10-inch-inlet-diameter diffuser, a 12°, 21-inch-inlet-diameter diffuser, and a 23°, 21-inch-inlet-diameter diffuser. The investigation covered an inlet Mach number range from about 0.10 to the choking Mach number. The corresponding Reynolds numbers, based on inlet diameter, varied from about 0.5×10^6 to 7.5×10^6. Total-pressure losses increased and the static-pressure recovery decreased with increasing inlet-boundary-layer thickness for all three diffusers. Increasing flow rate (increasing Mach and Reynolds number) produced an adverse effect on performance, which became more severe with increasing inlet-boundary-layer thickness or increased diffuser angle.

NACA Rept. 1207

STUDIES OF THE LATERAL-DIRECTIONAL FLYING QUALITIES OF A TANDEM HELICOPTER IN FORWARD FLIGHT. Kenneth B. Amer and Robert J. Tapscott. 1954. ii, 15p. diagrs., photos., tab. (NACA Rept. 1207. Supersedes TN 2984)

Results of flight measurements and pilots' opinions of the forward-flight lateral-directional flying qualities of a tandem helicopter in several different configurations are compared and analyzed. The conclusions are presented in the form of desirable flying-qualities goals applicable to all types of helicopters. Comparison between theoretical analyses and experimental results indicates theory to be a useful tool for studying means of achieving these goals. On the basis of theoretical analyses, possible practical methods of achieving these goals in the tandem helicopter are suggested.

*AVAILABLE ON LOAN ONLY.

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NACA Rept. 1208

A COMPARISON OF THE SPANWISE LOADING CALCULATED BY VARIOUS METHODS WITH EXPERIMENTAL LOADINGS OBTAINED ON A 45° SWEPTBACK WING OF ASPECT RATIO 8.02 AT A REYNOLDS NUMBER OF 4.0×10^6. William C. Schneider. 1954. ii, 11p. diagrs., tab. (NACA Rept. 1208. Supersedes RM L51G30)

Experimental force and moment data obtained by pressure measurements on a wing of aspect ratio 8.02, 45° sweepback of the quarter-chord line, taper ratio of 0.45, and NACA 63_1A012 airfoil sections parallel to the plane of symmetry have been compared with the calculated loadings obtained by the standard methods proposed by Weissinger, Falkner, and Multhopp, as well as by variations thereof. On the basis of the present calculations, the Weissinger solution, when the number of control points was increased from 7 (the number suggested by Weissinger) to 15, or the Multhopp solution when using at least 15 control points, resulted in a good compromise between lift-curve slope and load shape, although all of the calculations underestimated the lift-curve slope.

NACA RM 55I30

STATIC SHEAR STRENGTH OF 2117-T4 (A17S-T4) ALUMINUM-ALLOY RIVETS AT ELEVATED TEMPERATURES. W. J. Dewalt and K. O. Bogardus, Aluminum Company of America. January 1956. 12p. diagrs., photo., tabs. (NACA RM 55I30)

Static single shear tests were made of 3/16-inch-diameter 2117-T4 (A17S-T4) aluminum-alloy rivets at elevated temperatures. The maximum test temperature employed was 800° F, and the time at temperature prior to testing ranged from 1/2 hour to 720 hours.

NACA RM E55I28

EFFECT OF DISSOLVED OXYGEN ON THE FILTERABILITY OF JET FUELS FOR TEMPERATURES BETWEEN 300° AND 400° F. Anderson B. McKeown and Robert R. Hibbard. December 1955. 22p. diagrs., photos., tabs. (NACA RM E55I28)

The effect of dissolved oxygen on the filter-clogging characteristics of three JP-4 and two JP-5 fuels was studied at 300° to 400° F in a bench-scale rig, employing filter paper as the filter medium. The residence time of the fuel at the high temperature was approximately 6 seconds. For these conditions, the clogging characteristics of the fuels increased with both increasing temperature and increasing concentration of dissolved oxygen. The amount of insoluble material formed at high temperatures necessary to produce clogging of filters was very small, of the order of 1 milligram per gallon of fuel.

NACA RM E55J04

PRELIMINARY INVESTIGATION OF SEVERAL ROOT DESIGNS FOR CERMET TURBINE BLADES IN TURBOJET ENGINE. III - CURVED-ROOT DESIGN. Benjamin Pinkel, George C. Deutsch, and William C. Morgan. December 1955. 17p. diagr., photos., tabs. (NACA RM E55J04)

Stresses in the root fastenings of turbine blades were appreciably reduced by redesign of the root. The redesign consisted in curving the root to approximately conform to the camber of the airfoil and elimination of the blade platform. Full-scale jet-engine tests at rated speed using cermet blades of the design confirmed the improvement.

NACA TN 3529

THE TRANSONIC CHARACTERISTICS OF 36 SYMMETRICAL WINGS OF VARYING TAPER, ASPECT RATIO, AND THICKNESS AS DETERMINED BY THE TRANSONIC-BUMP TECHNIQUE. Warren H. Nelson, Edwin C. Allen, and Walter J. Krumm. December 1955. 131p. diagrs., photo. (NACA TN 3529. Supersedes RM A53I29)

An investigation was made in the Ames 16-foot high-speed wind tunnel, utilizing the transonic-bump technique to determine the effects of plan-form taper on a series of wings having aspect ratios of 4, 3, and 2, and NACA 63A00X sections with thickness-to-chord ratios of 8, 6, 4, and 2 percent. The Mach number range was 0.6 to 1.1 with a corresponding Reynolds number range of about 1.4 million to 2.0 million. The results indicate that increasing the taper ratio caused only small increases in lift-curve slope except for the wings of highest aspect ratio and thinnest sections. Increasing taper ratio generally increased the overall center-of-pressure travel in going from subsonic to supersonic speeds.

NACA TN 3549

FLIGHT INVESTIGATION AT MACH NUMBERS FROM 0.8 TO 1.5 TO DETERMINE THE EFFECTS OF NOSE BLUNTNESS ON THE TOTAL DRAG OF TWO FIN-STABILIZED BODIES OF REVOLUTION. Roger G. Hart. December 1955. 11p. diagrs., photos., tabs. (NACA TN 3549. Supersedes RM L50I08a)

Values of total-drag coefficient were measured for two fin-stabilized, blunt-nose bodies of revolution in free flight at Mach numbers from 0.8 to 1.5. The blunt-nose bodies were designed by rounding off the sharp noses of bodies, having nose fineness ratios of about 3-1/2, to radii equal to about one-fourth the maximum radii. No increase in the drag of either body was found.

NACA TN 3551

EXPERIMENTAL INVESTIGATION AT LOW SPEED OF EFFECTS OF FUSELAGE CROSS SECTION ON STATIC LONGITUDINAL AND LATERAL STABILITY CHARACTERISTICS OF MODELS HAVING 0° AND 45° SWEPTBACK SURFACES. William Letko and James L. Williams. December 1955. 45p. diagrs., tabs. (NACA TN 3551)

An experimental investigation was made at low speed to determine the effects of fuselage cross section on the static longitudinal and lateral stability characteristics of airplane models having 0° and 45° sweptback surfaces. The results indicate that the shallow-fuselage configurations are the least stable longitudinally, and the deep-fuselage configurations are the least stable directionally.

NACA TN 3556

GRAIN-BOUNDARY BEHAVIOR IN CREEP OF ALUMINUM BICRYSTALS. F. N. Rhines, W. E. Bond, and M. A. Kissel, Carnegie Institute of Technology. December 1955. 56p. diagrs., photos., tabs. (NACA TN 3556)

The gliding of one metal crystal with respect to another parallel to their mutual grain boundary has been studied in pure aluminum bicrystals during isothermal creep at temperatures ranging from 200° to 650° C under static stresses of 10 to 1,600 psi. The motion is spasmodic and begins with an induction period. The mechanism of grain-boundary gliding is described as a coordinated alternation of slip and recovery in a chain of subgrains along the creep boundary. This concept is employed to account both for the rate of primary creep and for the transition from primary to steady-state creep.

NACA TN 3559

LAMINAR SEPARATION OVER A TRANSPIRATION-COOLED SURFACE IN COMPRESSIBLE FLOW. Morris Morduchow, Polytechnic Institute of Brooklyn. December 1955. 32p. diagrs. (NACA TN 3559)

A theoretical analysis of laminar separation in compressible flow over a transpiration-cooled surface maintained at a uniform wall temperature is made. A simple method of calculating the separation point over such a surface for a given adverse pressure gradient, Mach number, wall temperature, and uniform coolant temperature is developed. A numerical example shows the effects of these parameters on the separation point.

NACA TN 3584

FREE-CONVECTION EFFECTS ON HEAT TRANSFER FOR TURBULENT FLOW THROUGH A VERTICAL TUBE. E. R. G. Eckert, Anthony J. Diaguila, and John N. B. Livingood. December 1955. 24p. diagrs. (NACA TN 3584)

Experimental heat-transfer data for the turbulent flow of fluids through stationary vertical tubes with both small and large length-to-diameter ratios (to 40) are compared. The limits of the different flow regions, originally established for a tube with small length-to-diameter ratio, apply on the basis of existing data for a tube with large length-to-diameter ratio.

NACA TN 3588

SUMMARY OF LAMINAR-BOUNDARY-LAYER SOLUTIONS FOR WEDGE-TYPE FLOW OVER CONVECTION- AND TRANSPIRATION-COOLED SURFACES. John N. B. Livingood and Patrick L. Donoughe. December 1955. 33p. diagrs., tabs. (NACA TN 3588)

The solutions presented were determined for conditions prevailing over cooled turbine blades. The principal results are restricted to a Prandtl number at the wall of 0.7 and are presented for large temperature changes through the boundary layer adjacent to a constant-temperature wall and for small temperature changes through the boundary layer adjacent to a wall of either a constant or a variable temperature. Results from the literature for Prandtl numbers up to 5.0 are discussed for a flat porous plate.

NACA TN 3599

TURBULENT HEAT-TRANSFER MEASUREMENTS AT A MACH NUMBER OF 0.87. Maurice J. Brevoort and Bernard Rashis. December 1955. 13p. diagrs. (NACA TN 3599)

An axially symmetric annular nozzle was used to obtain essentially flat-plate data on turbulent-heat-transfer coefficients and temperature-recovery factors for a Mach number of 0.87 and for a Reynolds number range from 9.88×10^6 to 2.09×10^8. The heat-transfer coefficients are slightly higher than theoretical results for a Mach number of 1.0, and they agree with theoretical results for incompressible flow. The temperature-recovery factors decreased from 0.899 at a Reynolds number of 9.88×10^6 to 0.876 at a Reynolds number of 2.09×10^8.

NACA TN 3601

PRESSURE RISE ASSOCIATED WITH SHOCK-INDUCED BOUNDARY-LAYER SEPARATION. Eugene S. Love. December 1955. 32p. diagrs. (NACA TN 3601)

Some recent contributions to the problem of shock-induced separation of the boundary layer are examined, and additional analytical and experimental results are presented. The probable ranges of pressure rises and flow deflections associated with separation are indicated. Consideration is given to the effects of Mach number, adverse pressure gradient, and Reynolds number for laminar boundary layers and to the effects of Mach number, Reynolds number, and ratio of specific heats for turbulent boundary layers.

NACA TN 3602

LABORATORY INVESTIGATION OF AN AUTOPILOT UTILIZING A MECHANICAL LINKAGE WITH A DEAD SPOT TO OBTAIN AN EFFECTIVE RATE SIGNAL. Ernest C. Seaberg. December 1955. 27p. diagrs., photos., tab. (NACA TN 3602. Supersedes RM L9F15a)

The results of a laboratory investigation of a frontlash autopilot are presented in this analysis. The operation of this autopilot is based on the nonlinear principle of utilizing a dead spot in the servomotor feedback linkage to the gyroscope base reference as a means of obtaining a leading control signal. The investigation consists of oscillating-table tests in order to determine the effect of frontlash on the amplitude and phase responses of the system. Roll-simulator tests were also conducted in order to confirm the possibility of stabilization of pilotless aircraft with this type of automatic pilot, and an attempt to bracket the usable range of this autopilot was made by plotting the degree of stability as a function of the aerodynamic roll parameters.

NACA TN 3605

THEORETICAL SPAN LOAD DISTRIBUTIONS AND ROLLING MOMENTS FOR SIDESLIPPING WINGS OF ARBITRARY PLAN FORM IN INCOMPRESSIBLE FLOW. M. J. Queijo. December 1955. 45p. diagrs. (NACA TN 3605)

A method is presented for determining the span load distribution and rolling moment due to sideslip for wings of arbitrary plan form in incompressible flow. The method was used to prepare charts from which the rolling moment due to sideslip can be obtained for wings having a large variety of aspect ratio, sweep, and taper ratio. Calculated values of span loads and rolling moments are compared with those of other theories and with experimental results.

NACA TN 3613

THE PROBLEM OF REDUCING THE SPEED OF A JET TRANSPORT IN FLIGHT. Don D. Davis, Jr. December 1955. 22p. diagrs. (NACA TN 3613)

The distance required to decelerate a high-speed jet transport from the normal operating speed to the design speed for maximum gust intensity (rough-air speed) has been calculated for the case of level flight with the engines idling. This distance was found to be much greater for a jet transport than for a typical piston-engine transport at the same altitude, and the distance was found to increase with altitude up to the altitude for maximum true airspeed. The use of aerodynamic brakes, thrust reversal, or a climbing maneuver is shown to be effective in reducing the distance required to reach the rough-air speed.

BRITISH REPORTS

N-39787*

Department of Supply (Australian)
TURBULENT BOUNDARY LAYER CONTROL BY RAMPS OR WEDGES. A. V. Stephens and G. A. Collins. May 1955. 19p. diagrs., photos. (Department of Supply. ACA-55)

Part I describes preliminary experiments of a new device for the delay or elimination of turbulent separation. The device redistributes the total pressure in a boundary layer by means of wedge-shaped excrescences on the surface. Part II deals with the continuation of these experiments. The operation of boundary-layer wedges for controlling turbulent separation was investigated in an adverse pressure gradient on the upper surface of a wing. A new type of wedge in the form of a flat ramp was developed. These were applied to various wings and flaps with significant improvements in the lift characteristics. In most of the applications tried, the drag due to the wedges or ramps themselves detracted a large portion from the reduction in drag brought about by the delay of turbulent separation from the flap or wing.

N-40078*

Aeronautical Research Council (Gt. Brit.)
CALCULATION OF THE EFFECT OF CAMBER AND TWIST ON THE PRESSURE DISTRIBUTION AND DRAG ON SOME CURVED PLATES AT SUPERSONIC SPEEDS. G. M. Roper. 1955. 68p. diagrs. (ARC R & M 2794; ARC 13,755. Supersedes RAE Aero 2386)

The shapes of two groups of curved wings are found, such that the thrust loading on the leading edges, particularly near the wing tips, is removed or modified. It is also shown how the shapes of wings of one of the groups can be determined to satisfy certain requirements with respect to camber and twist, or the magnitude of aerodynamic characteristics. The lift, induced drag, and pitching-moment coefficients for some wings of triangular plan form have been calculated, and the results are shown graphically.

N-40079*

Aeronautical Research Council (Gt. Brit.)
WIND-TUNNEL TESTS ON THE NPL 434 NOSE-SLOT SUCTION AEROFOIL. J. Williams, R. C. Bankhurst, and Edna M. Love. 1955. 10p. diagrs., tab. (ARC R & M 2876. Supersedes ARC 14,713; Perf. 897; FM 1690)

Stalling tests were made on the 8-percent-thick section NPL 434, which has been specially designed for nose-slot suction. At the higher suction quantities, the maximum lift of the airfoil was considerably greater than for the Lighthill and Glauert sections previously tested when due allowance was made for the difference in camber. At low suction quantities, there was no improvement. Tests with various slot widths showed that the velocity into the slot as well as the suction quantity was important in relation to high maximum lift, and that the values of $C_{L_{max}}$ achieved with suction were determined more nearly uniquely by the momentum coefficient rather than by the quantity coefficient. Static-pressure measurements made in the slot and ducting indicated that the suction head required at the stall was high, being at least equal to the dynamic head in the slot throat, but that some reduction could be expected from improvements in the slot entry shape.

N-40081*

Aeronautical Research Council (Gt. Brit.)
HIGH-SPEED WIND-TUNNEL TESTS ON SIX WINGS OF 40° SWEEPBACK, WITH VARIOUS SECTION SHAPES. L. N. Holmes and A. B. Haines. 1955. 39p. diagrs., photos., tabs. (ARC R & M 2930; ARC 14,687. Supersedes RAE Aero 2452)

Tests have been made in the Royal Aircraft Establishment high-speed wind tunnel on six wings, all of the same plan form (aspect ratio 3.5, taper ratio 0.4, quarter-chord sweep 40°) and thickness/chord ratio (10 percent) but of different section shapes. Four of the wings had symmetrical sections, one was cambered, and one was twisted with camber varying from root to tip. Of the symmetrical wings, the one with RAE 101 section had a much better performance than the other three (RAE 104, NACA 66A-010, and HSA 1). The steep drag rise with Mach number occurred at a Mach number about 0.02 higher on the RAE 101 wing than on the next best wing. The RAE 101 wing also had a higher lift-curve slope and more regular pitching-moment characteristics.

N-40083*

Aeronautical Research Council (Gt. Brit.)
MEASUREMENTS OF TWO-DIMENSIONAL DERIVATIVES ON A WING-AILERON-TAB SYSTEM WITH A 1541 SECTION AEROFOIL. PART I - DIRECT AILERON DERIVATIVES. K. C. Wight. 1955. 18p. diagrs., tabs. (ARC R & M 2934. Supersedes ARC 15,292; ARC 0.1017; ARC S & C 2694)

This report presents results obtained for the direct aileron derivatives with the 1541 section, showing the effects of the following variables: frequency parameter, Reynolds number, amplitude of oscillation, position of transition on the wing, and mean aileron angle. Corrections arising from the apparatus are discussed and reference is made to an attempt to measure the direct tab derivatives. Comparison with vortex-sheet theory shows that measured values of stiffness and damping derivatives are approximately 0.6 of the theoretical values.

N-40085*

Aeronautical Research Council (Gt. Brit.)
SUPERSONIC FLOW PAST SLENDER BODIES OF ELLIPTIC CROSS-SECTION. L. E. Graenkel. 1955. 27p. diagrs. (ARC R & M 2954; ARC 15,166. Supersedes RAE Aero 2466)

The theories of supersonic flow past slender, smooth, pointed bodies of arbitrary cross-sectional shape, due to Ward, and of the flow past slender bodies of revolution with discontinuities in profile slope, due to Lighthill, are applied and extended to calculate first approximations for the aerodynamic forces on bodies of elliptic cross section with discontinuities in profile slope. Open-nose bodies are included in this class, but only the external forces are considered. The investigation is restricted to bodies the major axes of whose cross sections are coplanar and whose cross sections have constant eccentricity. General expressions are deduced for the wave drag, lift, induced drag, and pitching moments of such bodies.

N-40277*

Aeronautical Research Council (Gt. Brit.)
PRESSURE DISTRIBUTIONS ILLUSTRATING FLOW REATTACHMENT BEHIND A FORWARD MOUNTED FLAP. E. C. Maskell. 1955. 22p. diagrs., tab. (ARC CP 211)

Pressure distributions, for M = 0.3, at midspan of a 5-percent chord split flap mounted on an NACA 0015 airfoil are presented from results previously obtained by Clarke in 1946. Two basic types of pressure distribution are identified. These are associated with fully detached flow behind the flap and with reattachment of the flow to the wing surface. An intermediate type, corresponding to reattachment in the neighborhood of the wing trailing edge, is also identified. The physical nature of the flow behind a flap is considered, and some ideas on the mechanism of reattachment are suggested.

N-40278*

Aeronautical Research Council (Gt. Brit.)
INVESTIGATION OF HIGH LENGTH/BEAM RATIO SEAPLANE HULLS WITH HIGH BEAM LOADINGS - HYDRODYNAMIC STABILITY. PART 2 - THE EFFECT OF CHANGES IN THE MASS, MOMENT OF INERTIA AND RADIUS OF GYRATION ON LONGITUDINAL STABILITY LIMITS. J. K. Friswell, A. G. Kurn, and D. M. Ridland. 1955. 34p. diagrs., photos., tab. (ARC CP 202)

Effects of varying load, moment of inertia, and radius of gyration on the stability limits of a high length-to-beam-ratio dynamic model have been ascertained. A theoretical analysis has been compared with experimental results. The effects on the limits of a change from a velocity to a draught base have also been considered. It has been found that the load is the most critical factor, and that provided the load is kept constant increasing the moment of inertia has little effect on the limits. There was good agreement between theory and experiment.

N-40279*

Aeronautical Research Council (Gt. Brit.)
INVESTIGATION OF HIGH LENGTH/BEAM RATIO SEAPLANE HULLS WITH HIGH BEAM LOADINGS - HYDRODYNAMIC STABILITY. PART 6 - THE EFFECT OF FOREBODY WARP ON STABILITY AND SPRAY CHARACTERISTICS. D. M. Ridland. 1955. 34p. diagrs., photos., tabs. (ARC CP 203)

The effects of forebody warp on stability, spray, and elevator effectiveness are deduced from the results of tests on three models of length-beam ratio 11, which were alike in every respect except that of forebody warp, the angle of dead rise being increased at the rate of 0°, 4°, and 8° per beam, respectively. It was found that forebody warp considerably improved longitudinal stability and spray characteristics, impaired directional stability slightly, and increased elevator effectiveness. The best configuration was that with 8° of forebody warp per beam.

N-40280*

Aeronautical Research Council (Gt. Brit.)
INVESTIGATION OF HIGH LENGTH/BEAM RATIO SEAPLANE HULLS WITH HIGH BEAM LOADINGS - HYDRODYNAMIC STABILITY. PART 1 - TECHNIQUES AND PRESENTATION OF RESULTS OF MODEL TESTS. D. M. Ridland, J. K. Friswell, and A. G. Kurn. 1955. 50p. diagrs., photos., tabs. (ARC CP 201)

This report aims at providing a background, to be read in conjunction with the individual model test reports, to the hydrodynamic stability phase of a research program on seaplanes with high length-beam ratio hulls and high beam loadings. Methods of testing and presenting results, which it is intended will be used throughout the program, are described and points requiring further investigation are noted.

N-40281*

Aeronautical Research Council (Gt. Brit.)
SOME NOTES ON THE CALCULATION OF PRESSURE PICK-UP SENSITIVITY AND THE CONDITIONS FOR MAXIMUM SENSITIVITY AND THE DEVELOPMENT OF A MINIATURE PRESSURE PICK-UP. J. K. Friswell. 1955. 46p. diagrs., photos. (ARC CP 199)

A theoretical analysis is made of the sensitivity of a pressure pickup of the strain-gaged cantilever type and of the conditions for maximum sensitivity. Two different configurations are treated and the effect of tension in the diaphragm is also considered. An account is given of experiments carried out in order to verify the analysis and to observe the behavior outside the range of validity of the theory. Suggestions are made for practical pickup design based on both theory and experiment and details are given of the construction of a miniature pressure pickup of the type considered in the theoretical treatment.

N-40282*

Aeronautical Research Council (Gt. Brit.)
FURTHER EXPERIMENTS WITH A SLOTTED-WALL TEST SECTION. Friedrich Vandrey. 1955. 16p. diagrs. (ARC CP 207)

As shown previously, a slotted-wall test section is especially suitable for a water tunnel intended for the testing of long models. The present report deals with the transition from this type of test section to the diffuser. The main results are: The optimum diameter of the diffuser entry is 10 percent greater than the diameter of the nozzle (for 30 percent losses in the test section, less for smaller losses). A gap should be left between the end of the slotted wall and the diffuser entry. A model in the test section has very little influence on the pressure in the diffuser entry. Experiments both in air and water are in good agreement.

N-40283*

Aeronautical Research Council (Gt. Brit.)
INVESTIGATION OF HIGH LENGTH/BEAM RATIO SEAPLANE HULLS WITH HIGH BEAM LOADINGS - HYDRODYNAMIC STABILITY. PART 10 - THE EFFECT OF AFTERBODY LENGTH ON STABILITY AND SPRAY CHARACTERISTICS. D. M. Ridland. 1955. 35p. diagrs., photos., tabs. (ARC CP 204)

The effects of afterbody length on stability, spray, and elevator effectiveness are deduced from the results of tests on four models of the series which were alike in every major respect except that of afterbody length. The models had afterbody lengths of 4, 5, 7, and 9 beams, respectively. Increasing afterbody length improved the disturbed stability characteristics considerably, made no effective overall change in the undisturbed qualities, and reduced trim generally; it impaired spray characteristics and directional stability and reduced elevator effectiveness.

N-40305*

Royal Aircraft Establishment (Gt. Brit.)
CORROSION AND PROTECTION OF MAGNESIUM ALLOYS CONTAINING ZIRCONIUM. H. G. Cole. June 1955. 17p. photos., tabs. (RAE Tech. Note Met. 222)

Seawater spray corrosion tests showed that magnesium zirconium type alloys had a corrosion resistance similar to that of ordinary purity magnesium aluminum alloys. Chromate treatment alone was less effective on magnesium zirconium alloys, but chromating followed by paint was as effective as on magnesium aluminum alloys; this result emphasizes the importance of durable paint. Substantial dark brown films deposited by the M. E. L. chrome-manganese bath gave approximately the same results as films formed in bath iii of D. T. D. 911A. High corrosion resistance was again shown by high purity magnesium aluminum alloys in both cast and sheet form.

N-40307*

Royal Aircraft Establishment (Gt. Brit.)
THE CALCULATION OF THE PRESSURE DISTRIBUTION ON THE SURFACE OF THICK CAMBERED WINGS AND THE DESIGN OF WINGS WITH GIVEN PRESSURE DISTRIBUTIONS. J. Weber. June 1955. 104p. diagrs., tabs. (RAE Aero 2548)

This report is a further contribution toward solving the problem of calculating the pressure distribution over the surface of swept wings of any section shape in inviscid incompressible flow. Wings with symmetrical airfoil sections and cambered wings with a special type of camberline have already been dealt with in references 1 to 7. This report deals with thick cambered wings of any section shape and also with the inverse problem of designing airfoils which have prescribed velocity distributions. As the general method is so organized that particular solutions are built up of a few basic solutions, so also in the present case only the basic cases of the two-dimensional airfoil and the center section of swept wings need be treated in detail. A simple calculation method, suitable for practical application, is derived by approximating to the integral expressions for the unknown quantities (velocity increment or section ordinate or the slope of the section) by finite sums over the given section ordinates or velocity increments and tabulating the required coefficients. For the two-dimensional airfoil, a comparison is made with exact results, which shows that the accuracy is sufficient for practical purposes.

N-40308*

Marine Aircraft Experimental Establishment (Gt. Brit.) INVESTIGATION OF HIGH LENGTH/BEAM RATIO SEAPLANE HULLS WITH HIGH BEAM LOADINGS - HYDRODYNAMIC STABILITY. PART 21 - SOME NOTES ON THE EFFECT OF WAVES ON LONGITUDINAL STABILITY CHARACTERISTICS. D. M. Ridland. August 1955. 58p. diagrs., tabs. (MAEE F/Res/257)

In this report the results are given of tests on three models of the series, designed to provide information on the correlation between stability with disturbance and stability in waves. No correlation was observed, but the results are analyzed and compared with previous work, and some important general conclusions drawn as to the nature of disturbed stability and the behavior of flying boats in waves.

N-40309*

Royal Aircraft Establishment (Gt. Brit.)
VARIATIONS IN THE STRENGTH OF ALUMINIUM ALLOY SHEET. D. T. Jones. July 1955. 11p. diagrs. (RAE Tech. Note Structures 171)

In the design of aircraft structures allowance is made for variation in the material strength of sheet but the thickness of the sheet is usually assumed to be constant at the nominal value for the gage used. Thickness variation may appreciably affect the tensile strength of nominally identical pieces of sheet, especially when the tolerance range in thickness is wide. A method is given in this note for calculating the distribution of strength when the mean and scatter of material strength and the mean and scatter of thickness of pieces are known. Expressions are given for the mean and scatter in strength of pieces and, for those cases where the distribution of the strength can be taken as normal, design values can readily be deduced from the expressions.

N-40312*

Royal Aircraft Establishment (Gt. Brit.)
VELOCITY DISTRIBUTION ON THIN TAPERED ARROWHEAD AND DELTA WINGS WITH SPANWISE CONSTANT THICKNESS RATIO AT ZERO INCIDENCE. S. Neumark and J. Collingbourne. APPENDIX - COMPUTATION OF SUPERVELOCITY ON A. C. E. E. J. York. May 1955. 44p. diagrs., tabs. (RAE Aero 2545)

This report is a continuation of four earlier ones by the present authors and contains a theoretical investigation of subsonic flow past thin tapered sweptback wings at zero incidence, by the first order method. The basic theory is followed by the results of computation carried out on the Automatic Computing Engine of the National Physical Laboratory, for several groups of plan forms, partly of arrowhead and partly delta type, with varying sweepback, aspect ratio and taper, the profile being biconvex parabolic and thickness ratio constant spanwise. The results are illustrated by graphs of isobar patterns on 36 wings.

N-40335*

National Gas Turbine Establishment (Gt. Brit.)
A SAFETY DEVICE FOR DOUBLE LEVER TYPE CREEP TESTING MACHINES. T. Thorley. September 1955. 8p. diagrs. (NGTE Memo. M. 194)

The device described in this memorandum has been designed in order to protect double lever creep testing machines and test specimens from damage in the event of furnace failure or power shutdown. This danger arises from the contraction of the pull rod/specimen assembly consequent upon the reduction of temperature resulting from furnace failure. Due to the double lever system, a small amount of movement of the pull rod end of the lower lever results in a large movement of the free end of the upper lever. As the travel of the upper lever is limited by a stop, only a small contraction of the pull rod/specimen assembly can occur before the lever contacts the stop. Once this occurs, any further contraction results in forces of considerable magnitude which may damage either the machine or test piece.

N-40336*

Royal Aircraft Establishment (Gt. Brit.)
SOME WORK ON TENSION PADS FOR STRUCTURAL TESTS. J. K. Oaks and P. B. Hovell. August 1955. 15p. diagrs., photos. (RAE Tech. Note Structures 172)

Sorbo rubber tension pads glued with Bostik adhesive have been developed for loading aircraft components during static and fatigue strength tests. The gluing technique, detail tests, and pilot test on a typical component are described. A safe working stress for this type of pad is suggested. An account is given of some component approval tests in which tension pads were used.

N-40337*

Royal Aircraft Establishment (Gt. Brit.)
DEVELOPMENT AND TEST OF A COOLED ROTATING DISC ICING METER. F. J. Bigg. March 1955. 20p. diagrs., photos. (RAE Tech. Note Mech. Eng. 200)

The rotating disk icing meter is described. A useful flight instrument, its application is limited since it does not function at ambient temperatures above -3° C, even if the airspeed is as low as 120 knots, neither does it accurately record the total water content at any temperature. These limitations can be overcome by cooling the disk. A cooling method is described, and flight tests show the method to be most successful.

N-40338*

Royal Aircraft Establishment (Gt. Brit.)
THE ATOMISATION OF WATER BY AIR BLAST NOZZLES FOR THE SIMULATION OF CLOUD CONDITIONS FOR ICING RESEARCH. F. J. Bigg. June 1955. 24p. diagrs., photos. (RAE Tech. Note Mech. Eng. 203)

A review of the data on water atomization indicates that air blast nozzles are the only type capable of producing a spray of droplets in the required size range, around 20 microns, and in the necessary concentrations for the simulation of natural cloud. From a size analysis of droplet samples taken from several different air blast nozzles at various waterflows, up to 3 gal/hr, and air pressures from 10 to 40 lb/in.^{2}, made in a wind tunnel with air velocities in the range of 100 to 200 ft/sec, it is concluded that the volume median diameter of the spray is given approximately by the formula

$$\text{V.M.D.} = 10 + \frac{1.5 \text{ gal/hr}}{(\text{applied air pressure})(\text{area of air annulus})}$$

N-40339*

Royal Aircraft Establishment (Gt. Brit.)
ULTRA-HIGH STRENGTH STEELS. G. Meikle. May 1955. 8p. tabs. (RAE Tech. Note Met. 221)

The results of tests on steels of over 100 tons/sq in. U.T.S. by The Brown-Firth Research Laboratories and by Fairey Aviation Co. Ltd., are given. Results on one steel tested at RAE are mentioned and the future use of these steels discussed.

N-40340*

National Gas Turbine Establishment (Gt. Brit.)
THE 600 H.P. OVERSPEED AND BURSTING RIG AND N.G.T.E. PYESTOCK. T. M. Jones and R. L. Brooking. September 1955. 10p. diagrs. (NGTE Memo. M. 249)

The main design and installation features of the 600-hp spinning rig are described. It was designed for general spinning tests on gas turbine components and the test facilities offered by it are available to industry. It is capable of spinning rotors up to 6 feet in diameter and 8 feet long as well as single stage disks and impellers. The nominal maximum design speed is 47,000 rpm. Its chief uses are the following: (1) for spinning tests carried to destruction, in order to determine the safety margin existing on current rotor designs; (2) for testing and developing new or novel rotor designs; (3) for general research work, to determine the effect of various factors on disk behavior and strength; and (4) for experiments on the whirling of shaft systems.

N-40348*

Aeronautical Research Council (Gt. Brit.)
LIST OF CURRENT PAPERS PUBLISHED BY THE AERONAUTICAL RESEARCH COUNCIL (NUMBERS 151-200). 1955. 4p. (ARC CP 200)

N-40349*

Aeronautical Research Council (Gt. Brit.)
EXPERIMENTS ON A SLOTTED-WALL WORKING SECTION IN A WIND TUNNEL. F. Vandrey and K. Wieghardt. 1955. 17p. diagrs. (ARC CP 206)

The present investigation was undertaken in order to develop a test section for a planned water tunnel with the correction properties of a free jet, but with a considerably greater length than a conventional open working section. The experiments were carried out in air (V = 96 fps) with a jet of 5-inch diameter and 30-inch length, enclosed in a cage of 16 longitudinal rods with an opening ratio of 18 percent of the total boundary. The cage was surrounded by a rigid cylinder of 12-1/2 inch diameter representing the outer boundary of the water tunnel. The main results were: The velocity distributions of the jet in the cage are about the same as in a free jet at half the distance from the nozzle. The static pressure in the cage is constant. Pressure distributions of models in the cage are the same as in a free jet. Even considerable alterations of the design and deformations of the cage have practically no influence on the results.

N-40350*

Aeronautical Research Council (Gt. Brit.)
OPTICAL CHARACTERISTICS OF LAMINATED CAMERA WINDOWS. A. C. Marchant and B. M. Mathieson. 1955. 22p. diagrs., photos., tabs. (ARC CP 210)

Tests were made on windows of both plane and spherical form. Photographic tests of their effect upon the resolving power of an associated camera system have been carried out. The wedge angle of the windows has been measured, and the surface flatness and internal homogeneity of the plane windows tested; while the effects of the curved windows, upon the correction of the camera lens associated with them, have been assessed visually. It is concluded that the laminating process does not, in itself, introduce deleterious effects on optical performance. Plane windows may introduce a focal shift which will reduce resolving power. Curved windows are shown to reduce overall resolution through the introduction of astigmatism and field curvature.

N-40351*

Aeronautical Research Council (Gt. Brit.)
FULL SCALE MEASUREMENTS OF IMPACT LOADS ON A LARGE FLYING BOAT (SUNDERLAND MK. 5) PART II - RESULTS FOR IMPACTS ON MAIN STEP. J. A. Hamilton. 1955. 53p. diagrs., tabs. (ARC CP 205)

Full-scale measurements of landing impact forces and pressures have been made on the hull of a Sunderland Mk. 5 flying boat (weight 50,000 lb) in order to provide basic information on the agreement between experiment and the latest available impact theories. The experiments were arranged to give impact conditions as near as possible to those assumed in theory. The results revealed a marked discrepancy between the form of the total impact-time curve predicted by the theory, and that measured on the aircraft. In particular, the measurement of time to reach maximum impact force was about twice that indicated by theory. The magnitudes of the theoretical and measured maximum impact forces were in reasonable agreement.

N-40353*

Aeronautical Research Council (Gt. Brit.)
AN ANALYSIS OF AERODYNAMIC DATA ON BLOWING OVER TRAILING EDGE FLAPS FOR INCREASING LIFT. J. Williams. 1955. 33p. diagrs., tab. (ARC CP 209)

Results on blowing over trailing-edge flaps are discussed and the force measurements from wind-tunnel tests are correlated in terms of the blowing-moment coefficient. Simple methods are tentatively suggested for the practical prediction of the lift increment (at constant α) attainable on finite wings, and the associated increase in pitching moment. Theoretical curves, relating to compressible isentropic flow through the blowing slot, are presented for the determination of the various blowing coefficients in terms of the blowing-pressure ratio. For sweptback wings in particular, more experiments are needed to establish a satisfactory method of prediction and to determine the optimum blowing configuration. The change in wing stalling angle due to blowing over trailing-edge flaps also warrants further investigation.

N-40486*

Ministry of Supply (Gt. Brit.)
METAL FATIGUE. A BIBLIOGRAPHY OF UNPUBLISHED REPORTS. August 1955. 23p. (MOS TIB/BIB(U)/4)

N-40488*

Royal Aircraft Establishment (Gt. Brit.)
TURBULENCE ENCOUNTERED BY COMET 1 AIRCRAFT. J. R. Heath-Smith. May 1955. 32p. diagrs., tabs. (RAE Structures 179)

Acceleration records have been obtained of the turbulence encountered by B.O.A.C. Comet aircraft in 680,000 miles of operational flying on routes connecting London with South Africa and the Far East. It is shown that turbulence decreases with increasing altitude. Of all gusts greater than 10 ft/sec E.A.S. 91 percent were encountered below 27,500. Above 27,500 feet, about 75 percent of gusts greater than 10 ft/sec E.A.S. occur in cumuliform cloud. In flight sectors where conditions favor the formation of cumuliform cloud, gusts may be several times more numerous on average than over widespread routes.

N-40489*

Royal Aircraft Establishment (Gt. Brit.)
WEIGHT PREDICTION FOR WINGS OF BOX CONSTRUCTION. M. E. Burt. August 1955. 66p. diagrs., tabs. (RAE Structures 186)

The need for thin wings of high torsional stiffness leads to the use of box construction, in which both bending strength and torsional stiffness are provided by a single structural box. This report gives a method by which the wing weight for four types of box construction can be predicted from data available in the project stage of a new design. The equations are derived mainly on a theoretical basis, supported as far as possible by analysis of actual structures, and are evaluated for aluminum alloy at "room" temperature.

N-40491*

Royal Aircraft Establishment (Gt. Brit.)
THE BUCKLING UNDER LONGITUDINAL COMPRESSION OF A SIMPLY SUPPORTED PANEL THAT CHANGES IN THICKNESS ACROSS THE WIDTH. E. C. Capey. August 1955. 27p. diagrs. (RAE Tech. Note Structures 174)

An exact solution is obtained for the buckling under longitudinal compression of a simply supported panel made up of three strips in which the central strip differs in thickness from the outer strips. The critical buckling stress is calculated numerically for a number of different ratios between thicknesses and widths of the central and outer strips. Some comparative results are given for the case when the longitudinal edges are clamped.

N-40492*

National Gas Turbine Establishment (Gt. Brit.)
THE FOULING OF TURBINE BLADING BY THE PRODUCTS OF COMBUSTION OF PULVERISED FUEL. PART III. SIMULATION OF THE FOULING, USING AN INERT MINERAL. R. I. Hodge. October 1955. 36p. diagrs., photos., tabs. (NGTE Memo. M. 237)

Pulverized feldspar was substituted for combustion products in tests under similar conditions. It was found that the erosion rates were of the same order. A similar transition from erosion to deposition of the impacting material at gas temperatures several hundred degrees centigrade below the impacting material fusion point was observed, but only when the dust loading contained submicron sizes. This throws some light on the nature of the deposition mechanism.

N-40494*

Royal Aircraft Establishment (Gt. Brit.)
THE RELATIVE REACTIVITIES OF BIFUNCTIONAL MONOMERS. PART II. SWELLING STUDIES OF CROSS-LINKED ALLYL METHACRYLATE POLYMERS. G. M. Bristow. September 1955. 17p. diagrs., tabs. (RAE Tech. Note Chem. 1261)

The preparation of allyl methacrylate and its polymerization to a cross-linked polymer in a form suitable for swelling measurements are described. From such measurements values are deduced for the reactivity ratio of the monomeric groups at various stages of the reaction. The general trend of these values is briefly discussed.

N-40497*

Royal Aircraft Establishment (Gt. Brit.)
FATIGUE OF AIRCRAFT PRESSURE CABINS. Percy B. Walker. (Presented at Anglo-American Conference in Los Angeles, June 1955). September 1955. 33p. diagrs., photos. (RAE Structures 188)

The stress pattern in a pressure cabin is first discussed, mainly with respect to cabin-pressure loading. The various other aircraft loading actions contributing to fatigue are then considered and attention is drawn to those which appear most important. The report is concluded by a study of a technique of fatigue testing complete aircraft under cabin-pressure and wing-loading cycles, and examples are given of typical failures of the pressure cabin. RAE test apparatus is described and problems of technique are discussed. The paper concludes with a description of some of the modes of failure that have been produced on a Comet fuselage now available for research purposes.

N-40506*

Aeronautical Research Council (Gt. Brit.)
METHODS OF DETERMINATION AND OF FIXING BOUNDARY LAYER TRANSITION ON WIND TUNNEL MODELS AT SUPERSONIC SPEEDS. K. G. Winter, J. B. Scott-Wilson, and F. V. Davies. 1955. 27p. diagrs., photos., tab. (ARC CP 212)

An account is given of methods used in supersonic wind tunnels for observation of boundary-layer phenomena, in particular of the sublimation and oil film techniques. Examples are given of the uses of these techniques. On the fixing of transition a rough guide is given for the minimum size of wire required, with an example of the use of wires. The results of a brief experiment on the profile of an artifically promoted turbulent boundary layer are given.

N-40507*

Aeronautical Research Council (Gt. Brit.)
WIND TUNNEL TESTS ON A 6 FT DIAMETER HELICOPTER ROTOR. T. B. Owen, R. Fail, and R. C. W. Eyre. 1955. 33p. diagrs., tabs. (ARC CP 216)

Thrust, torque, and flapping angle have been measured on a 6-foot diameter rotor over a range of blade angle, shaft inclination, and tip speed ratio for comparison with the 12-foot diameter rotor previously tested in the 24-foot tunnel. In addition to the tests in the 24-foot tunnel, the 6-foot diameter rotor was also tested in the No. 2 11-1/2 foot tunnel to investigate tunnel constraint. Brief investigations were made of support interference and blade twisting. Blade stalling has larger effects on the 6-foot diameter rotor but owing to the progressive nature of the phenomenon it is not possible to define any precise limits to the ranges of validity of the results on the two rotors.

N-40508*

Aeronautical Research Council (Gt. Brit.)
STRESS CONSIDERATIONS IN THE DESIGN OF PRESSURISED SHELLS. E. H. Mansfield. 1955. 27p. tab. (ARC CP 217)

This report considers the stresses developed under internal pressure in thin-walled shells of spherical, cylindrical, or conical form. Formulas are presented for predicting the maximum stresses in a spherical shell with a reinforced circular opening, with a cap of greater thickness; and a cylindrical shell with stringers and closely spaced frames, stringers and widely spaced frames, and end caps of various forms. The feasibility of neutral holes in shells which have a developable surface has been ascertained and investigated in detail for the cylindrical and conical shells. A simple formula is given to allow for the reduced efficiency of reinforcement on one side only of the shell wall.

N-40509*

Aeronautical Research Council (Gt. Brit.)
THE TORSIONAL VIBRATIONS OF A CLASS OF THIN, TAPERED, SOLID WINGS. Elizabeth A. Frost. 1955. 22p. diagrs., tab. (ARC CP 218)

This report considers the torsional vibrations of thin solid wings of doubly symmetrical chordwise section, with linear variation of chord and parabolic variation of thickness. Frequencies of symmetrical and antisymmetrical vibrations are presented graphically for a range of values of the aspect ratio and the taper ratio.

N-40511*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF TIGHT CLAMPING ON THE FATIGUE STRENGTH OF JOINTS. W. A. P. Fisher and W. J. Winkworth. 1955. 10p. diagrs., photos. (ARC R & M 2873; ARC 14,919. Supersedes RAE Structures 121)

The effect of clamping on the fatigue strength of joints in aluminum alloy is investigated experimentally. Tests on Z-section stringers connected to long, slotted cleats give an endurance for tightly clamped joints about nine times that for unclamped joints. Tests of bolted joints in aluminum alloy sheet material show still greater improvement for very tight clamping. In both series of tests, the clamping tends to cancel the weakness in fatigue of a loaded hole. Tight clamping is considered to have many applications in design of aircraft joints from the standpoint of fatigue strength.

N-40512*

Aeronautical Research Council (Gt. Brit.) CALCULATION OF THE PRESSURE DISTRIBUTION OVER A WING AT SONIC SPEEDS. K. W. Mangler. 1955. 55p. diagrs., tab. (ARC R & M 2888; ARC 14,642. Supersedes RAE Aero 2439)

A method is developed for the calculation of the pressure distribution and the aerodynamic forces and moments acting on a wing at angle of attack, a wing in (steady) roll, and a wing in (steady) pitch. The calculation is based on the assumption of an inviscid potential flow and is restricted to small α and thickness ratio, so that the quadratic terms in the perturbation velocities are neglected. The results are valid either for any Mach number for wings of small aspect ratio, or for any aspect ratio for sonic speeds. The aerodynamic coefficients and stability derivatives for a wing family are given in charts. It is indicated that the plan form of the wing is of similar importance as regards the pressure distribution at sonic speeds as the chordwise section of a wing of larger aspect ratio at subsonic speeds.

N-40544*

Marine Aircraft Experimental Establishment (Gt. Brit.) IMPACT MEASUREMENTS ON A LARGE MODEL OF A REPRESENTATIVE LAND-PLANE FUSELAGE ON WATER. J. E. Allen. October 1954. 69p. diagrs., photos., tabs. (MAEE F/Res/264)

An experimental investigation has been made into splash-up, impact pressures, and impact forces occurring during controlled alightings on smooth water of a landplane fuselage of elliptical cross-section. Pressure distributions are presented for several landings over a range of initial attitudes and at flight-path angles down to 1.5. The acceleration results are of limited usefulness due to imperfections in the apparatus. Photographs are included of the external spray formation. Results are not generally applicable to design cases for ditching until a rational theory of impact of fuselage shapes be made available.

MISCELLANEOUS

NACA Rept. 1207

Errata on "STUDIES OF THE LATERAL-DIRECTIONAL FLYING QUALITIES OF A TANDEM HELICOPTER IN FORWARD FLIGHT." Kenneth B. Amer and Robert J. Tapscott. 1954.

NACA TN 3305

Errata on "SOME MEASUREMENTS AND POWER SPECTRA OF RUNWAY ROUGHNESS." James H. Walls, John C. Houbolt, and Harry Press. November 1954.

NACA TN 3477

Errata on "HYDRODYNAMIC PRESSURE DISTRIBUTIONS OBTAINED DURING A PLANING INVESTIGATION OF FIVE RELATED PRISMATIC SURFACES." Walter J. Kapryan and George M. Boyd, Jr. September 1955.

NACA TN 3561

Errata on "INTENSITY, SCALE, AND SPECTRA OF TURBULENCE IN MIXING REGION OF FREE SUBSONIC JET." James C. Laurence. September 1955.

N-27631*

Advisory Group for Aeronautical Research and Development. SPECIFICATIONS FOR AGARD WIND TUNNEL CALIBRATION MODELS. Revised August 1955. 6p. diagrs. (AGARD AG4/M3)

Model A (NACA RM-10). Model B is a body-wing combination with a delta wing with span four times the body diameter and symmetrical circular-arc section; the body is a cylindrical body of revolution. Model C is designed principally for testing and calibration in the transonic range; it is identical to B except that the body is extended aft 1.5 body diameters and tail surfaces are added. Model D is an elementary wing intended for testing, calibrating, and comparing different means and mechanisms for measuring dynamic stability derivatives by the forced oscillation method.

N-35894, v.1*

Advisory Group for Aeronautical Research and Development. FLIGHT TEST MANUAL, VOLUME 1 - PERFORMANCE. Edited by Courtland D. Perkins and Daniel O. Dommasch, Princeton University. 1955. Loose-leaf. (Advisory Group for Aeronautical Research and Development)

N-35894, v.2*

Advisory Group for Aeronautical Research and Development. FLIGHT TEST MANUAL, VOLUME 2 - STABILITY AND CONTROL. Edited by Courtland D. Perkins, Princeton University. 1955. Loose-leaf. (Advisory Group for Aeronautical Research and Development)

N-35894, v.3*

Advisory Group for Aeronautical Research and Development. FLIGHT TEST MANUAL, VOLUME 3 - INSTRUMENTATION CATALOG. Edited by Enoch J. Durbin and Edward Seckel, Princeton University. 1955. Loose-leaf. (Advisory Group for Aeronautical Research and Development)

N-37881*

EXPERIMENTAL ANALYSIS OF AIRCRAFT STRUCTURES BY MEANS OF PLASTIC MODELS. George W. Zender. (Presented to Soc. for Experimental Stress Analysis Fall Meeting, Chicago, November 16-18, 1955). 18p. diagrs., photos.

The stresses and deflections of plastic models of a delta plan-form multicell wing and a pressurized cylinder representative of an aircraft fuselage are compared with theoretical analyses. The comparisons indicate that valuable information regarding the stresses and deflections of aircraft structures may be obtained from tests of plastic models.

N-39765

Advisory Group for Aeronautical Research and Development. AUTOMATIC PRESSURE MEASURING SYSTEMS USED WITH HIGH-SPEED WIND TUNNELS. Carl L. Frederick and Associates. June 1955. 51p. diagrs., photos. (AGARDograph 10)

A brief review is given of high-speed wind-tunnel characteristics with particular reference to instrumentation needs. This is followed by a survey of the major elements of pressure measuring systems. Representative pressure measuring systems in actual use in the United States are described.

N-39888

Advisory Group for Aeronautical Research and Development. TURBULENCE MEASUREMENTS WITH THE HOT-WIRE ANEMOMETER. Ralph D. Cooper, David Taylor Model Basin, and Marshall P. Tulin, Office of Naval Research. August 1955. 58p. diagrs., photo., tabs. (AGARDograph 12)

The contemporary status of turbulence measurements utilizing the techniques of hot-wire anemometry is discussed. The motivations and objectives of current experimental turbulence research are indicated. Certain essential definitions and ideas of the statistical theory of turbulence are reviewed. A list and brief description of significant experimental investigations are presented in tabular form. The basic components of the anemometer and their functions are discussed. The principal sources of error in hot-wire measurements of turbulence are presented and the reliability of such measurements discussed. Progress in the measurement of turbulence in high-speed flows is reviewed.

N-39905

Advisory Group for Aeronautical Research and Development. TRAVELING SEMINAR: THREE-DIMENSIONAL FLOW IN AXIAL TURBOMACHINES WITH LARGE FREE STREAM VORTICITY. W. D. Rannie, California Institute of Technology. DISCRETE VORTICES IN THE TRANSITION RANGE OF FLOW IN A PIPE. John R. Weske, Maryland University. DEVELOPMENT AND TESTS OF A 4 x 4 INCH CORNER NOZZLE FOR THE MACH NUMBER RANGE 1.4 TO 4.0. Arnold M. Kuethe, Michigan University. PROBLEMS AND EXPERIMENTAL TECHNIQUES IN HYPERSONIC AERODYNAMICS. Antonio Ferri, Polytechnic Institute of Brooklyn. DRYING OF THE AIR IN SUPERSONIC WIND TUNNELS. (LA DESSICCATION DES SOUFFLERIES SUPERSONIQUES). J. Smolderen, Centre National d'Etudes et de Recherches Aeronautiques. HIGH-SPEED FLUTTER. Lee Arnold, Columbia University. GUST GENERATION EXPERIMENTS. J. D. Schetzer, Michigan University. THE PROBLEM OF MATERIALS FOR HIGH TEMPERATURES IN AERONAUTICAL CONSTRUCTION. (LE PROBLEME DES MATERIAUX POUR HAUTES TEMPERATURES EN CONSTRUCTION AERONAUTIQUE). Pol Duwez, California Institute of Technology. (Papers presented at Palais De Chaillot, Paris, June 16 - July 16, 1954). 78p. diagrs., photos.

N-39906*

INSTRUMENTATION FOR INVESTIGATION OF SEAPLANE IMPACT LOADS IN WAVES. Philip M. Edge, Jr. (Presented to the First Conference on Coastal Engineering Instruments, Council on Wave Research, University of California, Berkeley, November 1955). 18p. diagrs., photo.

Equipment and instrumentation used by NACA in seaplane loads research are described and a brief background as to the nature of seaplane loads and the variables measured during hydrodynamic impact is presented. NACA's research in seaplane loads and the research equipment of the Langley impact basin are briefly described. Laboratory and flight measurements associated with determining the parameters controlling the loads are discussed in addition to measurements of actual loads and load distributions on seaplanes. Among the instruments described is the optical wave height recorder which has been developed for the specific needs of the Langley impact basin.

N-39945

Advisory Group for Aeronautical Research and Development. PAPERS PRESENTED AT THE SIXTH MEETING OF THE WIND TUNNEL AND MODEL TESTING PANEL: CALIBRATION OF TEST SECTIONS AND ACCURACY OF MEASUREMENTS IN WIND TUNNEL. (Tarage des Veines et Précision des Measures en Soufflerie). Henry Girerd, Office National d'Etudes et de Recherches Aeronautiques. REQUIREMENTS FOR UNIFORMITY OF FLOW IN SUPERSONIC WIND TUNNELS. D. E. Morris, National Aeronautical Establishment, Bedford and K. G. Winter, Royal Aircraft Establishment. CALIBRATION OF THE FLOW IN THE WORKING SECTION OF THE 3 FT x 3 FT TUNNEL, NATIONAL AERONAUTICAL ESTABLISHMENT. D. E. Morris, National Aeronautical Establishment, Bedford. FLOW DIRECTION MEASUREMENTS IN SUPERSONIC WIND TUNNELS. D. J. Raney, Royal Aircraft Establishment. SCALE EFFECTS AT HIGH SUBSONIC AND TRANSONIC SPEEDS, AND METHODS FOR FIXING BOUNDARY-LAYER TRANSITION IN MODEL EXPERIMENTS. A. B. Haines, Royal Aircraft Establishment, D. W. Holder and H. H. Pearcey, National Physical Laboratory. METHODS OF DETERMINATION AND OF FIXING BOUNDARY-LAYER TRANSITION ON WIND TUNNEL MODELS AT SUPERSONIC SPEEDS. K. G. Winter, J. B. Scott-Wilson, National Aeronautical Establishment, Bedford, and F. V. Davies, Royal Aircraft Establishment. IDENTIFICATION AND STARTING OF THE TRANSITION. (Identification et Déclenchement de la Transition). Ph. Poisson-Quinton and J. P. Chevallier, Office National d'Etudes et de Recherches Aeronautiques. TRANSONIC WIND TUNNEL DEVELOPMENT OF THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS. H. Julian Allen, National Advisory Committee for Aeronautics, Ames Aeronautical Laboratory. SOME ASPECTS OF THE BEHAVIOR OF PERFORATED TRANSONIC WIND TUNNEL WALLS. P. F. Maeder, Brown University. FLOW ESTABLISHMENT AND WALL INTERFERENCE IN TRANSONIC WIND TUNNELS. B. H. Goethert, Aro, Inc. HEAT TRANSFER AND SKIN FRICTION INVESTIGATIONS IN THE NOL HYPERSONIC WIND TUNNEL. R. E. Wilson, Naval Ordnance Laboratory. GALCIT HYPERSONIC RESEARCH. Henry T. Nagamatsu, California Institute of Technology. DEVELOPMENT OF TWO HYPERSONIC TEST FACILITIES AT THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS, AMES AERONAUTICAL LABORATORY. H. Julian Allen, National Advisory Committee for Aeronautics, Ames Aeronautical Laboratory. ULTRA-HIGH TEMPERATURE AERODYNAMIC TESTING FACILITIES. J. A. Dodge, Arnold Engineering Development Center. IMPROVEMENT OF THE STUDY OF SPINNING WIND TUNNEL. (Perfectionnements dans l'Etude de la Vrille en Soufflerie). André Martinot-Lagarde and Jean Gobeltz, Universite de Lille, France. DESIGN AND OPERATING TECHNIQUES OF VERTICAL SPIN TUNNELS. A. I. Neihouse, National Advisory Committee for Aeronautics, Langley Aeronautical Laboratory. THE VERTICAL SPINNING TUNNEL AT THE NATIONAL AERONAUTICAL ESTABLISHMENT, BEDFORD. A. E. Clarke and R. L. Maltby, Royal Aircraft Establishment. (Presented in Paris, France, November 2-6, 1954). 440p. diagrs., photos., tabs. (Advisory Group for Aeronautical Research and Development. AG17/P7).

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification December 14, 1955.

NACA RM A50L07

CHARACTERISTICS OF FLOW OVER INCLINED BODIES OF REVOLUTION. H. Julian Allen and Edward W. Perkins. March 5, 1951. 47p. diagrs., photos. (NACA RM A50L07)

Experimental force, moment, and center-of-pressure variations for a large number of bodies of revolution have been compared with the theoretical results based on NACA RM A9I26, 1949. It is shown that the lift and drag characteristics are fairly accurately predicted by the theory, but that the actual center of pressure is more rearward than the theory indicates. Visual flow studies and pressure distributions have shown that the development of the cross flow with distance along an inclined body of revolution is somewhat similar to the development with time of the flow about a circular cylinder impulsively set in motion from rest.

NACA RM A51L03

TESTS IN THE AMES 40- BY 80-FOOT WIND TUNNEL OF AN AIRPLANE CONFIGURATION WITH AN ASPECT RATIO 2 TRIANGULAR WING AND AN ALL-MOVABLE HORIZONTAL TAIL - LATERAL CHARACTERISTICS. David Graham and David G. Koenig. February 1952. 38p. diagrs., 2 tabs. (NACA RM A51L03)

An investigation has been made to determine the low-speed lateral characteristics of a triangular-wing airplane model. The model consisted of an aspect ratio 2 triangular wing in combination with a fuselage of fineness ratio 12.5; a thin, triangular, vertical tail with a constant-chord rudder; and a thin, unswept, all-movable horizontal tail. The wing had an NACA 0005 modified section and was equipped with partial-span, slotted, trailing-edge flaps. Tests were made with the wing alone, wing-fuselage, and wing-fuselage-vertical-tail configurations in addition to the tests of the complete model. The Reynolds number, based on the wing mean aerodynamic chord, was approximately 14.6×10^6 and the Mach number was 0.13. The results of the tests are presented without analysis.

NACA RM A51L17

DOWNWASH AND SIDEWASH FIELDS BEHIND CRUCIFORM WINGS. John R. Spreiter. January 1952. 18p. photos., diagrs. (NACA RM A51L17)

A brief account is presented of the results of theoretical and experimental investigations of the flow fields behind lifting plane and cruciform wings. Particular attention is focussed on wings of low aspect ratio. It is shown that the deformation of the vortex sheet behind a plane wing consists essentially of a rolling up at the edges. For banked cruciform wings, however, it is shown that, in addition to this effect, the vortices from the upper wing tips pass downward between those from the lower tips. Certain anomalous behaviors of the pitching-moment characteristics of a typical missile configuration are shown to be explainable on the basis of these results.

NACA RM A52L15

TESTS IN THE AMES 40- BY 80-FOOT WIND TUNNEL OF AN AIRPLANE CONFIGURATION WITH AN ASPECT RATIO 3 TRIANGULAR WING AND AN ALL-MOVABLE HORIZONTAL TAIL - LONGITUDINAL AND LATERAL CHARACTERISTICS. David G. Koenig. April 1953. 61p. diagrs., photos., 4 tabs. (NACA RM A52L15)

Force tests were made with an aspect-ratio-3 triangular wing fuselage-tail configuration with and without horizontal tail. Characteristics at zero sideslip were obtained with the tail located at three vertical positions above the extended wing-chord plane (0, 0.21, and 0.41 wing semispan) for one longitudinal distance aft of the wing. Sideslip data were obtained with the horizontal tail in the extended wing-chord plane. The use of partial-span, slotted, trailing-edge wing flaps or the horizontal tail as a lateral control was investigated. The Reynolds number based on the wing mean aerodynamic chord was 12.8×10^6 and the Mach number was 0.13. The results of the tests are presented without analysis.

NACA RM A52L16

TESTS IN THE AMES 40- BY 80-FOOT WIND TUNNEL OF TWO AIRPLANE MODELS HAVING ASPECT RATIO 2 TRAPEZOIDAL WINGS OF TAPER RATIOS 0.33 AND 0.20. Ralph W. Franks. February 1953. 56p. diagrs., photos., 3 tabs. (NACA RM A52L16)

Tests were made of two trapezoidal-wing airplane models. Each model consisted of a trapezoidal wing in combination with a fuselage of fineness ratio 12.5, a thin, triangular, vertical tail with a constant chord rudder, and a thin, unswept, all-movable horizontal tail. Tests were made with the horizontal tail at each of three vertical positions with respect to the extended wing-chord plane, and with the horizontal tail removed. The wings had an NACA 0005 modified section and were equipped with slotted, trailing-edge flaps. For both models, the flaps were tested as high-lift devices and as lateral controls; the horizontal tail was tested as a lateral control on one of the models. The Reynolds number for the tests was approximately 12 million and the Mach number approximately 0.13.

NACA RM A52L16a

A FLIGHT INVESTIGATION OF THE EFFECT OF LEADING-EDGE CAMBER ON THE AERODYNAMIC CHARACTERISTICS OF A SWEPT-WING AIRPLANE. Seth B. Anderson, Frederick H. Matteson, and Rudolph D. Van Dyke, Jr. February 1953. 23p. diagrs., photos., tab. (NACA RM A52L16a)

Flight measurements were made on a swept-wing aircraft with a wing modified to have forward camber and increased leading-edge radius. Maximum lift at low speed, stalling characteristics, drag and longitudinal stability were measured.

NACA RM A53A30a

THE EFFECTS OF COMPRESSIBILITY ON THE UPWASH AT THE PROPELLER PLANES OF A FOUR-ENGINE TRACTOR AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10. Armando E. Lopez and Jerald K. Dickson. April 1953. 38p. diagrs., photos., tab. (NACA RM A53A30a)

The upflow angles at the horizontal center lines of the propeller planes were measured at Mach numbers up to 0.92 on a wing-fuselage-nacelle combination and on an isolated nacelle. A comparison is made between the experimental and theoretical values of the variation of the upwash angle with angle of attack.

NACA RM A53H18a

THEORY OF WING-BODY DRAG AT SUPERSONIC SPEEDS. Robert T. Jones. September 1953. 11p. diagrs. (NACA RM A53H18a)

The relation of Whitcomb's "area rule" to the linear formulas for wave drag at slightly supersonic speeds is discussed. By adopting an approximate relation between the source strength and the geometry of a wing-body combination, the wave-drag theory is expressed in terms involving the areas intercepted by oblique planes or Mach planes. The resulting formulas are checked by comparison with the drag measurements obtained in wind-tunnel experiments and in experiments with falling models in free air. Finally, a theory for determining wing-body shapes of minimum drag at supersonic Mach numbers is discussed and some preliminary experiments are reported.

NACA RM A53J23

THE EFFECTS OF OPERATING PROPELLERS ON THE LONGITUDINAL CHARACTERISTICS AT HIGH SUBSONIC SPEEDS OF A FOUR-ENGINE TRACTOR AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10. Fred B. Sutton and Fred A. Demele. January 1954. 106p. diagrs., photo., 11 tabs. (NACA RM A53J23)

Wing-tunnel tests were conducted in the Ames 12-foot pressure wind tunnel through ranges of angles of attack and model thrust coefficients at Mach numbers from 0.60 to 0.90 at Reynolds numbers of 1,000,000 and 2,000,000. The effects of varying propeller blade angle and of varying the vertical height of the horizontal tail were determined. The overall effects of operating propellers on the longitudinal characteristics were small. Propeller normal-force effects were predicted with good accuracy.

NACA RM A53L03

WIND-TUNNEL INVESTIGATION OF THE EFFECT OF CLIPPING THE TIPS OF TRIANGULAR WINGS OF DIFFERENT THICKNESS, CAMBER, AND ASPECT RATIO - TRANSONIC BUMP METHOD. Horace F. Emerson. February 1954. 183p. diagrs., photo., 2 tabs. (NACA RM A53L03)

Transonic aerodynamic characteristics are presented for four basic triangular wings having aspect ratios of 2.0, 2.5, 3.0, and 4.0, and for these wings when their tips were progressively clipped to provide taper ratios of 0.1, 0.2, 0.3, 0.4, and in some cases 0.5. The NACA 63A00X profile was used with thickness-to-chord ratios of 0.02, 0.04, and 0.06. In addition, a wing with the NACA 63A(1.5)04 section was tested for each aspect ratio investigated. The Mach number range extended from 0.60 to 1.10, corresponding to a test Reynolds number range from 1.85 million to 2.90 million. Lift, drag, and pitching-moment coefficients are presented for each of the wings.

NACA RM A53L17

THE TRANSONIC CHARACTERISTICS OF UNSWEPT WINGS HAVING ASPECT RATIOS OF 4, SPANWISE VARIATIONS IN THICKNESS RATIO, AND VARIATIONS IN PLAN-FORM TAPER - TRANSONIC-BUMP TECHNIQUE. Warren H. Nelson. March 1954. 29p. diagrs., photo. (NACA RM A53L17)

Lift, drag, and pitching-moment data are presented for three unswept wings having aspect ratios of 4, taper ratios of 1.0, 0.5, and 0.2, NACA 63A006 sections at the root, and NACA 63A002 sections at the tip. The Mach number range of the tests was from 0.6 to 1.1, corresponding to a Reynolds number range from 1.4 million to 1.9 million. The results indicate that near a Mach number of 1.0, the drag can be correlated effectively in terms of thickness ratio with the drag of wings having a constant thickness ratio if a weighted thickness ratio is used.

NACA RM A53L29

EFFECTS OF OPERATING PROPELLERS ON THE WING-SURFACE PRESSURES OF A FOUR-ENGINE TRACTOR AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK. Carl D. Kolbe and Frederick W. Boltz. April 1954. 133p. diagrs., photo., 19 tabs. (NACA RM A53L29)

Measurements have been made to evaluate the effects of operating propellers and of nacelles on the wing-surface pressures on a semispan model of a four-engine tractor airplane configuration in the Ames 12-foot pressure wind tunnel. Tabulated pressure data for nine spanwise stations on the wing are presented for the model with the propellers operating and with the propellers removed. Section normal-force coefficients, section pitching-moment coefficients, and the spanwise distribution of loading are presented for selected conditions. Comparative plots of the overall force data are also presented. The tests were conducted through a range of angles of attack and a range of thrust coefficients (up to 0.8 per propeller) at Mach numbers from 0.082 to 0.90 for Reynolds numbers ranging from 1,000,000 to 8,000,000.

NACA RM A53L29a

EFFECTS OF TWO SPINNER SHAPES ON THE PRESSURE RECOVERY IN AN NACA 1-SERIES D-TYPE COWL BEHIND A THREE-BLADE PROPELLER AT MACH NUMBERS UP TO 0.80. Ashley J. Molk and Robert M. Reynolds. March 1954. 34p. diagrs., photo., tab. (NACA RM A53L29a)

The cowl and propeller were tested with an NACA 1-series spinner and a more nearly conical spinner to determine the effects of spinner shape on the pressure recovery in the cowl at Mach numbers from 0.20 to 0.80 and inlet velocity ratios from 0.29 to 1.37. Tests were made with the propeller removed and with the propeller operating at blade angles from 33° to 58.5° and advance ratios from 0.79 to 4.60. Tests were conducted at an angle of attack of 0° and at a Reynolds number of 1.17 million based on the maximum diameter of the cowl. Recoveries obtained with the more nearly conical spinner were higher than with the NACA 1-series spinner for all test conditions.

NACA RM A54F14

ANALYSIS OF WIND-TUNNEL TESTS AT LOW SPEEDS OF A FOUR-ENGINE PROPELLER-DRIVEN AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK. George G. Edwards and Donald A. Buell. October 1954. 137p. diagrs., photos., 2 tabs. (NACA RM A54F14)

Experimental data published in NACA RM A53I28 are analyzed. The effects of operating propellers on the longitudinal characteristics of the model are separated into various components to illustrate the origin, nature, and intensity of each. The analysis indicates certain configuration changes which would reduce the adverse effects of propellers on the longitudinal stability.

NACA RM A54J19

APPLICATION OF WING-BODY THEORY TO DRAG REDUCTION AT LOW SUPERSONIC SPEEDS. Barrett S. Baldwin, Jr., and Robert R. Dickey. January 1955. 42p. (NACA RM A54J19)

A method for extending to higher Mach numbers the region of low drag attainable for wing-body combinations by use of the transonic area rule is developed and examined experimentally. It is found that the drag depends upon the longitudinal distributions of area and moments of area about the body axis.

NACA RM A55A06a

A COMPARISON OF TWO METHODS FOR COMPUTING THE WAVE DRAG OF WING-BODY COMBINATIONS. Alberta Alksne. April 1955. 32p. diagrs. (NACA RM A55A06a)

Computations of wave drag based on linearized theory have been performed for four wing-body combinations and the results are compared with experimental data. Two computational techniques for evaluating the integrals in the theoretical expressions for wave drag are discussed. Advantages and disadvantages of each are pointed out.

NACA RM A55A18

THE WAVE DRAG OF ARBITRARY CONFIGURATIONS IN LINEARIZED FLOW AS DETERMINED BY AREAS AND FORCES IN OBLIQUE PLANES. Harvard Lomax. March 1955. 16p. (NACA RM A55A18)

The wave drag of any object in a steady (linearized) supersonic flow is shown to be identical to the average wave drag of a series of equivalent bodies of revolution, the streamwise gradient of normal cross-sectional areas of which are given by the streamwise gradients of oblique cross-sectional areas of the object plus terms proportional to the resultant force on the object measured in the same (oblique) planes.

NACA RM A55B07

GENERAL THEORY OF WAVE-DRAG REDUCTION FOR COMBINATIONS EMPLOYING QUASI-CYLINDRICAL BODIES WITH AN APPLICATION TO SWEPT-WING AND BODY COMBINATIONS. Jack N. Nielsen. June 1955. 74p. diagrs. (NACA RM A55B07)

An analysis is made of wave-drag reduction for wing and quasi-cylindrical body combinations produced by changes in cross-sectional shape and in area distribution. The theory, applicable at all supersonic speeds, has been applied to a swept-wing and body combination with sonic leading and trailing edges. A reduction of 22 percent of the wave drag of the winged part of the undistorted combination was achieved by utilizing the optimum axially symmetric indentation, and a further reduction of 42 percent was achieved by distortion of cross-sectional shape.

NACA RM A55B16

A SPECIAL METHOD FOR FINDING BODY DISTORTIONS THAT REDUCE THE WAVE DRAG OF WING AND BODY COMBINATIONS AT SUPERSONIC SPEEDS. Harvard Lomax and Max. A. Heaslet. May 1955. 113p. diagrs., tab. (NACA RM A55B16)

For a given wing and supersonic Mach number, the problem of shaping an adjoining fuselage so that the combination will have a low wave drag is considered. Only fuselages that can be simulated by singularities (multipoles) distributed along the body axis are studied. However, the optimum variations of such singularities are completely specified in terms of the wing geometry.

NACA RM E51L13

ANALYSIS OF COOLANT-FLOW REQUIREMENTS FOR AN IMPROVED, INTERNAL-STRUT-SUPPORTED, AIR-COOLED TURBINE-ROTOR BLADE. Wilson B. Schramm and Alfred J. Nachtigall. February 1952. 26p. diagrs., photo. (NACA RM E51L13)

An analytical evaluation of a new type of air-cooled turbine-rotor-blade design, based on the principle of submerging the load-carrying element in cooling air within a thin high-temperature shell, indicates that this principle of blade design permits the load-carrying element to be operated at considerably lower temperature than that of the enveloping shell. Comparison with an air-cooled shell-supported blade showed that the internal-strut-supported air-cooled blade has greater potentiality to withstand increased stresses that can be anticipated in future engines.

NACA RM E51L19

INVESTIGATION AT MACH NUMBER 1.91 OF SPREADING CHARACTERISTICS OF JET EXPANDING FROM CHOKED NOZZLES. Morris D. Rousso and L. Eugene Baughman. February 1952. 27p. photos., diagrs. (NACA RM E51L19)

The gross spreading characteristics of jets expanding from convergent and convergent-divergent nozzles in the base of a body of revolution with various boattail configurations at a Mach number of 1.91 are presented. It is demonstrated that the temperature profiles of jets expanding into a supersonic stream are considerably smaller than the temperature profiles of jets expanding into quiescent air. The effect on the wake of varying afterbody geometry is shown to be small.

NACA RM E51L26

SOME OBSERVATIONS OF SHOCK-INDUCED TURBULENT SEPARATION ON SUPERSONIC DIFFUSERS. T. J. Nussdorfer. May 1954. 14p. diagrs., photos. (NACA RM E51L26)

A survey of experimental data at supersonic speed indicated that shock-induced separation of a turbulent boundary layer will result for Mach numbers of approximately 1.33 or greater when a theoretical stream static-pressure-rise ratio of approximately 1.89 occurs across a shock interacting with the boundary layer. The significance of this tentative criterion for turbulent boundary-layer separation is discussed with respect to the design of supersonic diffusers.

#NACA RM E53L30a

NACA RM L6J18a

LOW-SPEED WIND-TUNNEL TESTS OF A PILOTLESS AIRCRAFT HAVING HORIZONTAL AND VERTICAL WINGS AND CRUCIFORM TAIL. N. Mastrocola and A. Assadourian. August 19, 1947. 100p. diagrs., photos., tab. (NACA RM L6J18a)

Low-speed tests of a pilotless aircraft were conducted in the Langley propeller-research tunnel to provide information for the estimation of the longitudinal stability and control, to measure the aileron effectiveness, and to calibrate the radome and the Machmeter pitot-static orifices.

NACA RM L7L01

ADDITIONAL RESULTS IN A FREE-FLIGHT INVESTIGATION OF CONTROL EFFECTIVENESS OF FULL-SPAN, 0.2-CHORD PLAIN AILERONS AT HIGH SUBSONIC, TRANSONIC, AND SUPERSONIC SPEEDS TO DETERMINE SOME EFFECTS OF WING SWEEPBACK, ASPECT RATIO, TAPER, AND SECTION THICKNESS RATIO. Carl A. Sandahl and H. Kurt Strass. April 23, 1948. 31p. diagrs., photos. (NACA RM L7L01)

An aerodynamic-control-effectiveness investigation using free-flight, rocket-propelled test vehicles is being conducted by the Pilotless Aircraft Research Division of the Langley Aeronautical Laboratory. Additional results have been obtained recently which indicate some effects of wing sweepback, aspect ratio, taper ratio, and section thickness ratio on the rolling effectiveness of plain full-span, 0.2-chord, sealed ailerons.

NACA RM L7L22

EFFECT OF A PILOT'S CANOPY ON THE DRAG OF AN NACA RM-2 DRAG RESEARCH MODEL IN FLIGHT AT TRANSONIC AND SUPERSONIC SPEEDS. Paul E. Purser. April 20, 1948. 7p. diagrs., photos. (NACA RM L7L22)

Results of flight tests of an NACA RM-2 drag research model equipped with a pilot's canopy are presented for the Mach number range from 0.85 to 1.4. The canopy added an almost constant increment in drag coefficient of approximately 0.08 (based on the frontal area of the basic body, 0.1364 sq ft) in the Mach number range from 1.0 to 1.4. When the drag coefficients of the canopy-equipped model are based on the frontal area of that model (0.1511 sq ft), they are 5 to 9 percent higher than for the basic model.

NACA RM L8L30

PRELIMINARY WIND-TUNNEL TESTS OF TRIANGULAR AND RECTANGULAR WINGS IN STEADY ROLL AT MACH NUMBERS OF 1.62 AND 1.92. Clinton E. Brown and Harry S. Heinke, Jr. February 17, 1949. 39p. diagrs., photo., tabs. (NACA RM L8L30)

Damping-in-roll coefficients for a series of triangular plan-form wings and two rectangular plan-form wings have been obtained from supersonic tunnel tests. The wings were mounted on a body of revolution and tested at Mach numbers of 1.62 and 1.92.

NACA RM L50L12

INVESTIGATION OF THE EFFECTS OF GEOMETRIC CHANGES IN AN UNDERWING PYLON-SUSPENDED EXTERNAL-STORE INSTALLATION ON THE AERODYNAMIC CHARACTERISTICS OF A 45° SWEPTBACK WING AT HIGH SUBSONIC SPEEDS. Kenneth P. Spreemann and William J. Alford, Jr. March 5, 1951. 91p. diagrs., photos., tabs. (NACA RM L50L12)

An investigation was conducted in the Langley high-speed 7- by 10-foot tunnel through a Mach number range of 0.41 to 0.97 to determine the effects of external-store fineness ratio, store shape, store chordwise position, pylon thickness, pylon length, and pylon sweep angle on the aerodynamic characteristics of a number of underwing pylon-suspended external stores in combination with a 45° sweptback semispan wing and fuselage. The store profiles corresponded to NACA 65A-series bodies of revolution, the pylons were NACA 64A-series airfoil sections, and the wing was an NACA 65A006 airfoil section parallel to the free stream.

NACA RM L51D06

COMPARISON OF ZERO-LIFT DRAGS DETERMINED BY FLIGHT TESTS AT TRANSONIC SPEEDS OF SYMMETRICALLY MOUNTED NACELLES IN VARIOUS SPANWISE POSITIONS ON A 45° SWEPTBACK WING AND BODY COMBINATION. William B. Pepper, Jr., and Sherwood Hoffman. May 23, 1951. 29p. diagrs., photos., tabs. (NACA RM L51D06)

Rocket-powered models were flown at transonic speeds to determine the effect of spanwise nacelle location on the zero-lift drag. Solid nacelles were mounted in symmetrical positions and varied spanwise along a 45° sweptback tapered wing. From these tests, it is apparent that the drag increment associated with adding nacelles to a wing-body combination is largely dependent upon the nacelle location.

NACA RM L51F15

THE EFFECT ON ZERO-LIFT DRAG OF AN INDENTED FUSELAGE OR A THICKENED WING-ROOT MODIFICATION TO A 45° SWEPTBACK WING-BODY CONFIGURATION AS DETERMINED BY FLIGHT TESTS AT TRANSONIC SPEEDS. William B. Pepper. September 1951. 20p. diagrs., photos., 2 tabs. (NACA RM L51F15)

Rocket-powered models were flown at transonic speeds to determine the effect of a thickened wing-root and an indented fuselage modification on the zero-lift drag. The basic configuration consisted of a 45° sweptback wing 9 percent thick and of aspect ratio 6.0 mounted on a fuselage of fineness ratio 10.0. Significant drag variations due to these modifications were noted.

NACA RM L51L07a

PRESSURE MEASUREMENTS ON A BODY OF REVOLUTION IN THE LANGLEY 16-FOOT TRANSONIC TUNNEL AND A COMPARISON WITH FREE-FALL DATA. Joseph M. Hallissy, Jr. March 1952. 19p. diagrs. (NACA RM L51L07a)

Pressure distributions have been obtained on a 10-foot-long body of revolution in the Langley 16-foot transonic tunnel and the results are compared with pressure data obtained by the free-fall method on an identical body. For Mach numbers from 0.74 to 1.00, the data curves show generally good agreement in shape but a small displacement in overall level. For Mach numbers from 1.02 to 1.09 there are increased differences, due to wind-tunnel wall interference.

NACA RM L52D07

SOME EFFECTS OF BODY CROSS-SECTIONAL SHAPE, INCLUDING A SUNKEN-CANOPY DESIGN, ON DRAG AS SHOWN BY ROCKET-POWERED-MODEL TESTS AT MACH NUMBERS FROM 0.8 TO 1.5. William E. Stoney, Jr., and Leonard W. Putland. July 1952. 15p. diagrs., photos. (NACA RM L52D07)

Flight tests were made with two pairs of rocket-propelled bodies of fineness ratio 8.91 to determine the effect of changes in body cross-sectional shape on drag. At supersonic speeds the small differences in drag between the models with the same cross-sectional-area distributions substantiate the predictions of linearized theory that, to the first order, drag is independent of cross-sectional shape.

NACA RM L52G08a

INVESTIGATION OF THE LOW-SPEED AERODYNAMIC CHARACTERISTICS OF A VARIABLE-SWEEP AIRPLANE MODEL WITH A WING HAVING PARTIAL-SPAN CAMBERED-LEADING-EDGE MODIFICATIONS. Robert E. Becht and Andrew L. Byrnes, Jr. September 1952. 47p. diagrs., photos. (NACA RM L52G08a)

An investigation was made to determine the aerodynamic characteristics at low speed of a variable-sweep airplane model with a wing having two interchangeable partial-span leading-edge-camber modifications. A comparison is made with data obtained on the same model incorporating a wing of symmetrical sections and also a fully cambered and twisted wing. Included in the investigation is the effect of partial-span split flaps at the minimum sweep angle of 20°.

NACA RM L52I23

THE EFFECTS OF SWEEPBACK ON LONGITUDINAL CHARACTERISTICS OF A 1/30-SCALE SEMISPAN MODEL OF THE BELL X-5 AIRPLANE AS DETERMINED FROM NACA WING-FLOW TESTS AT TRANSONIC SPEEDS. Joseph J. Kolnick and Robert M. Kennedy. November 1952. 48p. diagrs., photos., tab. (NACA RM L52I23)

Tests were made by the NACA wing-flow method to determine the effect of sweepback angle on the longitudinal characteristics of a 1/30-scale semispan model of the Bell X-5 variable-sweep airplane within the transonic speed range (Mach numbers from 0.70 to 1.05). Lift, drag, and pitching-moment results are presented with wings in the 20°, 30°, 40°, 50°, and 60° positions. A test was also made with the fuselage alone. The Reynolds number was about 1.3×10^6.

NACA RM L52K12

LONGITUDINAL-CONTROL EFFECTIVENESS AND DOWNWASH CHARACTERISTICS AT TRANSONIC SPEEDS OF A 1/30-SCALE SEMISPAN MODEL OF THE BELL X-5 AIRPLANE AS DETERMINED BY THE NACA WING-FLOW METHOD. Norman S. Silsby and Garland J. Morris. January 1953. 48p. diagrs., photos., 2 tabs. (NACA RM L52K12)

An investigation was made at transonic speeds by the NACA wing-flow method to determine the longitudinal control effectiveness and downwash characteristics of a 1/30-scale semispan model of the Bell X-5 airplane with the wings of the model swept back 60°, 40°, and 20°. Lift, drag, and pitching moments were obtained for various angles of attack for several horizontal tail incidences and with tail off for each angle of sweep of the wing. The Reynolds number was about 1.0×10^6.

NACA RM L52L11b

LOW-SPEED LONGITUDINAL CHARACTERISTICS OF AN UNSWEPT HEXAGONAL WING WITH AND WITHOUT A FUSELAGE AND A HORIZONTAL TAIL LOCATED AT VARIOUS POSITIONS AT REYNOLDS NUMBERS FROM 2.8×10^6 TO 7.6×10^6. Gerald V. Foster, Ernst F. Mollenberg, and Robert L. Woods. February 26, 1953. 63p. diagrs., photos., 3 tabs. (NACA RM L52L11b)

An investigation was made in the Langley 19-foot pressure tunnel to determine the low-speed longitudinal characteristics of an unswept wing having hexagonal airfoil sections and aspect ratio of 2.5. This paper includes the results concerning the effect of leading- and trailing-edge flaps on the aerodynamic characteristics of the wing with and without a fuselage. The effects of wing-tip cross-sectional shape and wing trailing-edge thickness and the effect of a horizontal tail located at various vertical and horizontal positions on the longitudinal characteristics of the wing are also shown.

NACA RM L52L18

WIND-TUNNEL INVESTIGATION OF THE STATIC LATERAL STABILITY CHARACTERISTICS OF WING-FUSELAGE COMBINATIONS AT HIGH SUBSONIC SPEEDS. ASPECT-RATIO SERIES. Paul G. Fournier and Andrew L. Byrnes, Jr. February 1953. 26p. diagrs., photos. (NACA RM L52L18)

This report presents the aerodynamic characteristics in sideslip of wing-fuselage combinations having wings of 45° sweepback, a taper ratio of 0.6, aspect ratios of 2, 4, and 6, and an NACA 65A006 airfoil section. The tests covered a Mach number range from 0.4 to 0.95, a Reynolds number range from 1.5×10^6 to 5×10^6, depending upon the wing and Mach number, and an angle-of-attack range from -3° to 24°.

NACA RM L52L24

PRELIMINARY THEORETICAL INVESTIGATION OF SEVERAL METHODS FOR STABILIZING THE LATERAL MOTION OF A HIGH-SPEED FIGHTER AIRPLANE TOWED BY A SINGLE CABLE. Albert A. Schy and Carroll H. Woodling. March 1953. 46p. diagrs., 2 tabs. (NACA RM L52L24)

A theoretical investigation of the lateral stability of a high-speed fighter airplane towed by a long cable indicates several possible methods of stabilization. Calculated motions and characteristic modes show that an automatic control that provides a rolling moment proportional to angle of bank or deflection of a rudder-type surface proportional to a linear combination of transverse acceleration and velocity would give satisfactory lateral stability. Other possible methods of stabilization are also suggested.

NACA RM L52L29

AN EXPERIMENTAL INVESTIGATION OF BOUNDARY INTERFERENCE ON FORCE AND MOMENT CHARACTERISTICS OF LIFTING MODELS IN THE LANGLEY 16- AND 8-FOOT TRANSONIC TUNNELS. Charles F. Whitcomb and Robert S. Osborne. February 1953. 31p. photos., diagrs., tab. (NACA RM L52L29)

Tests of a fuselage-alone and of wing-fuselage configurations having model-to-tunnel cross-sectional-area ratios from 0.0003 to 0.0038 have been conducted in the slotted test sections of the Langley 16-foot and 8-foot transonic tunnels in order to obtain experimental information concerning the effects of boundary interference on force and moment characteristics of typical models at lifting attitudes for Mach numbers from 0.60 to 1.07. The agreement of the test results indicated that boundary-interference effects on the force and moment characteristics of these models were small.

NACA RM L52L29a

THE EFFECTS OF FUSELAGE SIZE ON THE LOW-SPEED LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A THIN 60° DELTA WING WITH AND WITHOUT A DOUBLE SLOTTED FLAP. John M. Riebe. February 1953. 24p. diagrs., photo., tab. (NACA RM L52L29a)

Results and discussion are presented of a wind-tunnel investigation to determine the effects of fuselage size on the low-speed longitudinal aerodynamic characteristics of a thin delta wing with and without a double slotted flap. Increased fuselage diameter from 0.094 to 0.292 wing span reduced the maximum lift coefficient from 1.40 to 1.01 for the flap-retracted condition and from 1.71 to 1.16 with the flap at 54° deflection and resulted in about a 0.4 reduction in increment of lift at 0° angle of attack for the flap-deflected condition.

NACA RM L53I18b

SOME EFFECTS OF AEROELASTICITY AND SWEEPBACK ON THE ROLLING EFFECTIVENESS AND DRAG OF A 1/11-SCALE MODEL OF THE BELL X-5 AIRPLANE WING AT MACH NUMBERS FROM 0.6 TO 1.5. Roland D. English. November 1953. 21p. diagrs., photos. (NACA RM L53I18b)

An investigation has been made to determine some effects of aeroelasticity and sweepback on the rolling effectiveness and drag of a 1/11-scale model of the variable-sweep Bell X-5 airplane wing. Rolling effectiveness and drag data are presented at Mach numbers from 0.6 to 1.5. Results of the investigation indicate that the Bell X-5 airplane with present wing construction is subject to severe rolling effectiveness losses due to flexibility. Increasing the angle of wing sweepback increases the rolling effectiveness in the Mach number range above 0.65. Increasing the angle of sweepback also decreases the subsonic drag coefficient and increases the Mach number at which transonic drag rise occurs. No effects of flexibility on drag were found.

NACA RM L53L14

STABILITY CHARACTERISTICS AT LOW SPEED OF A VARIABLE-SWEEP AIRPLANE MODEL HAVING A PARTIALLY CAMBERED WING WITH SEVERAL CHORD-EXTENSION CONFIGURATIONS. Robert E. Becht. February 1954. 37p. diagrs., photos. (NACA RM L53L14)

An investigation was made to determine the aerodynamic characteristics at low speed of a model representative of a variable-sweep airplane having a partially cambered wing and chord-extensions of several designs. Included in the investigation is the effect of drooped chord-extensions in conjunction with split flaps on the wing at 20° sweep. In addition, a comparison is made of the stability characteristics of the model with either a partially cambered wing and chord-extensions or a symmetrical wing and slats.

#NACA RM SE7L12a
#NACA RM SE7L22
#NACA RM SE7L22a
#NACA RM SE7L22b
#NACA RM SE7L26
#NACA RM SL7G16
#NACA RM SL8A21
#NACA RM SL51E01a
#NACA RM SL52F20

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1202

CHARTS RELATING THE COMPRESSIVE BUCKLING STRESS OF LONGITUDINALLY SUPPORTED PLATES TO THE EFFECTIVE DEFLECTIONAL AND ROTATIONAL STIFFNESS OF THE SUPPORTS. Roger A. Anderson and Joseph W. Semonian. 1954. ii, 19p. diagrs., tabs. (NACA Rept. 1202. Supersedes TN 2987)

The stability of a plate under edge compressive stress is analyzed in terms of the deflectional and rotational stiffnesses of one or more longitudinal lines of support between the plate side edges. The results are presented in the form of charts which make possible the determination of the compressive buckling stress of plates supported by members whose stiffness may or may not be defined by elementary beam bending and twisting theory but yet whose effective restraint is amenable to evaluation. The deflectional and rotational restraint provided by longitudinal stiffeners and full-depth webs is discussed, and numerical examples illustrate the application of the charts to the design of wing structures.

NACA Rept. 1204

APPLICATION OF SEVERAL METHODS FOR DETERMINING TRANSFER FUNCTIONS AND FREQUENCY RESPONSE OF AIRCRAFT FROM FLIGHT DATA. John M. Eggleston and Charles W. Mathews. 1954. ii, 24p. diagrs., tabs. (NACA Rept. 1204. Supersedes TN 2997)

A study is presented of several methods for determining the transfer functions and frequency response of aircraft from flight tests. Results obtained from experience in the use of these methods are compared as to time required for application, comparative accuracy, and means for facilitating their use. The studies cover three categories of methods: sinusoidal response, Fourier analysis of transients, and curve-fitting analysis of transients. Three general types of aircraft are used to illustrate the application of these methods.

NACA Rept. 1205

A WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF THRUST-AXIS INCLINATION ON PROPELLER FIRST-ORDER VIBRATION. W. H. Gray, J. M. Hallissy, Jr., and A. R. Heath, Jr. 1954. ii, 37p. diagrs., photo., tab. (NACA Rept. 1205. Supersedes RM L50D13)

Data are presented on aerodynamic excitation of propeller vibration with the thrust axis at two angles of inclination to the airstream. Aerodynamic excitation is calculated and compared with measured values for several conditions. Measured and calculated blade vibratory stresses for several excitation values are presented. The calculated values of exciting force compared well with the measured values at low rotational speeds but not so well at high rotational speeds.

NACA RM E55I29

PERFORMANCE CHARACTERISTICS OF CYLINDRICAL TARGET-TYPE THRUST REVERSERS. Fred W. Steffen and Jack G. McArdle. January 1956. 40p. diagrs., photo. (NACA RM E55I29)

From tests on cylindrical target-type thrust reversers, it was found that the reverser frontal area, lip angle, end-plate angle, and end-plate depth had important effects on reverse-thrust performance. Frontal area, reverser depth, lip angle, and end-plate angle had important effects on the spacing required for unrestricted nozzle flow. For reverse-thrust ratios greater than 64 percent, the reversed flow attached to the 7° cowl in quiescent air. Swept-type cylindrical reversers were generally unstable. The thrust-modulation characteristics of a cylindrical target-type thrust reverser were found to be satisfactory.

NACA TM 1401

DIRECTIONAL STABILITY OF TOWED AIRPLANES. (Die Seitenstabilität eines geschleppten Flugzeuges). W. Söhne. January 1956. 53p. diagrs., tab. (NACA TM 1401. Trans. from Ingenieur-Archiv, v. 21, no. 4, 1953, p. 245-265)

A theoretical investigation of the lateral dynamic stability of an airplane towed by a single towline is presented, and the equations of motion are derived. The effects of variations of towline length, attachment point, lift coefficient, model mass, and angle of climb are examined. In addition, the effects of changes in dihedral, tail area, and damping in roll are studied.

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NACA TN 3490

EXPERIMENTAL AND CALCULATED TEMPERATURE AND MASS HISTORIES OF VAPORIZING FUEL DROPS. M. M. El Wakil, R. J. Priem, H. J. Brikowski, P. S. Myers, and O. A. Uyehara, Wisconsin University. January 1956. 82p. diagrs., photos., tab. (NACA TN 3490)

Experimental and calculated mass and temperature histories of drops vaporizing with a constant velocity relative to the air velocity are compared herein, and it is confirmed that, under many conditions, the unsteady state or time required for the drop to reach the wet-bulb temperature is an appreciable portion of the total vaporization time. Work was done to verify or disprove the assumptions used in the computations. Data are presented to show that the assumption of infinite thermal conductivity is valid primarily because of circulation inside the drop.

NACA TN 3534

INSTRUMENTATION FOR MEASUREMENT OF FREE-SPACE SOUND PRESSURE IN THE IMMEDIATE VICINITY OF A PROPELLER IN FLIGHT. William D. Mace, Francis J. Haney, and Edmund A. Brummer. January 1956. 16p. diagrs., photo. (NACA TN 3534)

Instrumentation suitable for the measuring, recording, and subsequent harmonic analysis of the free-space sound pressures in the immediate vicinity of an airplane propeller at flight Mach numbers up to 0.72 is described. The dynamic range of the equipment is 150 to 113 decibels (re 0.0002 dyne/cm^2) and the system frequency response is flat within $\pm$1 decibel from 80 to 1,000 cps. Maximum second-harmonic distortion is less than 3 percent for a sound level of 140 decibels, and the overall accuracy is $\pm$2 decibels.

NACA TN 3545

INVESTIGATION OF THE EFFECT OF SHORT FIXED DIFFUSERS ON STARTING BLOWDOWN JETS IN THE MACH NUMBER RANGE FROM 2.7 TO 4.5. John A. Moore. January 1956. 32p. diagrs., photos. (NACA TN 3545)

An investigation was made at Mach numbers of 2.7, 3.0, 3.5, 4.0, and 4.5 to determine the effect of short fixed convergent-divergent wedge diffusers on the starting characteristics of blowdown jets exhausting to the atmosphere. Wedge diffusers that were extensions of the nozzle contours reduced the overall pressure ratios required for starting to less than one-half the values obtained without a diffuser. The minimum overall pressure ratio required for starting at each Mach number was about twice the value predicted by one-dimensional theory. Central-body diffusers were not so effective in reducing the overall pressure ratio for starting as were the wedge extensions of the nozzle, except at the higher values of diffuser minimum area.

NACA TN 3552

INVESTIGATION OF THE COMPRESSIVE STRENGTH AND CREEP LIFETIME OF 2024-T3 ALUMINUM-ALLOY PLATES AT ELEVATED TEMPERATURES. Eldon E. Mathauser and William D. Deveikis. January 1956. 40p. diagrs., photos., tabs. (NACA TN 3552. Supersedes RM L55E11b)

The results of elevated-temperature compressive-strength and creep tests of 2024-T3 (formerly 24S-T3) aluminum-alloy plates supported in V-grooves are presented. The strength-test results indicate that a relation previously developed for predicting plate compressive strength at room temperature is satisfactory for determining elevated-temperature strength. Creep-lifetime results are presented for the plates in the form of master creep-lifetime curves by using a time-temperature parameter that is convenient for summarizing tensile creep-rupture data. The use of time-dependent stress-strain curves obtained from plate-creep curves for predicting plate-creep failure stresses is investigated.

NACA TN 3553

COMPRESSIVE CRIPPLING OF STRUCTURAL SECTIONS. Melvin S. Anderson. January 1956. 31p. diagrs., tabs. (NACA TN 3553)

A method is presented for calculating crippling stresses of structural sections as a function of material properties and the proportions of the section. The presence of formed or anisotropic material is accounted for by the use of an effective stress-strain curve. The method of analysis applies to many sections for which a procedure for calculating crippling was not previously available.

NACA TN 3560

SPONTANEOUS IGNITION STUDIES RELATING TO LUBRICANTS OF REDUCED FLAMMABILITY. Kenneth T. Mecklenborg, Cincinnati University. January 1956. 17p. diagrs., tabs. (NACA TN 3560)

Increased interest in the use of diesters as lubricants has suggested a study of the influence of the structure of the alcohol moiety on the spontaneous ignition temperature of a series of dialkyl azelates. The determination of spontaneous ignition temperatures has been extended to a number of representative organic phosphorous esters with predominantly aliphatic structures. Determination of the change in spontaneous ignition temperature with composition has been carried out with hydrogenated polyisobutylene in combination with a siloxane and with a phosphonate. The synthesis of polyisobutylene in the lubricant molecular weight range has been improved in yield.

NACA TN 3571

LIFT HYSTERESIS AT STALL AS AN UNSTEADY BOUNDARY-LAYER PHENOMENON. Franklin K. Moore. November 1955. 32p. diagrs., tab. (NACA TN 3571)

With the problem of rotating compressor stall in view, an unsteady boundary-layer calculation is made to find the unsteady increment of lift of a stalled elliptic airfoil in a flow of time-dependent incidence. The analysis indicates a counterclockwise hysteresis loop of the lift curve, the various forms of which are discussed.

NACA TN 3581

EXPERIMENTAL INVESTIGATION OF BLADE FLUTTER IN AN ANNULAR CASCADE. J. R. Rowe and A. Mendelson. November 1955. 24p. diagrs., photos. (NACA TN 3581)

Compressor-type annular cascades of airfoils were investigated to determine effects on flutter characteristics of varying angle of attack, blade chord and spacing, number of blades, and air velocity. Strain-gage, pressure-probe, and hot-wire-anemometer instrumentation was used. Large-amplitude sporadic vibrations in the stall region were encountered and are reported. No rotating stall was observed.

NACA TN 3582

EFFECT OF CLIMB TECHNIQUE ON JET-TRANSPORT NOISE. Warren J. North. January 1956. 19p. diagrs. (NACA TN 3582)

A theoretical investigation of jet-transport climb technique was made to determine the effect of variations in engine thrust and airspeed on sound-pressure levels heard by a ground observer. Reduced noise levels will be obtained when climbing on the steepest flight path consistent with minimum safe airspeed. Additional noise reduction may be obtained by throttling the engine; however, the additional benefit accompanying permissible thrust reduction is small.

NACA TN 3587

IMPINGEMENT OF WATER DROPLETS ON A SPHERE. Robert G. Dorsch, Paul G. Saper, and Charles F. Kadow. November 1955. 29p. diagrs., tab. (NACA TN 3587)

Droplet trajectories about a sphere in ideal fluid flow were calculated. From the calculated droplet trajectories, the droplet-impingement characteristics of the sphere were determined. Impingement data and equations for determining the collection efficiency, the area, and the distribution of impingement are presented in terms of dimensionless parameters. The range of flight and atmospheric conditions covered in the calculations was extended considerably beyond the range covered by previously reported calculations for the sphere.

NACA TN 3590

INVESTIGATION OF FAR NOISE FIELD OF JETS. I - EFFECT OF NOZZLE SHAPE. Edmund E. Callaghan and Willard D. Coles. January 1956. 44p. diagrs., photos. (NACA TN 3590)

The noise generation of jets discharging from convergent (circular, square, rectangular, and elliptical), plug, and convergent-divergent nozzles was investigated. At low jet pressure ratios (less than 2.2) all the nozzles had approximately the same sound field. At high pressure ratios, all the nozzles produced noise having discrete-frequency peaks. Only the convergent-divergent nozzle showed a reduction in both amplitude of the discrete-frequency noise and in total sound power radiated as compared with ordinary convergent nozzles.

NACA TN 3591

INVESTIGATION OF FAR NOISE FIELD OF JETS. II - COMPARISON OF AIR JETS AND JET ENGINES. Willard D. Coles and Edmund E. Callaghan. January 1956. 19p. diagrs., photos. (NACA TN 3591)

A comparison of the noise generation of air jets and turbojet engines was made from data obtained from similar free-field surveys. At jet pressure ratios below or only slightly above that for choked flow, the overall sound power was well represented by the Lighthill parameter, but the sound-power results obtained during afterburner operation were somewhat low. Directional patterns for overall sound pressures were similar for the engines and air jets. Air-jet and engine spectral data were dissimilar because of a dip in the engine-noise spectrum.

NACA TN 3592

AN OIL-STREAM PHOTOMICROGRAPHIC AEROSCOPE FOR OBTAINING CLOUD LIQUID-WATER CONTENT AND DROPLET SIZE DISTRIBUTIONS IN FLIGHT. Paul T. Hacker. January 1956. 36p. diagrs., photos., tabs. (NACA TN 3592)

An airborne cloud aeroscope by which droplet size, size distribution, and liquid-water content of icing and nonicing clouds can be determined has been developed and tested in flight and in wind tunnels with water sprays. The cloud droplets are continuously captured in a stream of oil, which is then photographed. In most cases, droplet size distribution can be obtained from a single photograph. With the droplet size distribution known, the liquid-water content of the cloud can be calculated from the geometry of the aeroscope, the airspeed, and the oil flow rate. The aeroscope is described in detail, and some droplet size distributions and liquid-water contents obtained during tests are presented.

BRITISH REPORTS

N-40505*

Aeronautical Research Council (Gt. Brit.)
THEORY OF THE BROAD-BLADED PROPELLER. G. I. Ginzel. 1955. 28p. diagrs., tabs. (ARC CP 208)

The standard propeller theory is that of the lifting line and therefore valid for narrow blades only. The present first step towards a theory of the propeller blade as a lifting surface considers, beside the downwash which induces an inclination of flow, the downwash derivative and the corresponding induced camber of the streamlines in the special case of shock free entry of flow at the leading edge. The result is given in the form of a correction factor to be applied to the camber ratio of the section derived by the lifting line theory. The theory of Ludweig and Ginzel is presented with a modified derivation. The influence on the camber correction factor of blade shape, of number of blades, and of circulation distribution over the radius is shown.

N-40510*

Aeronautical Research Council (Gt. Brit.)
THE MANOEUVRABILITY OF AIRCRAFT IN CIRCLING FLIGHT. H. L. Price. 1955. 32p. diagrs. (ARC R & M 2838; ARC 8, 367)

The entry into and recovery from a true banked horizontal turn executed without sideslip or loss of height is investigated. The proper continuous coordination of aileron, rudder, and elevator is deduced for all stages of the maneuver. It is shown that the rolling motion is practically unaffected by the other modes of motion, enabling the kinematics of the rolling mode to be solved in terms solely of the applied aileron movement or stick force. The aileron is regarded as the prime initiator of the turn, operated in some prechosen manner, and the elevator and rudder loads are expressed as functions of the determinable rolling velocity and acceleration. The loads to trim in the final steady turn are found as a particular case. Mathematical analysis is included.

N-40573*

Forest Products Research Lab. (Gt. Brit.)
INVESTIGATIONS INTO GLUES AND GLUING. PROGRESS REPORT EIGHTY-SEVEN - AUGUST 1955. THE COMPARATIVE DURABILITY OF PLYWOOD GLUES IN ENGLAND AND IN NIGERIA (SERIES IV). FIFTH YEAR AND FINAL REPORT. J. F. S. Carruthers and R. W. Hudson. 9p. tabs. (Forest Products Research Lab.)

Beech and gaboon plywood made with phenol-, resorcinol-, melamine-, and fortified and normal urea-formaldehyde types of adhesives has been exposed for five years in two English and two Nigerian environments. The deterioration of all glues is without practical significance for a normally heated workshop. In exposed or outdoor sites the melamine- and fortified and normal urea-formaldehyde adhesives have either failed or show significant deterioration.

N-40683*

Forest Products Research Lab. (Gt. Brit.)
COMPOSITE WOOD SECTION. TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. PILLARWOOD - CASSIPOUREA ELLIOTII - TANGANYIKA. (48 POUNDS PER CUBIC FOOT AT 15 PER CENT MOISTURE CONTENT). (PROGRESS REPORT THIRTY-TWO) October 1955. 7p. tabs. (Forest Products Research Lab.)

After processing trials this timber was classed as being unsuitable for British mills due to its small diameter, heaviness, variable color, and poor gluing characteristics. Technically the timber is sound and might be of value in its country of origin.

N-40684*

Forest Products Research Lab. (Gt. Brit.)
COMPOSITE WOOD SECTION. TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. RED MERANTI - SHOREA PARVIFOLIA - BRITISH NORTH BORNEO. (28 POUNDS PER CUBIC FOOT AT 15 PER CENT MOISTURE CONTENT). (PROGRESS REPORT THIRTY-ONE) October 1955. 7p. tabs. (Forest Products Research Lab.)

As a result of drying, gluing, and compression tests, this timber is believed to be suitable for use in British mills for plywood manufacture. Special handling will be required since the veneer is fragile.

N-40685*

Forest Products Research Lab. (Gt. Brit.)
COMPOSITE WOOD SECTION. TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. MUHUHU - BRACHYLAENA HUTCHINISII - TANGANYIKA. (61 POUNDS PER CUBIC FOOT AT 15 PER CENT MOISTURE CONTENT). (PROGRESS REPORT THIRTY) October 1955. 5p. tab. (Forest Products Research Lab.)

After processing trials this species was considered unsuitable for plywood making because of its weight and the difficulty of conversion to veneer.

N-40686*

Forest Products Research Lab. (Gt. Brit.)
COMPOSITE WOOD SECTION. TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. SCOTS PINE - PINUS SYLVESTRIS L. - HOME GROWN. (33 POUNDS PER CUBIC FOOT AT 15 PER CENT MOISTURE CONTENT). DOUGLAS FIR - PSEUDOTSUGA TAXIFOLIA - HOME GROWN. (31 POUNDS PER CUBIC FOOT AT 15 PER CENT MOISTURE CONTENT). (PROGRESS REPORT TWENTY-NINE) July 1955. 24p. tabs. (Forest Products Research Lab.)

Scots pine was found unsatisfactory as plywood due to its poor gluing characteristics and blistering. The Douglas fir was classed unsuitable for plywood making because of knots and the high compression accompanying the pressure needed to obtain an acceptable bond.

N-40687*

Forest Products Research Lab. (Gt. Brit.)
MOISTURE RELATIONS OF COMPOSITE WOOD PRODUCTS. PROGRESS REPORT TWENTY-EIGHT - OCTOBER 1955. THE SUPERFICIAL MOVEMENT OF PLYWOOD. R. A. G. Knight and R. J. Newall. 13p. tabs. (Forest Products Research Lab.)

The superficial movements of plywood of three-ply construction with moisture change have been measured for 69 species. For the two environment changes, the mean averages of the along- and across-grain movements for the 69 species were 1/5 percent and 1/4 percent, respectively. The movement of plywood across the grain was 1/25 that of veneer or solid wood.

MISCELLANEOUS

N-3074, Suppl. 4

INDEX OF NACA TECHNICAL PUBLICATIONS, JUNE 1954 - MAY 1955. 1955. viii, 205p. (NACA)

There is a classified listing of subject categories; a chronological listing of NACA publications under each subject category; an alphabetical index to the subject categories; and an author index.

DECLASSIFIED NACA RESEARCH REPORTS

NONE.

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Research Abstracts
and
Reclassification Notice

NO. 96 **FEBRUARY 10, 1956**

CURRENT NACA RESEARCH REPORTS

NACA Rept. 1203

WIND-TUNNEL INVESTIGATION AT LOW SPEED OF THE EFFECTS OF CHORDWISE WING FENCES AND HORIZONTAL-TAIL POSITION ON THE STATIC LONGITUDINAL STABILITY CHARACTERISTICS OF AN AIRPLANE MODEL WITH A 35° SWEPTBACK WING. M. J. Queijo, Byron M. Jaquet, and Walter D. Wolhart. 1954. ii, 29p. diagrs., photos., tab. (NACA Rept. 1203. Supersedes RM L50K07; RM L51H17)

Low-speed tests of a model with a wing swept back 35° at the 0.33-chord line and a horizontal tail located well above the extended wing-chord plane indicated static longitudinal instability at moderate angles of attack for all configurations tested. The present investigation was made to determine whether the longitudinal stability could be improved by use of chordwise fences, by lowering the horizontal tail, or by a combination of both.

NACA Rept. 1210

ANALYSIS OF TURBULENT HEAT TRANSFER, MASS TRANSFER, AND FRICTION IN SMOOTH TUBES AT HIGH PRANDTL AND SCHMIDT NUMBERS. Robert G. Deissler. 1955. ii, 14p. diagrs. (NACA Rept. 1210. Supersedes TN 3145)

The expression for eddy diffusivity from a previous analysis was modified in order to account for the effect of kinematic viscosity in reducing the turbulence in the region close to a wall. By using the modified expression, good agreement was obtained between predicted and experimental results for heat and mass transfer at Prandtl and Schmidt numbers between 0.5 and 3000. The effects of length-to-diameter ratio and of variable viscosity were also investigated for a wide range of Prandtl numbers.

NACA Rept. 1212

ANALOG STUDY OF INTERACTING AND NON-INTERACTING MULTIPLE-LOOP CONTROL SYSTEMS FOR TURBULENT ENGINES. George J. Pack and W. E. Phillips, Jr. 1955. ii, 13p. diagrs. (NACA Rept. 1212. Supersedes TN 3112)

An analog investigation of several turbojet control configurations was made. Both proportional and proportional-plus-integral controllers were studied, and compensating terms for engine interaction were added to the control system. Data were taken on the stability limits and the transient responses of these various configurations. Analytical expressions in terms of the component transfer functions were developed for the configurations studied and the optimum form for the compensation terms was determined. It was found that the addition of the integral term, while making the system slower and more oscillatory, was desirable in that it made the final values of the system parameters independent of source of disturbance and also eliminated droop in these parameters. Definite improvement in system characteristics results from the use of proper compensation terms. At comparable gain points the compensated system is faster and more stable. Complete compensation eliminates engine interaction permitting each loop to be developed to an optimum point independently.

NACA TM 1386

REMARK ON THE THEORY OF LIFTING SURFACES. (Sulla teoria delle superfici portanti). Aldo Muggia. January 1956. 11p. diagrs. (NACA TM 1386. Trans. from Atti della Accademia delle Scienze di Torino, v. 87, 1952-1953)

First, the Weissinger method, as it applies to a rectangular wing, is discussed. By building on this framework it is shown how to treat the lift problem for any thin wing of arbitrary plan form.

*AVAILABLE ON LOAN ONLY.

ADDRESS REQUESTS FOR DOCUMENTS TO NACA, 1512 H ST., NW., WASHINGTON 25, D. C., CITING CODE NUMBER ABOVE EACH TITLE, THE REPORT TITLE AND AUTHOR.

NACA TN 3414

INFLUENCE OF TEMPERATURE ON CREEP, STRESS-RUPTURE, AND STATIC PROPERTIES OF MELAMINE-RESIN AND SILICONE-RESIN GLASS-FABRIC LAMINATES. William N. Findley, Harlan W. Peithman, and Will J. Worley, University of Illinois. January 1956. 71p. diagrs., photos., tabs. (NACA TN 3414)

Results are reported of static-tension, static-compression, tension-creep, and time-to-fracture tests of melamine-resin and silicone-resin glass-fabric laminates at temperatures up to 400° and 600° F, respectively. The mechanical properties of both laminates decreased with increase in temperature, as a rule. The creep data supply additional evidence that the percent increase in strain from one given time to another given time is independent of stress. An equation which describes the effect of stress, time, and temperature and is based on the activation-energy theory and a power function of time represents an analysis of the creep data.

NACA TN 3527

A SECOND-ORDER SHOCK-EXPANSION METHOD APPLICABLE TO BODIES OF REVOLUTION NEAR ZERO LIFT. Clarence A. Syvertson and David H. Dennis. January 1956. 57p. diagrs., tabs. (NACA TN 3527)

A second-order shock-expansion method applicable to bodies of revolution is developed by the use of the predictions of the generalized shock-expansion method in combination with characteristics theory. Equations defining the zero-lift pressure distributions and the normal-force and pitching-moment derivatives are derived. Comparisons with experimental results show that the method is applicable at values of the similarity parameter, the ratio of free-stream Mach number to nose fineness ratio, from about 0.4 to 2.

NACA TN 3554

A PRELIMINARY INVESTIGATION OF THE EFFECTS OF FREQUENCY AND AMPLITUDE ON THE ROLLING DERIVATIVES OF AN UNSWEPT-WING MODEL OSCILLATING IN ROLL. Lewis R. Fisher, Jacob H. Lichtenstein, and Katherine D. Williams. January 1956. 29p. diagrs., photos. (NACA TN 3554)

The low-speed yawing moment due to rolling and the damping-in-roll derivatives were obtained from forced oscillation-in-roll tests. These data are presented chiefly for an angle of attack of 0° for a complete model and its various components through a range of frequencies and amplitudes of the rolling oscillation. Comparisons between the oscillation results and steady-state results from conventional rolling-flow tests are made.

NACA TN 3589

DESIGN CRITERIA FOR AXISYMMETRIC AND TWO-DIMENSIONAL SUPERSONIC INLETS AND EXITS. James F. Connors and Rudolph C. Meyer. January 1956. 42p. diagrs., tabs. (NACA TN 3589)

Design charts for single- and double-oblique shock inlets and for a systematic family of isentropic axisymmetric and two-dimensional surfaces, suitable for either inlet or exit applications, are presented for Mach numbers up to 4.0. For isentropic inlets having a mass-flow ratio of unity and focused compression at the cowl-lip, compression limits based either on shock-structure or cowl-shock-attachment requirements are analyzed and evaluated. At Mach number 4.0, an all-external-compression isentropic inlet is limited to a theoretical total-pressure recovery of 0.685 based solely on shock losses.

NACA TN 3593

CLOUD-DROPLET INGESTION IN ENGINE INLETS WITH INLET VELOCITY RATIOS OF 1.0 AND 0.7. Rinaldo J. Brun. January 1956. 52p. diagrs., tab. (NACA TN 3593)

The paths of cloud droplets into two engine inlets are calculated. The amount of water in droplet form ingested by the inlets and the amount and distribution of water impinging on the inlet walls are obtained from these droplet-trajectory calculations. In both types of inlet a prolate ellipsoid of revolution (10 percent thick) represents either part or all of the forebody at the center of an annular inlet to an engine. The configurations can also represent a fuselage of an airplane with side ram-scoop inlets. The principal difference between the two inlets studied is that the inlet air velocity of one is 0.7 that of the other.

NACA TN 3596

ON THE PERMEABILITY OF POROUS MATERIALS. E. Carson Yates, Jr. January 1956. 31p. diagrs. (NACA TN 3596)

The effects on porous-material permeability characteristics of absolute pressure level (and associated scale effects), choking of the flow, bending the material, and other factors have been investigated. Samples of 30- by 250-mesh rolled Monel metal cloth and 1/16-inch-thick sintered bronze were calibrated with constant upstream pressures of 1 atmosphere and 2-1/3 atmospheres (varying downstream pressure) and with constant downstream pressure of 1 atmosphere (varying upstream pressure). Experiments showed permeability to be appreciably affected by absolute pressure level, flow choking, and thickness of the material. Moderate bending of the material caused no noticeable change in the permeability. Simple calculation and correlation procedures were developed for determining permeability with reasonable accuracy when experimental data are limited.

NACA TN 3598

METHOD AND TABLES FOR DETERMINING THE TIME RESPONSE TO A UNIT IMPULSE FROM FREQUENCY-RESPONSE DATA AND FOR DETERMINING THE FOURIER TRANSFORM OF A FUNCTION OF TIME. Carl R. Huss and James J. Donegan. January 1956. 38p. diagrs., tabs. (NACA TN 3598)

Methods are presented for rapidly determining the time response to a unit impulse from frequency-response data and for obtaining the Fourier transform of a function of time. Tables are presented which facilitate the necessary computations of the methods.

NACA TN 3600

CORRELATION OF CRIPPLING STRENGTH OF PLATE STRUCTURES WITH MATERIAL PROPERTIES. Roger A. Anderson and Melvin S. Anderson. January 1956. 50p. diagrs., tabs. (NACA TN 3600)

A correlation approach to the crippling-strength analysis of multiplate-element structures in new materials and at elevated temperatures is presented. Appropriately defined crippling-strength moduli and correlation procedures are given for predicting the effect of a change in material properties on the strength of a structure. The accuracy of the approach is illustrated with available experimental data obtained in various materials and under different temperature conditions.

NACA TN 3608

HYDRODYNAMIC IMPACT LOADS IN SMOOTH WATER FOR A PRISMATIC FLOAT HAVING AN ANGLE OF DEAD RISE OF 10°. Philip M. Edge, Jr. January 1956. 20p. diagrs., tab. (NACA TN 3608)

Hydrodynamic-loads data obtained at the Langley impact basin from tests of a prismatic float with an angle of dead rise of 10° are presented. Tests were made at fixed trims of 3°, 12°, 20°, and 30° and a range of flight-path angles from 2° to 23°. The data are presented as dimensionless coefficients and experimental values of dead-rise function and aspect-ratio factor are obtained.

NACA TN 3614

FLOW STUDIES ON DROOPED-LEADING-EDGE DELTA WINGS AT SUPERSONIC SPEED. William H. Michael, Jr. January 1956. 29p. diagrs., photos. (NACA TN 3614)

An experimental investigation of the flow over flat delta wings has been extended to include studies on delta wings with drooped leading edges. Vapor-screen, pressure-distribution, and ink-flow tests were made on a series of semispan delta wings with semiapex angles of 15°, 22.5°, and 31.75° and with 10 percent and 20 percent of the semispans drooped 15° in streamwise sections. The tests were made at a Mach number of 1.9.

NACA TN 3625

INVESTIGATION OF THE PROPULSIVE CHARACTERISTICS OF A HELICOPTER-TYPE PULSE-JET ENGINE OVER A RANGE OF MACH NUMBERS AND ANGLE OF YAW. Paul J. Carpenter, James P. Shivers, and Edwin E. Lee, Jr. January 1956. 24p. diagrs., photos. (NACA TN 3625)

The nonwhirling propulsive characteristics of a helicopter-type pulse-jet engine mounted on a simulated rotor blade have been determined in the Langley 16-foot transonic tunnel. A propulsive thrust of about 1 lb/sq in. of engine frontal area at Mach numbers from 0.25 to 0.45 was obtained. Propulsive thrust at Mach number 0.6 decreased to about 0.73 lb/sq in. frontal area. Yaw angles of 0° to 20° had no significant effect on engine thrust at Mach numbers below 0.5 and only small effects at higher speeds. Specific fuel consumption reached a minimum of 5.3 lb of fuel per hr per hp between Mach numbers of 0.4 and 0.5. Comparison of whirling and nonwhirling data indicates significant performance losses due to whirling above centrifugal accelerations of about 200g.

NACA TN 3652

EXPERIMENTAL INVESTIGATION OF AIR-FLOW UNIFORMITY AND PRESSURE LEVEL ON WIRE CLOTH FOR TRANSPIRATION-COOLING APPLICATIONS. Patrick L. Donoughe and Roy A. McKinnon. January 1956. 28p. diagrs., photos., tab. (NACA TN 3652. *Supersedes RM E52E16*)

An experimental investigation was conducted to obtain information on air-flow uniformity and pressure-level effects for various meshes of stainless-steel corduroy wire cloth, and permeability and strength data for a 20x200 mesh stainless-steel wire cloth. It was found that close control of the wire cloth thickness yielded sufficiently uniform air flow and that available methods may be used to predict the effect of pressure level. Permeability and strengths of the 20x200 mesh wire cloth were similar to those already available from other meshes. The reduced tensile strength of the 20x200 mesh wire cloth in the direction of the primary stresses is one and a half to three times as great as the strength of the best porous sintered materials presently available.

BRITISH REPORTS

N-40731*

Aeronautical Research Council (Gt. Brit.)
THE SIMPLE HARMONIC MOTION OF A HELICOPTER ROTOR WITH HINGED BLADES. J. K. Zbrozek. 1955. 12p. diagrs. (ARC R & M 2813; ARC 12, 466. Supersedes RAE Aero 2319)

In simple harmonic oscillation of the helicopter with hinged blades, the tip path plane is tilted with respect to the shaft in the plane of oscillation and in the plane perpendicular to it. The angles of tilt are functions of angular velocity and acceleration. The influence of the acceleration term on the dynamic stability of the helicopter is small and depends mainly on the inertia number of the blade. The expressions for angles of tilt due to angular velocity can be simplified to the expressions obtained in previous work under assumptions of quasi-static conditions.

N-40732*

Aeronautical Research Council (Gt. Brit.)
A HIGH-SPEED CAMERA FOR THE PHOTOGRAPHY OF SHOCK-WAVE OSCILLATIONS IN A WIND TUNNEL. D. W. Holder, R. J. North, W. G. Standring, and J. S. T. Looms. 1955. 15p. diagrs., photos. (ARC R & M 2901; ARC 12,543)

A camera has been developed which enables oscillations of shock-waves and of other quasi-stationary phenomena in a wind tunnel to be photographed by either the schlieren method or the shadowgraph method at speeds up to 2000 frames per second, and with exposures of the order of 1 microsecond. Photographs of an oscillation which occurs when the critical Mach number is exceeded at low Reynolds number on an EC 1250 airfoil are included as examples.

N-40733*

Aeronautical Research Council (Gt. Brit.)
TESTS ON A TYPICAL WHITTLE COMPRESSOR. A. Simons and C. K. Roberts. 1955. 10p. diagrs. (ARC R & M 2913; ARC 15,145. Supersedes NGTE R. 121)

Tests have been carried out to determine the performance of a typical Whittle compressor (produced in 1944) as used in the W2/700 series of engines. At 1500 ft/sec tip speed the overall pressure ratio (total head) was 4.27 and the adiabatic efficiency was 75.6 percent at a mass flow of 36.3 lb/sec. The overall efficiency falls rapidly from 79.6 percent at 1400 ft/sec to 75.6 percent at 1500 ft/sec due to choking of the outer half of the impeller eye. The maximum diffuser efficiency is approximately 80 percent at a tip speed of 1500 ft/sec.

N-40734*

Aeronautical Research Council (Gt. Brit.)
MODEL TESTING TECHNIQUE EMPLOYED IN THE R. A. E. SEAPLANE TANK. T. B. Owen, A. G. Kurn, and A. G. Smith. 1955. 59p. diagrs., photos., tab. (ARC R & M 2976; ARC 16,464. Supersedes RAE Aero 2505)

A description is given of the various techniques evolved in recent years to provide model data as a basis for predicting the full-scale behavior of a seaplane. The seaplane tank and associated equipment are described in detail, together with the routine methods of operation. The factors affecting the choice of model scale are discussed and the methods of model construction described. A description is given of a typical test program on a new design to determine the longitudinal and lateral stability on the water, spray and rough water behavior, and water drag. The design factors affecting the longitudinal stability and spray formation are discussed in appendices.

MISCELLANEOUS

N-41416, 1955

FORTY-FIRST ANNUAL REPORT OF THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS. ADMINISTRATIVE REPORT WITHOUT TECHNICAL REPORTS. 1955. ix, 68p. (NACA)

UNPUBLISHED PAPERS

N-41216*

THE RESISTANCE LAW OF ROUGH PLATES. (Das Widerstandsgesetz rauher Platten). L. Prandtl and H. Schlichting. (1955) 16p. diagrs., tab. (Trans. from Werft Reederei Hafen, v. 15, no. 1, January 1, 1934, p. 1-4)

A conversion from the pipe resistance to the plate drag is carried out for the rough plate. The calculation is based on the results of Nikuradse for pipe tests with sand roughness. The final result is a diagram which represents the drag coefficient as a function of the plate Reynolds number with the relative roughness as the parameter.

N-41217*

RIGOROUS DETERMINATION OF PERMANENT WAVES OF FINITE AMPLITUDE. (Determination Rigoureuse des Ondes Permanentes D'ampleur Finie). T. Levi-Civita. December 1955. 73p. diagrs. (Trans. from Mathematische Annalen, v. 93, 1925, p. 264-314)

Details of concept and calculation are developed which permit a clear characterization of periodic irrotational permanent waves, that is, waves capable of being propagated without alteration of shape, at the surface of a liquid of infinite depth.

N-41218*

SHOCK WAVES IN A RELAXATION MEDIUM. (Udarnye volny v relaksiruyushchei srede). S. P. D'yakov. (1955). 9p. diagrs. (Trans. from Zhurnal Eksperimental'noi i Teoretisheskoi Fiziki, v. 27, no. 6, p. 728-734)

A general discussion of possible types of shock wave is attempted. In particular, the author asserts, without proof, the existence of a type of strong shock wave in which the pressure decreases as equilibrium is approached downstream from the initial compression shock. The major portion of the paper is concerned with an analytical discussion of weak shock waves in a medium in which relaxation processes can occur. No reference is made to pertinent American papers.

N-41219*

SHOCK WAVES IN AXIALLY SYMMETRIC SUPERSONIC JETS. Ryuma Kawamura. (1955). 19p. diagrs., photos. (Trans. from Tokyo University, Institute of Science and Technology, Reports, v. 6, no. 3, June 1952, p. 141-148)

A study is made of a jet of air issuing from a sonic orifice at low jet pressure ratios with special attention being devoted to the so-called triple point of the shock structure.

N-41254*

THEORY OF NONLINEAR SERVOMECHANISMS. (Théorie Des Servo-Mécanismes Non Linéaires). J. R. Dutilh. January 1956. 20p. diagrs. (Trans. from La Radio Francaise, May 1950, p. 1-7)

General aspects of servomechanisms; steady-state oscillation conditions for sustainment (servomechanisms with "on or off" operation without threshold, conditions for the sustainment of the oscillations, real linear servomechanisms, and relay servomechanisms with threshold); imperfection of the relays (hysteresis and delay introduced by relays); and improvement of the relay servomechanism are discussed. It is shown that nonlinear servomechanisms can be studied by means of methods very close to those which have been applied in the technique of linear servomechanisms.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification January 11, 1956.

NACA RM A51A09

PRELIMINARY DATA ON THE EFFECT OF BODY-NOSE BLUNTNESS ON THE DRAG AND PRESSURE RECOVERY OF A SIDE-INLET-BODY COMBINATION AT MACH NUMBERS OF 1.4 AND 1.7. John F. Stroud and Warren E. Anderson. April 25, 1951. 13p. diagrs., photos. (NACA RM A51A09)

The pressure recovery, mass flow, and drag of a twin-scoop, side-inlet-body combination were measured at Mach numbers of 1.4 and 1.7. Tests were made with the original body and with three different nose shapes obtained by shortening the body and increasing the nose bluntness. The nose bluntness affected all the characteristics of the side-inlet-body combination, the major effect being a large increase in total external drag.

NACA RM A52A17

WIND-TUNNEL INVESTIGATION AT LOW SPEED OF A TWISTED AND CAMBERED WING SWEPT BACK 63° WITH VORTEX GENERATORS AND FENCES. James A. Weiberg and George B. McCullough. March 1952. 45p. diagrs., photos., 3 tabs. (NACA RM A52A17)

Force, pressure-distribution, and boundary-layer measurements at low speed showed that boundary-layer-control fences or vortex-generating devices can alleviate considerably the large variations in longitudinal stability with lift coefficient of a twisted and cambered 63° sweptback wing.

NACA RM A53A06

A FLIGHT COMPARISON OF A SUBMERGED INLET AND A SCOOP INLET AT TRANSONIC SPEEDS. L. Stewart Rolls. March 1953. 41p. diagrs., photo., tab. (NACA RM A53A06)

Flight tests were performed on a YF-93 airplane to evaluate the characteristics of a scoop inlet and a submerged divergent-wall inlet. The comparison between the two inlets was made on the basis of induction-system efficiency (ram-recovery ratio at the inlet and at the compressor, diffuser loss, and engine power output), the overall airplane drag coefficient, and computed factor of relative effectiveness. Although the tests indicated that the submerged inlet had higher drag coefficients and higher inlet recoveries than the scoop inlet, the overall performance with either configuration was about the same.

NACA RM A54A07

EFFECTS OF BASE BLEED ON THE BASE PRESSURE OF BLUNT-TRAILING-EDGE AIRFOILS AT SUPERSONIC SPEEDS. William R. Wimbrow. March 1954. 33p. diagrs., photos. (NACA RM A54A07)

The effect on base pressure of bleeding air to the semidead-air region at the trailing edge of two-dimensional blunt-trailing-edge airfoils has been investigated at Mach numbers of 1.5 and 2.0. The effects of varying the base-bleed rate, the cross-sectional area of the bleed nozzles, and the geometry of the nozzles were determined for two airfoil profiles with both laminar and turbulent boundary layers approaching the trailing edge. Reductions in base drag of the order of 50 percent were obtained.

NACA RM A54A22

INVESTIGATION AT HIGH SUBSONIC SPEEDS OF A BODY-CONTOURING METHOD FOR ALLEVIATING THE ADVERSE INTERFERENCE AT THE ROOT OF A SWEPTBACK WING. John B. McDevitt and William M. Haire. April 1954. 38p. diagrs., photos. (NACA RM A54A22)

An experimental investigation was made of a body-contouring method for alleviating at subsonic speeds the adverse interference at the root of a 35° sweptback wing in combination with various bodies. Modifying the body shape did not significantly affect the aerodynamic characteristics at subcritical speeds. At Mach numbers above the critical, improved aerodynamic characteristics were evidenced by large reductions of drag, an increase in lift-curve slope, and a reduced change of pitching-moment-curve slope with increasing Mach number.

NACA RM A54H23

COMPARISON OF EXPERIMENTAL AND THEORETICAL NORMAL-FORCE DISTRIBUTIONS (INCLUDING REYNOLDS NUMBER EFFECTS) ON AN OGIVE-CYLINDER BODY AT MACH NUMBER 1.98. Edward W. Perkins and Leland H. Jorgensen. November 1954. 50p. diagrs., tab. (NACA RM A54H23)

Effects of Reynolds number and angle of attack on the pressure distribution and normal-force characteristics of a body of revolution consisting of a fineness ratio 3 ogival nose tangent to a cylindrical afterbody 7 diameters long have been determined. The test Mach number was 1.98 and the angle-of-attack range from 0° to 20°. The Reynolds numbers, based on body diameter, were 0.15×10^6 and 0.45×10^6. The experimental results are compared with theory.

NACA RM E8L10a
NACA RM E9A31

NACA RM E50F15

PRELIMINARY CORRELATION OF EFFICIENCY OF AIRCRAFT GAS-TURBINE COMBUSTORS FOR DIFFERENT OPERATING CONDITIONS. J. Howard Childs. September 21, 1950. 40p. diagrs., tab. (NACA RM E50F15)

An empirical correlation is presented of the combustion efficiency data previously obtained in experimental investigations with 14 aircraft gas-turbine combustors. A theoretical analysis of the combustion process is also presented. The theoretical analysis yields equations that predict the shape of the curves obtained by plotting the experimental data.

NACA RM E51A08

FLAME VELOCITIES OF FOUR ALKYLSILANES. Melvin Gerstein, Edgar L. Wong, and Oscar Levine. March 9, 1951. 14p. diagrs., tab. (NACA RM E51A08)

The rates of flame propagation of four alkylsilanes have been determined by a tube method. The maximum fundamental rate of flame propagation increases in the order tetramethylsilane < trimethylsilane < diethylsilane < monoethylsilane. The alkylsilanes have considerably higher flame velocities than the hydrocarbons that would result if the silicon were replaced by carbon, whereas the physical properties of the alkylsilanes resemble those of the corresponding hydrocarbons. When diethylsilane is blended with n-pentane, no marked increase in flame velocity occurs until the concentration of diethylsilane is greater than 20 percent.

NACA RM E51A26

PRELIMINARY INVESTIGATION OF EFFECTIVENESS OF BASE BLEED IN REDUCING DRAG OF BLUNT-BASE BODIES IN SUPERSONIC STREAM. Edgar M. Cortright, Jr., and Albert H. Schroeder. March 9, 1951. 23p. diagrs., photos. (NACA RM E51A26)

Experimental results are presented that evaluate the drag-reducing effectiveness of bleeding air to the base region of blunt-base bodies in a supersonic stream. Both pressure and force measurements on bodies of revolution at a Mach number of 1.91 are included. In the case of a body of revolution with cylindrical afterbody, reductions in base-pressure drag coefficient of 0.04 were obtained of which 0.03 was realized as a net gain when bleed air intake was obtained through holes in the afterbody.

NACA RM E51J18

EFFECT OF SPARK REPETITION RATE ON THE IGNITION LIMITS OF A SINGLE TUBULAR COMBUSTOR. Hampton H. Foster. December 1951. 12p. diagrs., tab. (NACA RM E51J18)

The effect of spark repetition rate on the altitude ignition limits of a single tubular (turbojet engine) combustor was investigated. An increase in sparking rate from 3 to 140 sparks per second reduced the ignition limiting combustor-inlet pressure about 2 to 4 inches of mercury for air-flow rates of 1.87 and 2.80 pounds per second per square foot. At 3.75 pounds per second per square foot, the corresponding reduction was about 4 to 12 inches of mercury. The trend was similar for both low- and high-volatility fuels and for two spark-energy levels.

NACA RM E52F13

EFFECT OF OXYGEN CONCENTRATION OF THE INLET OXYGEN-NITROGEN MIXTURE ON THE COMBUSTION EFFICIENCY OF A SINGLE J33 TURBOJET COMBUSTOR. Charles C. Graves. August 1952 45p. diagrs., 2 tabs. (NACA RM E52F13)

An investigation was conducted to determine the importance of molecular-scale processes in the overall turbojet combustion process. The effect of oxygen concentration of the inlet oxygen-nitrogen mixture on the combustion efficiency of a single J33 combustor was determined for a range of combustor-inlet pressures, and fuel-flow rates at constant combustor inlet temperature and weight-flow rate. Attempts were made to correlate combustion efficiency with selected fundamental combustion properties and with a simplified reaction-kinetics equation. At a given fuel-flow rate, combustion efficiency decreased at an increasing rate with reduction in oxygen concentration. For the pressures and oxygen concentrations tested, combustion efficiency decreased with a decrease in fuel-flow rate. At a given fuel-flow rate, combustion efficiency correlated with minimum spark-ignition energy, flame speed, and a simplified reaction-kinetics equation. A greater range of combustor-inlet conditions or other types of combustor test will be required to distinguish the most significant correlation.

NACA RM E53A27

EFFECT OF INLET OXYGEN CONCENTRATION ON COMBUSTION EFFICIENCY OF J33 SINGLE COMBUSTOR OPERATING WITH GASEOUS PROPANE. Charles C. Graves. March 1953. 22p. diagrs., tab. (NACA RM E53A27)

The effect of oxygen concentration of the inlet oxygen nitrogen mixture on the combustion efficiency of a J33 single combustor operating with propane was determined. Combustion efficiency data were obtained at combustor-inlet total pressures from 10.0 to 30.0 inches of mercury absolute, fuel flow rates from 0.008 to 0.016 pound per second, and inlet oxygen concentrations from 14 to 46 percent by volume. The combustor-inlet temperature and weight flow rate of the inlet oxygen-nitrogen mixture were held constant at 40° F and 1.0 pound per second, respectively. At a given fuel flow rate, combustion efficiency increased with oxygen concentration. The rate of increase was appreciably greater at the lower oxygen concentrations and combustion efficiencies. Change in fuel flow rate had a small effect on combustion efficiency over the major portion of the conditions investigated. At a given fuel flow rate, satisfactory correlations were obtained between combustion efficiency and parameters based on (a) a simplified reaction kinetics equation and (b) a flame speed mechanism. No satisfactory correlation was obtained between combustion efficiency and minimum spark ignition energy. In a previous investigation using liquid iso-octane fuel, satisfactory correlations were obtained with all parameters. Combustion efficiencies obtained with propane were appreciably higher than those obtained with iso-octane. However, the relative effects of inlet pressure and oxygen concentration on combustion efficiency were approximately the same for both fuels.

NACA RM E54G23

RELATION OF TURBINE-ENGINE COMBUSTION EFFICIENCY TO SECOND-ORDER REACTION KINETICS AND FUNDAMENTAL FLAME SPEED. J. Howard Childs and Charles C. Graves. August 1954. 37p. diagrs. (NACA RM E54G23)

Previous theoretical studies of the turbojet combustion process are summarized, and the resulting equations are applied to experimental data obtained from previous combustor tests. The parameter $P_i T_i / V_r$, based on the assumption that chemical reaction kinetics control combustion efficiency, provided adequate correlation of the combustion efficiency at low pressures. At higher operating pressures, the data were correlated better by the parameter $\frac{P_i^{1/3} T_i^{1.1}}{V_r}$, derived from the assumption that flame spreading controls combustion efficiency.

NACA RM L8A28c

EFFECTS OF SWEEP ON CONTROLS. John G. Lowry, John A. Axelson, and Harold I. Johnson. June 3, 1948. 29p diagrs. (NACA RM L8A28c)

An analysis of the principal results of recent control-surface research pertinent to transonic flight has been made. An indication of the nature of the changes in control-surface characteristics above the critical speed of the wing and a preliminary design procedure for estimating the effectiveness of flap-type controls on swept wings are presented.

NACA RM L9A04

NACA RM L9A18a

INVESTIGATION AT A MACH NUMBER OF 1.9 AND A REYNOLDS NUMBER OF 2.2 x 10^6 OF SEVERAL FLAP-TYPE LATERAL-CONTROL DEVICES ON A WING HAVING 42.7° SWEEPBACK OF THE LEADING EDGE. Kennith L. Goin. March 11, 1949. 28p. diagrs., photos., tabs. (NACA RM L9A18a)

Tests of a 42.7° sweptback wing with several aileron and nose-flap configurations were made in the Langley 9- by 12-inch supersonic blowdown tunnel at a Mach number of 1.90 and a Reynolds number of 2.2 x 10^6. The wing had an aspect ratio of 4, a taper ratio of 0.5, and an 8-percent-thick biconvex airfoil section in the streamwise direction. The changes in aileron configuration were made by varying the aileron contour, chord, and span and changes in nose-flap configurations were made by varying the span.

NACA RM L9L07

AERODYNAMIC CHARACTERISTICS AND FLYING QUALITIES OF A TAILLESS TRIANGULAR-WING AIRPLANE CONFIGURATION AS OBTAINED FROM FLIGHTS OF ROCKET-PROPELLED MODELS AT TRANSONIC AND LOW SUPERSONIC SPEEDS. Grady L. Mitcham, Joseph E. Stevens, and Harry P. Norris. February 9, 1950. 67p. diagrs., photos., tabs. (NACA RM L9L07)

A flight investigation of rocket-powered models of a tailless, triangular-wing airplane configuration was made at the NACA Pilotless Aircraft Research Station through the transonic and low supersonic speed range. An analysis of the aerodynamic coefficients, stability derivatives, and flying qualities based on the results obtained from the successful flight tests of three models is presented.

NACA RM L50A19

EFFECT OF WING-TANK LOCATION ON THE DRAG AND TRIM OF A SWEPT-WING MODEL AS MEASURED IN FLIGHT AT TRANSONIC SPEEDS. Clement J. Welsh and John D. Morrow. April 4, 1950. 18p. diagrs., photos. (NACA RM L50A19)

Results of an exploratory free-flight investigation at zero lift of several rocket-powered drag research models equipped with wing tanks are presented for a Mach number range from about 0.50 to 1.15. The tanks, which were slender bodies of revolution, were mounted on 34° sweptback, nontapered wings of 2.7 aspect ratio. The tanks were directly attached to the wings such that their center lines were positioned on and vertically displaced from the wing-chord plane for tip and inboard spanwise locations. The tanks positioned on the chord plane were also located more forward than were the vertically displaced tanks.

NACA RM L50A27

THE EFFECT OF SPANWISE AILERON LOCATION ON THE ROLLING EFFECTIVENESS OF WINGS WITH 0° AND 45° SWEEP AT SUBSONIC, TRANSONIC, AND SUPERSONIC SPEEDS. H. Kurt Strass. April 25, 1950. 28p. diagrs., photo. (NACA RM L50A27)

An experimental free-flight investigation at subsonic, transonic, and supersonic speeds has been made of the rolling effectiveness of 0.2-chord plain faired inboard half-span, outer half-span, and full-span ailerons on wings employing the NACA 65A009 airfoil section at 0° and 45° sweepback. In addition a shielded horn balance was added to the outer half-span controls and the effect measured. Drag values were also obtained.

NACA RM L51A02

A TRANSONIC-WING INVESTIGATION IN THE LANGLEY 8-FOOT HIGH-SPEED TUNNEL AT HIGH SUBSONIC MACH NUMBERS AND AT A MACH NUMBER OF 1.2. WING-FUSELAGE CONFIGURATION HAVING A WING OF 0° SWEEPBACK, ASPECT RATIO 4.0, TAPER RATIO 0.6, AND NACA 65A006 AIRFOIL SECTION. Maurice S. Cahn and Carroll R. Bryan. March 6, 1951. 37p. diagrs., photos. (NACA RM L51A02)

Force, moment, and wake characteristics were investigated at high subsonic Mach numbers and at a Mach number of 1.2 for a wing-fuselage configuration employing a wing with unswept quarter-chord line, aspect ratio 4, taper ratio 0.6, and an NACA 65A006 airfoil section.

NACA RM L51A11

SOME EXPERIMENTS ON THE FLUTTER OF SWEPTBACK CANTILEVER WING MODELS AT MACH NUMBER 1.3. W. J. Tuovila. March 15, 1951. 10p. diagrs., tab. (NACA RM L51A11)

Flutter tests of sweptback cantilever wing models have been made in a small intermittent two-dimensional supersonic tunnel where the testing technique involved changing the structural parameters so that the models would flutter at the tunnel design Mach number of 1.3. Data for 21 models covering sweep angles from 30° to 60° and with varying parameters are included. No attempt is made to correlate the data with analytical developments. However, reference values of flutter speed, obtained with a swept-wing flutter analysis based on two-dimensional incompressible flow, are compared with the experimental flutter speed in order to unify the results.

NACA RM L51A15

LARGE-SCALE FLIGHT MEASUREMENTS OF ZERO-LIFT DRAG AT MACH NUMBERS FROM 0.8 TO 1.6 OF A WING-BODY COMBINATION HAVING AN UNSWEPT 4.5-PERCENT-THICK WING WITH MODIFIED HEXAGONAL SECTIONS. Eugene D. Schult. March 23, 1951. 14p. diagrs., photos., tab. (NACA RM L51A15)

Measurements of zero-lift drag were made at high Reynolds numbers and from Mach numbers of 0.8 to 1.6 of a wing-body combination having a tapered, essentially unswept, 4.5-percent-thick wing of aspect ratio 3.04 mounted on a parabolic-arc body of fineness ratio 10.

NACA RM L51A29

FLIGHT INVESTIGATION AT MACH NUMBERS FROM 0.8 TO 1.5 OF THE DRAG OF A CANOPY LOCATED AT TWO POSITIONS ON A PARABOLIC BODY OF REVOLUTION. Clement J. Welsh and John D. Morrow. March 15, 1951. 15p. diagrs., photos., tabs. (NACA RM L51A29)

Results of an exploratory free-flight investigation of two rocket-powered drag research models equipped with canopies are presented for a Mach number range of 0.8 to 1.5. The models were different only in that one had the leading edge of its canopy located at the 15-percent fuselage station and the other had its canopy located at the 25-percent station. The drag of the two models was measured and compared with that of a model having no canopy.

NACA RM L51A30

NOTES ON LOW-LIFT BUFFETING AND WING DROPPING AT MACH NUMBERS NEAR 1. Paul E. Purser. March 16, 1951. 22p. diagrs., tab. (NACA RM L51A30)

A brief study of the available transonic Mach number data on low-lift buffeting and wing dropping is presented. Study indicates that there are combinations of airfoil-thickness ratio, aspect ratio, and sweep which may allow flight through the transonic speed range without experiencing buffet or wing drop at low lift.

NACA RM L52A07

PERFORMANCE OF AIR INLETS AT TRANSONIC AND LOW SUPERSONIC SPEEDS. Mark R. Nichols and Robert E. Pendley. February 1952. 22p. diagrs. (NACA RM L52A07)

A general discussion of the air-inlet problem is presented. Recently obtained drag and pressure-recovery data for transonic-type nose, scoop, and wing-root inlets are summarized. Preliminary results concerning the performance of the sharp-edged supersonic-type inlets at transonic and subsonic speeds also are given.

NACA RM L52A24

EXPERIMENTAL INVESTIGATION OF INTERNAL-FLOW CHARACTERISTICS OF FORWARD UNDERSLUNG FUSELAGE SCOOPS WITH UNSWEPT AND SWEPTBACK ENTRANCE AT MACH NUMBERS OF 1.41 TO 1.96. Robert W. Boswinkle, Jr., and Meade H. Mitchell, Jr. March 1952. 34p. photos., diagrs. (NACA RM L52A24)

Two versions of a type of forward underslung scoop mounted on a pointed fuselage were investigated principally at a Mach number of 1.41 in the Langley 9- by 12-inch supersonic blowdown tunnel. The scoop entrances were in the shape of a 60° sector of an annulus; the sides of one scoop were unswept and the sides of the other were sweptback. Total-pressure recoveries, surface-pressure distributions, and shadowgraphs were obtained over wide ranges of angle of attack and mass-flow ratio. A few tests at Mach numbers of 1.62 and 1.96 were also made. From a total-pressure-recovery standpoint the unswept scoop appears to be a satisfactory configuration at a Mach number of 1.41.

NACA RM L52A29

WIND-TUNNEL INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS IN PITCH OF WING-FUSELAGE COMBINATIONS AT HIGH SUBSONIC SPEEDS. ASPECT-RATIO SERIES. Richard E. Kuhn and James W. Wiggins. April 1952. 42p. diagrs., photos., tab. (NACA RM L52A29)

This paper presents the aerodynamic characteristics in pitch of wing-fuselage combinations with wings having a taper ratio of 0.6, sweep angle of 45° at the quarter-chord line, and aspect ratios of 2, 4, and 6. The tests covered a Mach number range from approximately 0.4 to 0.95 and an angle-of-attack range of -2° to 25°. The test Reynolds number varied from 1,500,000 to 6,000,000, depending upon the wing and Mach number. Fuselage-alone data also are included.

NACA RM L52A30

SOME FACTORS AFFECTING AUTOMATIC CONTROL OF AIRPLANES. Charles W. Mathews. February 1952. 15p. diagrs. (NACA RM L52A30)

Contains discussions of the determination of airplane transfer functions from measured responses to control transients, the factors affecting airplane transfer functions, and the implications of these factors with respect to autopilot design. Initial discussion is concerned with longitudinal control while later discussion is concerned with lateral and directional control.

NACA RM L53A13

INVESTIGATIONS OF THE DAMPING IN ROLL OF SWEPT AND TAPERED WINGS AT SUPERSONIC SPEEDS. Russell W. McDearmon and Harry S. Heinke, Jr. March 1953. 35p. diagrs., photos., tab. (NACA RM L53A13)

Damping-in-roll derivatives for a series of 33 swept and tapered wings have been obtained from supersonic wind-tunnel tests. The wings were mounted on a small cylindrical sting and tested at Mach numbers of 1.62, 1.93, and 2.41. Comparisons were made with the values of damping in roll from linear theory.

NACA RM L54A14

AERODYNAMIC CHARACTERISTICS OF A CIRCULAR CYLINDER AT MACH NUMBER 6.86 AND ANGLES OF ATTACK UP TO 90°. Jim A. Penland. March 1954. 30p. diagrs., photos. (NACA RM L54A14)

Pressure-distribution and force tests of a circular cylinder have been made in the Langley 11-inch hypersonic tunnel at a Mach number of 6.86, a Reynolds number of 129,000, and angles of attack up to 90°. The results are compared with the hypersonic approximation of Grimminger, Williams, and Young and a simple modification of the Newtonian flow theory. An evaluation of the crossflow theory is made through comparison of present results with available crossflow Mach number drag coefficients.

NACA RM L54A19

EXPERIMENTAL AND CALCULATED STATIC CHARACTERISTICS OF A TWO-BLADE NACA 10-(3)(062)-045 PROPELLER. John M. Swihart. March 1954. 20p. diagrs., photos., tab. (NACA RM L54A19)

This paper presents the static characteristics of a two-blade NACA 10-(3)(062)-045 propeller over a blade angle range from -5° to 40° measured at the 0.75 radial station at tip Mach numbers up to 1.0. Comparisons of experimental data with thrust and power coefficients calculated by strip theory show good agreement where adequate airfoil data are available. At any given blade angle the static thrust figure of merit increases with increasing tip Mach number for values of tip Mach number up to 1.0.

NACA RM L54A22

CHORDWISE PRESSURES AND SECTION FORCE AND MOMENT COEFFICIENTS AT HIGH SUBSONIC SPEEDS NEAR MIDSPAN OF A TAPERED 35° SWEPTBACK WING WITH A FLAP-TYPE CONTROL AND AN ATTACHED TAB. Alexander D. Hammond and Barbara M. Keffer. March 1954. 57p. diagrs., 35 tabs. (NACA RM L54A22)

This paper presents the effect of the deflection of a flap-type control with an attached tab on the chordwise pressures and on the section force and moment coefficients at the 46-percent-semispan station of a tapered 35° sweptback wing of aspect ratio 4 with an NACA 65A006 airfoil section. The tests were made at angles of attack from 0° to 20° and at Mach numbers from 0.60 to 0.93 for aileron deflections from -30° to 30° and tab deflections from -20° to 20°.

NACA RM L54A28a

THE FLOW PAST A STRAIGHT- AND A SWEPT-WING—BODY COMBINATION AND THEIR EQUIVALENT BODIES OF REVOLUTION AT MACH NUMBERS NEAR 1.0. Walter F. Lindsey. April 1954. 18p. diagrs., photos. (NACA RM L54A28a)

The complete flow fields past a straight and a swept wing-body combination and their equivalent bodies of revolution at Mach numbers around 1.0 have been observed by means of motion-picture schlieren photography. The results of these observations indicate that the shock growth and positions on the wing-body combinations are closely reproduced in the flow past their respective equivalent bodies.

NACA RM SE9A31
NACA RM SL9A04
NACA RM SL9A13

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1192

THEORETICAL AND EXPERIMENTAL INVESTIGATION OF MUFFLERS WITH COMMENTS ON ENGINE-EXHAUST MUFFLER DESIGN. Don D. Davis, Jr., George M. Stokes, Dewey Moore, and George L. Stevens, Jr. 1954. iv, 47p. diagrs., photos., tabs. (NACA Rept. 1192. Supersedes TN 2893; TN 2943)

Equations are presented for the attenuation characteristics of several types of mufflers. Experimental curves of attenuation plotted against frequency are presented for 77 different mufflers with reflection-free tailpipe terminations and for four different mufflers with finite tailpipes. The results are compared with theory. The experiments were made at room temperature without flow; the sound source was a loud-speaker. The application of the theory to the design of engine-exhaust mufflers is discussed, and charts have been included for the assistance of the designer. Finally, the results of tests of four muffler-tailpipe combinations on a helicopter are presented.

NACA Rept. 1214

STATISTICAL MEASUREMENTS OF CONTACT CONDITIONS OF 478 TRANSPORT-AIRPLANE LANDINGS DURING ROUTINE DAYTIME OPERATIONS. Norman S. Silsby. 1955. ii, 17p. diagrs., photos., tabs. (NACA Rept. 1214. Supersedes TN 3194)

Statistical measurements have been obtained from photographs taken with a specially built motion-picture camera of 478 landings of present-day transport airplanes during routine daylight operations in clear air at the Washington National Airport. From these measurements, sinking speeds, bank angles, rolling velocities, and horizontal speeds have been evaluated and a limited statistical analysis of the results has been made. An attempt was made to determine the effect of various parameters such as gusty-wind conditions, wing loading, and size of airplane (number of engines) which influence the landing contact conditions.

NACA RM E55L14a

VISUAL STUDY OF FREE CONVECTION IN A NARROW VERTICAL ENCLOSURE. Ephraim M. Sparrow and Samuel J. Kaufman. February 1956. 14p. diagr., photos. (NACA RM E55L14a)

The free-convection flow of water in a narrow vertical enclosure, cooled at the top through a copper surface and open at the bottom to a heated reservoir, has been studied by means of a shadowgraph. It was found that there is no flow pattern which is steady with time, that is, no region of the enclosure is permanently a region of upflow or of downflow. Because of variations in the size of the various upflow and downflow regions arranged along the length of the enclosure at a given time, and because of changes with time, neither upflow nor downflow regions could be characterized by a definite size. The number of upflow and downflow regions varied with time.

NACA TM 1399

ACOUSTICS OF A NONHOMOGENEOUS MOVING MEDIUM. (Akustika Neodnorodnoi Dvizhushcheisya Sredy). D. I. Blokhintsev. February 1956. 194p. diagrs., photos. (NACA TM 1399. Trans. of Russian Book, 1946)

Theoretical basis of the acoustics of a moving nonhomogeneous medium is considered in this report. Experiments that illustrate or confirm some of the theoretical explanation or derivation of these acoustics are also included.

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NACA TM 1415

LAMINAR FLOW ABOUT A ROTATING BODY OF REVOLUTION IN AN AXIAL AIRSTREAM. (Die laminare Strömung um einen axial angeströmten rotierreden Drehkörper). H. Schlichting. (Abstract of paper presented at the Eighth International Mechanics Congress, Istanbul, August 27, 1952). February 1956. 43p. diagrs., photo. (NACA TM 1415. Trans. from Ingenieur-Archiv, v. 21, no. 4, 1953, p. 227-244)

A method is given for calculating the incompressible laminar boundary layer on a rotating body of revolution at zero angle of attack in an airstream. The method is based on two boundary-layer momentum equations, one for the meridional direction and one for the circumferential direction. A simultaneous solution of both momentum equations yields the boundary-layer parameters, the friction drag, and the torque. The boundary-layer flow about a rotating sphere, about a body with a blunt base, and about two streamline bodies is calculated. The separation point is found to be affected by the spin.

NACA TN 3530

MINIMUM WAVE DRAG FOR ARBITRARY ARRANGEMENTS OF WINGS AND BODIES. Robert T. Jones. February 1956. 11p. diagrs. (NACA TN 3530)

Studies of various arrangements of wings and bodies designed to provide favorable wave interference at supersonic speeds lead to the problem of determining the minimum possible value of the wave resistance obtainable by any disposition of the elements of an aircraft within given dimensions defined by a region. Under the assumptions that the total lift and the total volume of the aircraft are given, conditions that must be satisfied if the drag is to be a minimum are found. For arbitrary regions the minimum value can be estimated by a simple formula giving a lower bound.

NACA TN 3564

EFFECT OF PNEUMATIC DE-ICERS AND ICE FORMATIONS ON AERODYNAMIC CHARACTERISTICS OF AN AIRFOIL. Dean T. Bowden. February 1956. 59p. diagrs., photos. (NACA TN 3564)

Measurements of drag, lift, and pitching moment of an NACA 0011 airfoil were made in icing conditions using pneumatic de-icers having either spanwise or chordwise inflatable tubes. Lift and drag penalties due to de-icer inflation and to ice remaining after de-icer inflation are presented. Inflation of the spanwise-tube de-icer caused a much greater increase in drag than inflation of the chordwise-tube de-icer. The two de-icers were equally effective in removing ice. Lift and drag penalties resulting from ice formed with the de-icer inoperative are also presented, as well as spoiler data for analyzing drag increases due to ice formations.

NACA TN 3594

EFFECT OF TRANSVERSE BODY FORCE ON CHANNEL FLOW WITH SMALL HEAT ADDITION. Simon Ostrach and Franklin K. Moore. February 1956. 31p. diagrs. (NACA TN 3594)

As a channel flow traverses a plane normal to the flow axis over which heat sources are uniformly distributed, analysis shows the flow to be displaced in the direction of the body force, becoming a shear flow far downstream. If heat sources are distributed nonuniformly, vortices are produced by the action of the body forces. The cases of small Mach number and, separately, large Froude number are considered. The flow in a rotor-tip combustor of a helicopter ram jet is considered as an example.

NACA TN 3595

WEAR OF TYPICAL CARBON-BASE SLIDING SEAL MATERIALS AT TEMPERATURES TO 700° F. Robert L. Johnson, Max A. Swikert, and John M. Bailey. February 1956. 22p. diagrs., photos., tab. (NACA TN 3595)

Wear and friction studies were made with carbon-type seal materials sliding against tool steel, stainless steel, and chromium-plated steel at temperatures to 700° F and a sliding velocity of 10,000 feet per minute. Wear was several times greater at 500° F and above than with no heat added for all carbon materials. The mating material had more effect on wear and surface failure than did the use of various impregnants in the carbon. Chromium plate gave less wear than the other mating materials under all conditions of the experiment.

NACA TN 3610

COMPARISON OF LANDING-IMPACT VELOCITIES OF FIRST AND SECOND WHEEL TO CONTACT FROM STATISTICAL MEASUREMENTS OF TRANSPORT AIRPLANE LANDINGS. Eziaslav N. Harrin. February 1956. 22p. diagrs., photo., tabs. (NACA TN 3610)

A statistical analysis of vertical velocities at second wheel to touch was made from motion pictures of 353 landings of transport-type airplanes at Washington National Airport. The effects of gusts, rolling direction, and number of engines are presented. Comparisons are made with vertical velocities of the first wheel to touch from NACA TN 3194.

NACA TN 3621

GUST-LOAD AND AIRSPEED DATA FROM ONE TYPE OF TWO-ENGINE AIRPLANE ON SIX CIVIL AIRLINE ROUTES FROM 1947 TO 1955. Walter G. Walker. February 1956. 25p. diagrs., tabs. (NACA TN 3621)

V-G data covering 70,000 hours were obtained from six different operations of a two-engine civil transport airplane and are analyzed to determine the severity and frequency of occurrence of the airspeeds, gust loads, and gusts. The results show sizable variations in the gusts, gust loads, and operating speeds among the present operations but, in general, these results are similar to those from past operations of the same type of airplane.

NACA TN 3651

CROSS FLOWS IN LAMINAR INCOMPRESSIBLE BOUNDARY LAYERS. Arthur G. Hansen and Howard Z. Herzig. February 1956. 50p. diagrs., photos., tabs. (NACA TN 3651)

An analysis is derived for the three-dimensional boundary-layer flow over a flat surface with a leading edge under main-flow streamlines which are translates and representable by polynomial expressions. The boundary layers are laminar and incompressible, and the profiles of their velocity components have similarity with respect to rectangular coordinates. Solutions are obtained for main-flow streamlines presentable by polynomials up to the 11th order. Flow-visualization experimental checks for the theory are provided for several flow configurations and for comparisons of the behavior of thick and thin boundary layers.

NACA TN 3658

IMPINGEMENT OF WATER DROPLETS ON A RECTANGULAR HALF BODY IN A TWO-DIMENSIONAL INCOMPRESSIBLE FLOW FIELD. William Lewis and Rinaldo J. Brun. February 1956. 27p. diagrs., tabs. (NACA TN 3658)

Trajectories of water droplets moving in the ideal two-dimensional flow field ahead of a body of rectangular cross section and infinite extent in the downstream direction have been calculated by means of a differential analyzer. Data on collection efficiency and distribtuion of water impingement are presented.

NACA TN 3666

BODIES OF REVOLUTION HAVING MINIMUM DRAG AT HIGH SUPERSONIC AIRSPEEDS. A. J. Eggers, Jr., Meyer M. Resnikoff, and David H. Dennis. February 1956. 38p. diagrs., photos. (NACA TN 3666. Supersedes RM A51K27; A52D24)

Newtonian impact theory is used to determine body shapes of minimum drag under various combinations of the conditions of given body length, base diameter, surface area, and volume. In addition an estimate is made of centrifugal forces, and their effect on the minimum-drag shapes is considered. An experimental investigation carried out in the Ames 10- by 14-inch supersonic wind tunnel on a family of bodies, including two of the minimum-drag shapes, is found to provide a substantiation of the analysis.

NACA TN 3667

WING-BODY COMBINATIONS WITH CERTAIN GEOMETRIC RESTRAINTS HAVING LOW ZERO-LIFT WAVE DRAG AT LOW SUPERSONIC MACH NUMBERS. Harvard Lomax. February 1956. 32p. diagrs. (NACA TN 3667)

Several variational problems involving optimum wing and body combinations having minimum wave drags for different kinds of geometrical restraints are analyzed. Particular attention is paid to the effect on the wave drag of shortening the fuselage and, for slender axially symmetric bodies, the effect of fixing the fuselage diameter at several points or even of fixing whole portions of its shape.

MISCELLANEOUS

NACA TN 2985

Errata on "A FLIGHT INVESTIGATION OF THE EFFECT OF STEADY ROLLING ON THE NATURAL FREQUENCIES OF A BODY-TAIL COMBINATION." Norman R. Bergrun and Paul A. Nickel. August 1953.

NACA TN 3513

Errata on "HEAT TRANSFER AT THE FORWARD STAGNATION POINT OF BLUNT BODIES." Eli Reshotko and Clarence B. Cohen. July 1955.

NACA TN 3583

Errata on "CHARTS OF BOUNDARY-LAYER MASS FLOW AND MOMENTUM FOR INLET PERFORMANCE ANALYSIS MACH NUMBER RANGE, 0.2 TO 5.0." Paul C. Simon and Kenneth L. Kowalski. November 1955.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification for items marked (#) February 1, 1956. Effective date of declassification for all other items February 8, 1956.

NACA MR A6D08
NACA MR A6H27
NACA MR A6J28
NACA MR E5L21
NACA MR L6D08
NACA MR L6D09
NACA MR L6E17
NACA MR L6H01

NACA RM A9B16

WIND-TUNNEL INVESTIGATION OF A TAILLESS TRIANGULAR-WING FIGHTER AIRCRAFT AT MACH NUMBERS FROM 0.5 TO 1.5. Leslie F. Lawrence and James L. Summers. June 24, 1949. 56p. diagrs., photos., tab. (NACA RM A9B16)

The aerodynamic characteristics of a tailless fighter aircraft employing a triangular wing of aspect ratio 2.31 are presented for Mach numbers from 0.5 to 1.52. The variation with Mach number of the static longitudinal stability, the drag, and the effectiveness of constant-chord control surfaces are determined for the airplane with an external compression type of air entry and an open nose type of air entry.

NACA RM A52A04

FLIGHT CALIBRATION OF ANGLE-OF-ATTACK AND SIDESLIP DETECTORS ON THE FUSELAGE OF A 35° SWEPT-WING FIGHTER AIRPLANE. Norman M. McFadden, George A. Rathert, Jr., and Richard S. Bray. February 1952. 26p. diagrs., photos. (NACA RM A52A04)

The position errors of angle-of-attack and sideslip detectors located on the fuselage of a 35° swept-wing fighter airplane were measured in flight over a Mach number range of 0.50 to 0.92 and at normal-force coefficients up to the buffet boundary. The angle of attack can be computed to ±0.2° on 90 percent of the data points using a linear equation in terms of indicated angle of attack and the ratio of impact pressure to static pressure. The variation of indicated angle of attack with sideslip was linear and small. Indicated sideslip varied linearly with true sideslip and was independent of Mach number.

NACA RM A52B20

THE EFFECTS OF REYNOLDS NUMBER AT MACH NUMBERS UP TO 0.94 ON THE LOADING ON A 35° SWEPTBACK WING HAVING NACA 65_1A012 STREAMWISE SECTIONS. Bruce E. Tinling and Armando E. Lopez. June 1952. 115p. diagrs., photos., tabs. (NACA RM A52B20)

Forces, moments, and surface-pressure data are presented for a range of Reynolds numbers from 2,000,000 to 10,000,000 at a Mach number of 0.25, and from 2,000,000 to approximately 4,500,000 at Mach numbers from 0.60 to 0.94. The surface pressures have been integrated to obtain section normal-force and pitching-moment coefficients for sections at 10, 20, 40, 60, 80, 90, and 95 percent of the semispan.

NACA RM A53A15

COMPARISON OF MEASURED AND PREDICTED INDICATED ANGLES OF ATTACK NEAR THE FUSELAGES OF A TRIANGULAR-WING WIND-TUNNEL MODEL AND A SWEPT-WING FIGHTER AIRPLANE IN FLIGHT. Norman M. McFadden, John L. McCloud, III, and Harry A. James. March 1953. 13p. diagrs. (NACA RM A53A15)

Comparisons are presented of predicted values of flow angles and those measured using detectors close to the surface of the forward portion of fuselages of a large-scale, triangular-wing, wind-tunnel model at low speeds and a 35° swept-wing fighter airplane in flight. Effects of flap deflection on the upwash of the triangular-wing model are included.

NACA RM A53B06

AN INVESTIGATION OF A FOUR-BLADE SINGLE-ROTATION PROPELLER IN COMBINATION WITH AN NACA 1-SERIES D-TYPE COWLING AT MACH NUMBERS UP TO 0.83. Robert M. Reynolds, Robert I. Sammonds, and George C. Kenyon. April 1953. 71p. diagrs., photos. (NACA RM A53B06)

Propeller thrust coefficients, power coefficients, efficiency, and pressures on the cowling surfaces were determined. Tests were conducted at Mach numbers from 0.20 to 0.83 for propeller blade angles of 40°, 50°, and 60°; for propeller advance-diameter ratios from 1.3 to 4.5; for cowling inlet-velocity ratios from 0.26 to 1.33; and for ideal and platform types of propeller-spinner junctures. All tests were made with the propeller-spinner-cowling combination at an angle of attack of 0° and at a Reynolds number of 1.5 million per foot.

NACA RM A54B18

THE TRANSONIC AERODYNAMIC CHARACTERISTICS OF STRUCTURALLY RELATED WINGS OF LOW ASPECT RATIO HAVING A SPANWISE VARIATION IN THICKNESS RATIO - TRANSONIC BUMP TECHNIQUE. Joseph W. Cleary. April 1954. 28p. diagrs., photo. (NACA RM A54B18)

Wings having aspect ratios of 4, 3, and 2 and equal plan-form taper and thickness-ratio taper were investigated to determine their transonic longitudinal characteristics and the effects of tapering thickness ratio. The wings were structurally related to give approximately the same bending stress for a given percent span and a given lift coefficient. The results are compared with data for other wings having the same plan form but constant thickness ratio.

NACA RM A54B18a

INVESTIGATION OF A THREE-BLADE PROPELLER IN COMBINATION WITH TWO DIFFERENT SPINNERS AND AN NACA D-TYPE COWL AT MACH NUMBERS UP TO 0.80. George C. Kenyon and Robert M. Reynolds. April 1954. 62p. diagrs., photos., tab. (NACA RM A54B18a)

This report presents the aerodynamic characteristics of a three-blade propeller (designated NACA 3.638-(675)(057)-0572) at Mach numbers up to 0.80. Tests were made at positive thrust for the propeller with a 1-series spinner and a modified conical spinner operating in the presence of an NACA 1-series D-type cowl. Tests were also conducted for the isolated propeller-spinner combination operating at positive thrust, negative thrust, and at near static conditions. Included are the results of airstream surveys of the local velocities in the plane of the propeller.

NACA RM A54B26

FLIGHT INVESTIGATION OF THE EFFECTS OF A PARTIAL-SPAN LEADING-EDGE CHORD EXTENSION OF THE AERODYNAMIC CHARACTERISTICS OF A 35° SWEPT-WING FIGHTER AIRPLANE. Frederick H. Matteson and Rudolph D. Van Dyke, Jr. April 1954. 34p. diagrs., photos., tabs. (NACA RM A54B26)

Flight measurements were made of the effects of a 15-percent-chord, partial-span, leading-edge extension on the longitudinal stability and drag of the F-86A airplane. Wing-fuselage pitching moments were determined from balancing tail load measurements, and complete airplane stability was determined from trim elevator angle measurements. Two fence configurations were tested in conjunction with the extended leading edge. Tuft studies and pilot opinions were obtained and compared with stability data.

NACA RM E8A30

THEORETICAL PERFORMANCE OF SOME ROCKET PROPELLANTS CONTAINING HYDROGEN, NITROGEN, AND OXYGEN. Riley O. Miller and Paul M. Ordin. May 26, 1948. 53p. diagrs., tabs. (NACA RM E8A30)

Theoretical performance data including nozzle-exit temperature, specific impulse, volume specific impulse and composition, temperature, and mean molecular weight of reaction products based on frozen equilibrium and isentropic expansion are presented for 13 propellant combinations at reaction pressure of 300 pounds per square inch absolute and expansion ratio of 20.4. On basis of maximum specific impulse alone, five fuels had the following order for any given oxidant: liquid hydrogen, hydrazine, liquid ammonia, and either hydrazine hydrate or hydroxylamine. Three oxidants with a given fuel had the following order: liquid ozone, liquid oxygen, and 100-percent hydrogen peroxide.

NACA RM E52A18

EFFECT OF INLET-AIR AND FUEL PARAMETERS ON SMOKING CHARACTERISTICS OF A SINGLE TUBULAR TURBOJET-ENGINE COMBUSTOR. Helmut F. Butze. April 1952. 26p. diagrs., photos., tabs. (NACA RM E52A18)

The effect of systematic variations in inlet-air and fuel parameters on the smoking characteristics of a single tubular turbojet-engine combustor was investigated. In addition a series of tests were conducted with a full-scale engine operating at static sea-level conditions over a range of engine speeds. In the single combustor increases in pressure effected large increases in smoke density while increases in velocity reduced smoke density. As fuel-air ratio was increased, smoke density increased, passed through a maximum, and finally decreased. Increases in fuel temperature increased smoke density slightly while inlet-air temperature and fuel volatility had little effect on smoke. In the full-scale engine smoke density increased with increasing engine speed and with decreasing exhaust-nozzle area.

NACA RM E54B05

EVALUATION OF A SILICONE-DIESTER LUBRICANT IN BENCH STUDIES AND IN A TURBOPROPELLER ENGINE. Robert L. Johnson, S. F. Murray, and Edmond E. Bisson. Appendix D: COPY OF REPORT BY SILICONE PRODUCTS DEPARTMENT OF GENERAL ELECTRIC ON NACA SD-17 FLUID. N. G. Holdstock, General Electric Company. May 1954. 32p. diagrs., photos., tabs. (NACA RM E54B05)

A silicone-diester blend (SD-17) was investigated in various bench studies and in a turbopropeller engine to determine its suitability as a lubricant for aircraft engines. The performance of the fluid was

satisfactory during more than 17 hours of operation in a T-38 engine with power levels from 1745 to 2400 horsepower. The fluid has better viscometric properties than currently used lubricants and could eliminate low-temperature starting and pumpability problems for turbopropeller engines. The fluid has good boundary lubrication and other lubricant properties as measured with most bench devices. Especially good gear lubrication characteristics were established in bench studies and in the engine test.

NACA RM H55A11

WING-LOAD MEASUREMENTS OF THE BELL X-5 RESEARCH AIRPLANE AT A SWEEP ANGLE OF 58.7°. Richard D. Banner, Robert D. Reed, and William L. Marcy. April 1955. 22p. diagrs., photo., tab. (NACA RM H55A11)

Flight measurements of the aerodynamic wing-panel loads have been made on the Bell X-5 research airplane from which the wing-panel normal-force-curve slope, the chordwise center of pressure, and the spanwise center of pressure have been determined from a Mach number of 0.61 to 0.97. A comparison of the loads calculated by theory was made at one Mach number.

NACA RM H55C07

FLIGHT DETERMINATION OF THE LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF THE BELL X-5 RESEARCH AIRPLANE AT 58.7° SWEEPBACK. Thomas W. Finch. May 1955. 30p. diagrs., photo., tab. (NACA RM H55C07)

Flight tests were performed with the Bell X-5 research airplane at 58.7° sweepback to measure the longitudinal stability and control characteristics from elevator and stabilizer maneuvers at 40,000 feet and elevator maneuvers at 25,000 feet and 15,000 feet. Results are presented for Mach numbers up to 1.0 and include trim characteristics, apparent stability parameters, relative control effectiveness, stick-force gradient, normal-force-curve slope, and effect of dynamic pressure and engine power. Comparison is made with wind-tunnel data.

NACA RM H55E20a

FLIGHT MEASUREMENTS OF HORIZONTAL-TAIL LOADS ON THE BELL X-5 RESEARCH AIRPLANE AT A SWEEP ANGLE OF 58.7°. Robert D. Reed. July 1955. 19p. diagrs., photo., tab. (NACA RM H55E20a)

Flight measurements of the horizontal tail loads on the Bell X-5 research airplane have been made in accelerated maneuvers at Mach numbers from 0.61 to 1.00 at an altitude of 40,000 feet. At this altitude the aerodynamic and balancing tail loads were determined at all normal-force coefficients up to near maximum lift. Comparisons were made with flight and wind-tunnel data obtained at 25,000 feet and 15,000 feet over a limited lift range.

NACA RM H55H10

FLIGHT MEASUREMENTS OF THE DYNAMIC LATERAL AND LONGITUDINAL STABILITY OF THE BELL X-5 RESEARCH AIRPLANE AT 58.7° SWEEPBACK. Edward N. Videan. October 1955. 68p. diagrs., photo., tabs. (NACA RM H55H10)

Longitudinal and lateral dynamic-response characteristics to elevator and rudder pulse deflections have been measured on the Bell X-5 research airplane at 58.7° sweepback. Flight records were obtained at altitudes of 40,000 feet and 25,000 feet. Period and damping, including nonlinear damping effects, are presented and comparison is made with U. S. military lateral dynamic stability criteria. Engine gyroscopic coupling effects are discussed and frequency-response calculations are presented.

NACA RM L9B11

EFFECTS OF HIGH-LIFT AND STALL-CONTROL DEVICES, FUSELAGE, AND HORIZONTAL TAIL ON A WING SWEPT BACK 42° AT THE LEADING EDGE AND HAVING SYMMETRICAL CIRCULAR-ARC AIRFOIL SECTIONS AT A REYNOLDS NUMBER OF 6.9×10^6. Robert L. Woods and Stanley H. Spooner. April 20, 1949. 42p. diagrs., photos., tabs. (NACA RM L9B11)

The effects of high-lift and stall-control devices and fuselage and horizontal tail vertical positions on a wing swept back 42° at the leading edge and having symmetrical circular-arc airfoil sections are presented. The devices included drooped-nose flaps, extensible leading-edge flaps, split flaps, and upper-surface fences. The Reynolds number and Mach number of the investigation were 6.9×10^6 and 0.15, respectively.

NACA RM L50B08

FREE-FLIGHT INVESTIGATION AT TRANSONIC AND SUPERSONIC SPEEDS OF THE ROLLING EFFECTIVENESS OF A PARTIAL-SPAN AILERON ON AN INVERSELY TAPERED SWEPTBACK WING. H. Kurt Strass, E. M. Fields, and E. D. Schult. May 1, 1950. 17p. diagrs., photo., tabs. (NACA RM L50B08)

The rolling effectiveness of an inversely tapered sweptback wing having a 10-percent-thick cambered airfoil section and outboard partial-span controls has been measured in free flight by means of rocket-propelled test vehicles.

NACA RM L50B14

AN NACA TRANSONIC TEST SECTION WITH TAPERED SLOTS TESTED AT MACH NUMBERS TO 1.26. Vernon G. Ward, Charles F. Whitcomb, and Merwin D. Pearson. March 30, 1950. 19p. diagrs., photos., tab. (NACA RM L50B14)

Satisfactorily uniform and continuously variable supersonic flows up to a Mach number of 1.26 have been attained in an NACA transonic test section employing pointed 1-1/2 jet-diameter linear-divergent slots. The favorable characteristics of reduction of interference due to solid blockage and the elimination of choking are obtainable in this configuration on a relatively large nonlifting body of revolution through the Mach number range up to 1.08.

NACA RM L51B16

WIND-TUNNEL INVESTIGATION AT SUBSONIC AND LOW TRANSONIC SPEEDS OF THE EFFECTS OF AILERON SPAN AND SPANWISE LOCATION ON THE ROLLING CHARACTERISTICS OF A TEST VEHICLE WITH THREE UNTAPERED 45° SWEPTBACK WINGS. Harold S. Johnson. April 6, 1951. 26p. diagrs., photo., tab. (NACA RM L51B16)

A wind-tunnel investigation through a 0.30 to 0.94 Mach number range was made to determine the rolling characteristics of a free-flight rocket-propelled type of test vehicle having untapered 45° sweptback wings of aspect ratio 3.7 equipped with 0.20-chord ailerons having various spans and spanwise locations. The data are compared to theory and also to results obtained by other testing techniques.

NACA RM L51C16

INVESTIGATION OF THE EFFECTS OF TWIST AND CAMBER ON THE AERODYNAMIC CHARACTERISTICS OF A 50° 38' SWEPTBACK WING OF ASPECT RATIO 2.98. TRANSONIC-BUMP METHOD. Kenneth P. Spreemann and William J. Alford, Jr. August 1951. 33p. diagrs., photos., tab. (NACA RM L51C16)

An investigation of two semispan wings swept back 50° 38' was conducted in the Langley high-speed 7- by 10-foot tunnel over a Mach number range of 0.68 to 1.15 by use of the transonic-bump technique. This paper presents the results of the investigation of wing-alone and wing-fuselage configurations of the two wings; one was an untwisted uncambered wing and the other was the same wing but incorporated twist and camber designed to give uniform load at a lift coefficient of 0.25 at a Mach number of 1.10. The semispan wings had their quarter-chord lines swept back 50° 38', aspect ratios 2.98, taper ratios 0 45, and modified NACA 64A-series airfoil sections tapered in thickness. Lift, pitching moment, drag, and bending moment were obtained for these configurations.

NACA RM L51E02a

REVIEW OF SOME RECENT DATA ON BUFFET BOUNDARIES. Paul E. Purser and John A. Wyss. May 23, 1951. 11p. diagrs. (NACA RM L51E02a)

A study has been made of a large amount of data pertaining to high-speed buffet boundaries of various airplane configurations. The data indicate a strong influence of wing configuration on buffet boundaries. Based on the comparisons available, reasonably accurate estimates of the buffet boundary can probably be made for unswept wings with thickness ratios above 8 to 10 percent. Accurate estimates cannot yet be made for swept wings. Decreases in aspect ratio and thickness ratio and increases in sweepback tend to alleviate high-speed buffeting.

NACA RM L52B01

AN APPROXIMATION TO THE EFFECT OF GEOMETRIC DIHEDRAL ON THE ROLLING MOMENT DUE TO SIDESLIP FOR WINGS AT TRANSONIC AND SUPERSONIC SPEEDS. Paul E. Purser. April 1952. 10p. diagrs. (NACA RM L52B01)

A simple geometric relation is proposed by which the effect of geometric dihedral on the rolling moment due to sideslip at transonic and supersonic speeds may be estimated for wings if either the damping in roll or the rolling moment due to differential wing incidence is known.

NACA RM L52B12

TRANSONIC DRAG CHARACTERISTICS AND PRESSURE DISTRIBUTION ON THE BODY OF A WING-BODY COMBINATION CONSISTING OF A BODY OF REVOLUTION OF FINENESS RATIO 12 AND A WING HAVING SWEEPBACK OF 45°, ASPECT RATIO 4, TAPER RATIO 0.6, AND NACA 65A006 AIRFOIL SECTIONS. Max C. Kurbjun and Jim Rogers Thompson. April 1952. 28p. diagrs., photo., tabs. (NACA RM L52B12)

The drag and body pressure distribution were measured near zero lift for a representative wing-body combination at Mach numbers between 0.75 and 1.16 by the free-fall method. Analysis showed that the mechanism of the drag rise was similar to that for a body without wings except that the drag rise occurred at a lower Mach number because of the lower critical Mach number of the combination. The results were in generally satisfactory agreement with results for similar configurations obtained by different test techniques. An unfavorable interference effect on the body drag due to the presence of the wing occurred at transonic speeds.

NACA RM L52B14a

A PRELIMINARY WIND-TUNNEL INVESTIGATION OF FLUTTER CHARACTERISTICS OF DELTA WINGS. Robert W. Herr. April 1952. 35p. diagrs., tabs. (NACA RM L52B14a)

Results of 90 experimental wind-tunnel flutter tests performed on three delta-wing models are presented. The tests covered a range of tunnel pressures corresponding to altitudes from sea level to 78,000 feet. The natural vibration modes of these models were found experimentally by using a photographic technique.

NACA RM L52B15

LOW-SPEED LATERAL-CONTROL CHARACTERISTICS OF AN UNSWEPT WING WITH HEXAGONAL AIRFOIL SECTIONS AND ASPECT RATIO 2.5 EQUIPPED WITH SPOILERS AND WITH SHARP- AND THICKENED-TRAILING-EDGE FLAP-TYPE AILERONS AT A REYNOLDS NUMBER OF 7.6×10^6 James E. Fitzpatrick and Robert L. Woods. April 1952. 58p. photos., diagrs., tab. (NACA RM L52B15)

The lateral-control characteristics of two spans of spoilers and sharp- and thickened-trailing-edge ailerons on an unswept wing of aspect ratio 2.5 and hexagonal airfoil sections are presented. The tests were conducted at a Reynolds number of 7.6×10^6 and a Mach number of 0.15 and included measurements of rolling moments, yawing moments, aileron hinge moments, normal forces, and balance-chamber pressures for various configurations of wing and fuselage, droop-nose flap, and plain flaps. Measurements of the instantaneous pressure differential at several points on the aileron were also made.

NACA RM L52G14

PRELIMINARY RESULTS OF HORIZONTAL-TAIL LOAD MEASUREMENTS OF THE BELL X-5 RESEARCH AIRPLANE. John T. Rogers and Angel H. Dunn. August 15, 1952. 22p. diagrs., photos., tabs. (NACA RM L52G14)

Horizontal-tail load measurements were made during the Bell acceptance tests of a transonic speed research airplane having wings variable in flight between 20° and 60° sweepback. Load measurements were made during sweep changes in level flight from Mach numbers of 0.5 to 0.85, and during pull-ups at a Mach number of 0.83 at sweep angles of 20°, 45°, and 59°.

NACA RM L52K13b

FLIGHT MEASUREMENTS OF THE STABILITY CHARACTERISTICS OF THE BELL X-5 RESEARCH AIRPLANE IN SIDESLIPS AT 59° SWEEPBACK. Joan M. Childs. February 1953. 23p. diagrs., photos., tab. (NACA RM L52K13b)

Flight measurements of the stability characteristics of the Bell X-5 research airplane were made in steady sideslips at 59° sweepback at Mach numbers from 0.62 to 0.97 at altitudes varying from 35,000 to 40,000 feet.

NACA RM L52K18b

PRELIMINARY RESULTS OF STABILITY AND CONTROL INVESTIGATION OF THE BELL X-5 RESEARCH AIRPLANE. Thomas W. Finch and Donald W. Briggs. February 1953. 35p. diagrs., photos., tabs. (NACA RM L52K18b)

Results obtained during the acceptance tests of the X-5 airplane are presented. Information on the stalling characteristics, static longitudinal stability characteristics, and lateral control characteristics at various sweep angles is included.

NACA RM L53A09b

FLIGHT DETERMINATION OF THE STATIC LONGITUDINAL STABILITY BOUNDARIES OF THE BELL X-5 RESEARCH AIRPLANE WITH 59° SWEEPBACK. Thomas W. Finch and Joseph A. Walker. February 1953. 51p. diagrs., photo., tab. (NACA RM L53A09b)

Results obtained during flights of the Bell X-5 airplane with 59° sweepback are presented showing the variation with Mach number of the normal-force coefficient at the longitudinal reduction in stability. Results are given for a Mach number range of 0.67 to 0.98.

NACA RM L53A09c

LIFT AND DRAG CHARACTERISTICS OF THE BELL X-5 RESEARCH AIRPLANE AT 59° SWEEPBACK FOR MACH NUMBERS FROM 0.60 TO 1.03. Donald R. Bellman. February 1953. 37p. diagrs., photos., tab. (NACA RM L53A09c)

Lift and drag coefficients for the 59° sweptback configuration of the Bell X-5 airplane were determined from flight tests covering the Mach number range 0.60 to 1.03. A brief comparison is made between the 20° and 59° sweptback configuration.

NACA RM L53B17

THE EFFECT OF BLADE-SECTION CAMBER ON THE STALL-FLUTTER CHARACTERISTICS OF THREE NACA PROPELLERS AT ZERO ADVANCE. Arthur E. Allis and John M. Swihart. April 1953. 29p. diagrs., photo., tab. (NACA RM L53B17)

Stall-flutter characteristics of three 10-foot-diameter, two-blade propellers have been determined at zero advance for blade angles from 16° to 38° at the Langley propeller static test stand. The blades differed only in design lift coefficient, having constant radial values of 0, 0.3, and 0.5. The results indicate that an increase in design lift coefficient gave an increase in flutter-speed coefficient and thrust coefficient for practical propeller operating conditions.

NACA RM L53B26

LOW-SPEED AILERON EFFECTIVENESS AS DETERMINED BY FORCE TESTS AND VISUAL-FLOW OBSERVATIONS ON A 52° SWEPTBACK WING WITH AND WITHOUT CHORD-EXTENSIONS. Patrick A. Cancro. April 1953. 38p. diagrs., photos. (NACA RM L53B26)

The results of an investigation of the effects of leading-edge chord-extensions and extensible leading-edge flaps on the low-speed aileron characteristics of a 52° sweptback wing with circular-arc airfoil sections are presented. A description and illustrations of the vortex flow as it passes over the wing are included. The investigation was conducted at Reynolds numbers of 5.5×10^6 and 1.3×10^6 and corresponding Mach numbers of 0.11 and 0.065 for an angle-of-attack range of 0° through stall.

NACA RM L53E28

LONGITUDINAL FLIGHT CHARACTERISTICS OF THE BELL X-5 RESEARCH AIRPLANE AT 59° SWEEPBACK WITH MODIFIED WING ROOTS. James A. Martin. August 1953. 25p. diagrs., photos., tab. (NACA RM L53E28)

In an attempt to improve the longitudinal stability characteristics of the Bell X-5 research airplane at 59° sweepback the wing-root leading edge was modified, the original 52.5° sweptback leading-edge fillets being replaced by rounded leading-edge fillets. The two fillet configurations are compared in this paper on the basis of results obtained from maneuvers into the region of reduced stability at pressure altitudes from 28,000 to 40,000 feet and in the Mach number range from that for stall approach in the clean condition to a Mach number of 0.97.

NACA RM L53J01b

SOME DESIGN CONSIDERATIONS PERTINENT TO THE ROUGH-AIR BEHAVIOR OF AIRPLANES AT LOW ALTITUDE. Philip Donely and Clarence L. Gillis. November 1953. 21p. diagrs., tabs. (NACA RM L53J01b)

For high-speed low-altitude flight of 1 or 2 hours duration, study indicates that the airplane motions and accelerations due to rough air should be reduced to 30 percent of current levels. This reduction can be obtained by increasing the wing loading or reducing the lift-curve slope. For some configurations, artificial damping is beneficial.

NACA RM L54A11

DISTRIBUTION OF LIFT AND PITCHING MOMENT BETWEEN WING AND FUSELAGE AND EFFECTS OF WING FLEXIBILITY AND DIVE BRAKE ON A 1/30-SCALE SEMISPAN MODEL OF THE BELL X-5 AIRPLANE AT TRANSONIC SPEEDS AS DETERMINED BY THE NACA WING-FLOW METHOD. Garland J. Morris and Norman S. Silsby. March 1954. 46p. diagrs., photos., tab. (NACA RM L54A11)

An investigation was made at transonic speeds by the NACA wing-flow method to determine the interaction effects between the wing and fuselage, the effects of wing flexibility, and the effect of the addition of a dive brake on a 1/30-scale semispan model of the Bell X-5 airplane. Lift, pitching moments, and wing bending moments were obtained at various angles of attack for the 60°, 40°, and 20° sweptback duralumin wings in the presence of, but detached from, the fuselage. In addition, lift, drag, and pitching moments were obtained for the complete wing-body-tail configuration with a 60° sweptback wood wing and with a fuselage dive brake on the model with the 60° duralumin wing to determine the separate effects of flexibility and dive brake on the longitudinal stability characteristics. The Reynolds number was of the order of 1.0×10^6.

NACA RM L54B08

HINGE-MOMENT, LIFT, AND PITCHING-MOMENT CHARACTERISTICS OF A FLAP-TYPE CONTROL SURFACE HAVING VARIOUS HINGE-LINE LOCATIONS ON A 4-PERCENT-THICK 60° DELTA WING. TRANSONIC-BUMP METHOD. Robert F. Thompson. March 1954. 73p. diagrs., photo. (NACA RM L54B08)

Lift, pitching-moment, and flap hinge-moment coefficients were obtained for a 4-percent-thick 60° delta wing equipped with a flap-type control surface having various hinge-line locations. The trailing-edge control spanned the inboard 66 percent of the wing semispan and ratios of balance chord to flap chord tested were 0.07, 0.32, 0.50, 0.79, and 1.03. The investigation was made through an angle-of-attack range of -6° to 15°, a Mach number range from 0.60 to 1.18, and a flap-deflection range of approximately $\pm 30^{\circ}$.

NACA RM L54B15a

AN EXPERIMENTAL INVESTIGATION OF THE TRANSONIC-FLOW-GENERATION AND SHOCK-WAVE-REFLECTION CHARACTERISTICS OF A TWO-DIMENSIONAL WIND TUNNEL WITH 17-PERCENT-OPEN PERFORATED WALLS. Don D. Davis, Jr., Thomas B. Sellers, and George M. Stokes. April 1954. 40p. diagrs., photos. (NACA RM L54B15a)

The results of tests to determine the transonic-flow-generation and shock-wave-reflection characteristics of a wind tunnel with 17-percent-open perforated walls are presented. The wave-reflection tests were made at a free-stream Mach number of 1.28 with the perforated walls diverged 10', 15', 20', 25', and 30'. In conjunction with the wave-reflection tests, boundary-layer measurements were made with and without the model in the tunnel. Suction mass flow and perforated wall boundary-layer measurements were made at a Mach number of 0.98 over a range of divergence angles from -15' to 30'. Equations are derived which relate the suction flow to the perforated-wall boundary layer and friction coefficient.

NACA RM L54B18a

SUBSONIC INVESTIGATION OF EFFECTS OF BODY INDENTATION ON ZERO-LIFT DRAG CHARACTERISTICS OF A 45° SWEPTBACK WING-BODY COMBINATION WITH NATURAL AND FIXED BOUNDARY-LAYER TRANSITION THROUGH A RANGE OF REYNOLDS NUMBER FROM 1×10^6 TO 8×10^6. Gene J. Bingham and Albert L. Braslow. April 1954. 10p. diagrs., photos. (NACA RM L54B18a)

An investigation has been conducted in the Langley low-turbulence pressure tunnel to study the effects of body indentation according to the transonic area rule on the subcritical zero-lift drag coefficient of a 45° sweptback wing-body combination having an aspect ratio 4, taper-ratio-0.3 wing, with NACA 65A006 airfoil sections. The tests included studies of a basic and an indented body with natural transition and with fixed transition near the wing leading edge through a Reynolds number range from 1.0×10^6 to 7.6×10^6. A fluorescent lacquer technique was also used as a visual aid for comparison of the transition positions on the basic and indented configurations. The data obtained in the present investigation have been compared with British studies of the effects of sweepback on laminar boundary-layer stability.

NACA RM L54B22

MEASUREMENTS OF NORMAL-FORCE-COEFFICIENT FLUCTUATION ON FOUR 9-PERCENT-THICK AIRFOILS HAVING DIFFERENT LOCATIONS OF MAXIMUM THICKNESS. Milton D. Humphreys. April 1954. 21p. diagrs., photos. (NACA RM L54B22)

The effects of the location of maximum thickness on pressure pulsations and root-mean-square normal-force-coefficient fluctuations on 9-percent-thick airfoils have been obtained at transonic speeds, and typical flow conditions were recorded by schlieren motion pictures. The results indicated that at all Mach numbers, for normal-force coefficients up to 0.6, the section had little effect on the pressure pulsations and root-mean-square normal-force fluctuations. At normal-force coefficients above 0.6, up to approximately the maximum normal-force coefficient, considerable reductions in force fluctuations were obtained by using an airfoil having the maximum thickness located at or behind the 42.5-percent-chord station. From the standpoint of local panel loads, none of the airfoils had consistently lower loads throughout the speed and normal-force-coefficient ranges. It appears, however, that the NACA 65A009 airfoil would probably be the best choice of the sections tested for operation throughout the high subsonic Mach number range.

NACA RM L54B24a

THEORETICAL INVESTIGATION OF SOME DISCONTINUOUS YAW DAMPERS. William H. Phillips and Helmut A. Kuehnel. April 1954. 39p. diagrs. (NACA RM L54B24a)

A theoretical investigation of some discontinuous yaw dampers is made utilizing a modified phase-plane method of analysis. Four methods of operating a discontinuous control are considered and the damping and hunting tendencies are compared. Application of the theoretical results to a given set of conditions is illustrated and changes in airspeed as they affect the damping and hunting tendencies are considered.

NACA RM L54B25

EFFECTS OF SWEEP AND THICKNESS ON THE STATIC LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A SERIES OF THIN, LOW-ASPECT-RATIO, HIGHLY TAPERED WINGS AT TRANSONIC SPEEDS. TRANSONIC-BUMP METHOD. Albert G. Few, Jr., and Paul G. Fournier. April 1954. 107p. diagrs., photo., tab. (NACA RM L54B25)

The present paper presents results of the transonic static longitudinal aerodynamic characteristics of a series of thin, low-aspect-ratio, highly tapered wings. The tests covered a Mach number range from about 0.60 to 1.18 employing the transonic-bump technique. Reynolds number ranged from about 0.75×10^6 to 0.95×10^6, and angles of attack from -10° to approximately 32°.

NACA RM L54C17

FLIGHT DETERMINATION OF THE BUFFETING CHARACTERISTICS OF THE BELL X-5 RESEARCH AIRPLANE AT 58.7° SWEEPBACK. Donald W. Briggs. May 1954. 31p. diagrs., photo., tabs. (NACA RM L54C17)

Measurements have been made of wing and tail buffet intensities experienced by the Bell X-5 research airplane at 58.7° sweepback. Results are given for a Mach number range from 0.65 to approximately 1.03.

NACA RM L54F30

METHODS FOR OBTAINING DESIRED HELICOPTER STABILITY CHARACTERISTICS. F. B. Gustafson and Robert J. Tapscott. August 1954. 12p. tabs. (NACA RM L54F30)

A brief summary is made of methods available to the helicopter designer for obtaining desired stability characteristics by modifications to the airframe design. The discussion is based on modifications made during the establishment of flying-qualities criteria and includes sample indications of theoretical studies of additional methods.

NACA RM L54G05

METHODS OF PREDICTING HELICOPTER STABILITY. Robert J. Tapscott and F. B. Gustafson. November 1954. 15p. diagrs. (NACA RM L54G05)

Some of the methods of predicting rotor stability derivatives have been reviewed. The methods by which these rotor derivatives are employed to estimate helicopter stability characteristics have been summarized. It is concluded that, although these methods are not always feasible for predicting absolute values of the stability of the helicopter, the effects on stability of changes in individual derivatives can generally be estimated satisfactorily.

NACA RM L55J27

PRELIMINARY INVESTIGATION OF SELF-EXCITED VIBRATIONS OF SINGLE PLANING SURFACES. Elmo J. Mottard. January 1956. 19p. diagrs., photos., tab. (NACA RM L55J27)

The effect of various planing-surface shapes, conditions of restraint, loads, trims, and speeds on the occurrence of self-excited vibrations was sought. It was found that vibration occurs with high aspect ratio (order of 10) of the wetted portion with freedom in rise. It may occur without freedom in trim. Limiting the aspect ratio (by the use of dead rise or a pointed trailing edge, for example) tends to reduce or eliminate the vibrations. Data are presented for the range of variables likely to be encountered with airplane hydro-skis.

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Research Abstracts and Reclassification Notice

NO. 98 **MARCH 26, 1956**

CURRENT NACA RESEARCH REPORTS

NACA Rept. 1211

EXPERIMENTAL INVESTIGATION OF FREE-CONVECTION HEAT TRANSFER IN VERTICAL TUBE AT LARGE GRASHOF NUMBERS. E. R. G. Eckert and A. J. Diaguila. 1955. ii, 14p. diagrs., photos., tab. (NACA Rept. 1211. Supersedes RM E52F30)

Local free-convection heat-transfer coefficients and temperature fields in the turbulent flow range were obtained within a vertical, stationary tube closed at the bottom, heated along its walls, and having a length-to-diameter ratio of 5. Convective heat-transfer coefficients were correlated by the general relations for free-convection heat transfer. These coefficients, converted to dimensionless Nusselt numbers were 35 percent below known relations for vertical flat plates. Air temperature measurements within the tube indicated a thin boundary layer along the heated wall surface and unstable conditions in the air flow.

NACA Rept. 1216

CHARTS FOR ESTIMATING TAIL-ROTOR CONTRIBUTION TO HELICOPTER DIRECTIONAL STABILITY AND CONTROL IN LOW-SPEED FLIGHT. Kenneth B. Amer and Alfred Gessow. 1955. ii, 22p. diagrs., photo., tabs. (NACA Rept. 1216. Supersedes TN 3156)

Theoretically derived charts and equations are presented by which tail-rotor design studies of directional trim and control response at low forward speed can be conveniently made. Comparisons between theoretical and experimental results are presented. The charts indicate and flight tests confirm that, under certain flight conditions, a region of vortex roughness is encountered by the tail rotor, making prolonged operation difficult in this region. The charts can also be used to obtain the main-rotor stability derivatives of thrust with respect to collective pitch and angle of attack at low forward speeds.

NACA Rept. 1217

THEORETICAL PREDICTION OF PRESSURE DISTRIBUTIONS ON NONLIFTING AIRFOILS AT HIGH SUBSONIC SPEEDS. John R. Spreiter and Alberta Alksne. 1955. iii, 42p. diagrs., photos. (NACA Rept. 1217. Supersedes TN 3096)

Theoretical pressure distributions on nonlifting circular-arc airfoils in flows with high subsonic free-stream velocity are found by determining approximate solutions of an integral equation for transonic flow proposed by Oswatitsch. Solutions are obtained using an iteration process which differs from the classical methods in that the quadratic nature of the integral equation is recognized. Except for phenomena which are predominantly influenced by viscous effects, the results are in good accord with experimental data.

NACA Rept. 1218

EFFECT OF GROUND INTERFERENCE ON THE AERODYNAMIC AND FLOW CHARACTERISTICS OF A 42° SWEPTBACK WING AT REYNOLDS NUMBERS UP TO 6.8×10^6. G. Chester Furlong and Thomas V. Bollech. 1955. ii, 60p. diagrs., photos., tab. (NACA Rept. 1218. Combination of RM L8G22; TN 2487)

The effects of ground interference on the aerodynamic and flow characteristics of a 42° sweptback wing have been determined at distances above the ground 0.68 and 0.92 of the mean aerodynamic chord (measured from 0.25 mean aerodynamic chord). The wing was tested without flaps and with inboard trailing-edge split and outboard leading-edge flaps deflected. The wing had an aspect ratio of 4, a taper ratio of 0.625, and NACA 64_1-112 airfoil sections perpendicular to the 0.273 chord line. The results are, in general, comparable to those reported for unswept wings. The longitudinal stability at the stall was not materially affected at the ground heights of the present tests.

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NACA Rept. 1219

MEASUREMENT AND ANALYSIS OF WING AND TAIL BUFFETING LOADS ON A FIGHTER AIRPLANE. Wilber B. Huston and T. H. Skopinski. 1955. i, 27p. diagrs., photo., tabs. (NACA Rept. 1219. Supersedes TN 3080)

Wing and tail buffeting loads measured in 194 runs with a fighter-type airplane are tabulated with the associated flight conditions. Measurements were made at altitudes of 30, 000 to 10, 000 feet and at Mach numbers up to 0.8. Preliminary analysis indicates that the loads vary with the square root of the dynamic pressure and shows the effects of aerodynamic damping, duration of buffeting, maneuver abruptness, penetration beyond the buffet boundary, and reduction of the wing natural frequency in bending through addition of wing-tip weights.

NACA Rept. 1221

THEORETICAL STUDY OF THE TUNNEL-BOUNDARY LIFT INTERFERENCE DUE TO SLOTTED WALLS IN THE PRESENCE OF THE TRAILING-VORTEX SYSTEM OF A LIFTING MODEL. Clarence W. Matthews. 1955. ii, 19p. diagrs. (NACA Rept. 1221. Supersedes RM L53A26)

The equations which represent the interference on the lift of uniformly loaded wings of finite span in circular tunnels with mixed open and closed boundaries are derived, with special attention to those tunnels containing symmetrical arrangements of the open and closed portions. The equations are applicable to tunnels with other cross-sectional shapes, provided a transformation function can be found which will transform the tunnel cross section into a circle.

NACA Rept. 1222

A FREE-FLIGHT WIND TUNNEL FOR AERODYNAMIC TESTING AT HYPERSONIC SPEEDS. Alvin Seiff. 1955. ii, 17p. diagrs., photos. (NACA Rept. 1222. Supersedes RM A52A24)

Research models are fired from a gun through the wind-tunnel test section in a direction opposite to the airstream which has a moderate supersonic Mach number. A wide range of Mach numbers, from low supersonic speeds up to M = 10, can be obtained. The equipment and test techniques are described. The methods used to measure drag, lift-curve slope, center of pressure, and damping in roll are given. The imperfections in the airstream and their effect on model tests are discussed.

NACA Rept. 1226

A METHOD FOR THE DESIGN OF SWEPTBACK WINGS WARPED TO PRODUCE SPECIFIED FLIGHT CHARACTERISTICS AT SUPERSONIC SPEEDS. Warren A. Tucker. 1955. i, 17p. diagrs., tabs. (NACA Rept. 1226. Supersedes RM L51F08)

A method is presented for designing sweptback wings to be self-trimming at a given set of flight conditions. This characteristic is achieved by warping the wing in a particular manner, that is, by giving the wing a certain combination of angle of attack, twist, and camber. The method applies directly to a wide class of sweptback wings. The application to any specific wing is simplified to a routine computational procedure, and a discussion is given of some points to be considered in the application to a practical case. Several illustrative examples are worked out, and the resulting wings are shown to be feasible to construct.

NACA Rept. 1236

ARRANGEMENT OF FUSIFORM BODIES TO REDUCE THE WAVE DRAG AT SUPERSONIC SPEEDS. Morris D. Friedman and Doris Cohen. 1955. ii, 8p. diagrs. (NACA Rept. 1236. Supersedes RM A51I20; TN 3345)

Using linearized slender-body theory and reverse-flow theorems, the wave drag of a system of fusiform bodies at zero angle of attack and supersonic speeds is studied to determine the effect of varying the relative location of the component parts. It is found that in certain arrangements the interference effects are beneficial, and may even result in a two- or three-body system having no more wave drag than the principal body alone. The most favorable location appears to be one in which the maximum cross section of the auxiliary body is slightly forward of the Mach cone from the tail of the main body.

NACA RM E55K02

EVAPORATION OF JP-5 FUEL SPRAYS IN AIR STREAMS. Hampton H. Foster and Robert D. Ingebo. February 1956. 26p. diagrs., tabs. (NACA RM E55K02)

A continuous sampling-probe technique was used to determine quantities of JP-5 fuel spray evaporated under conditions common in ram-jet engines. Fuel was injected contrastream from a multiple-orifice injector, and sampling data were obtained at distances of 7 to 18 inches downstream of the injector for inlet-air velocities from 138 to 370 feet per second, air static pressures of 15 to 35 inches of mercury, absolute, and air temperatures of 80° to 700° F. The results gave the following expression for the fuel evaporated:

$$N = 7.4\, L^{0.33}\, \Delta T^{0.28} \left(\frac{U_a + U_f}{100 + U_a} \right)^2$$

where N is the percentage evaporated, L is the distance downstream of the injector, ΔT is the heat-transfer driving force (air temperature - wet-bulb temperature of fuel drop), U_a is the air velocity, and U_f the injection velocity of the fuel.

NACA RM E55K07

PRELIMINARY FLIGHT SURVEY OF AERODYNAMIC NOISE ON AN AIRPLANE WING. Harold R. Mull and Joseph S. Algranti. March 1956. 8p. diagrs. (NACA RM E55K07)

A brief series of measurements were made in flight of the noise of an airplane-wing turbulent boundary layer. The ratio of the root-mean-square sound pressure to the free-stream dynamic pressure is shown to decrease linearly with increasing Mach number up to Mach number 0.55 and to remain nearly constant thereafter up to near the limiting Mach number of the airplane.

NACA TM 1385

ON THE GAS DYNAMICS OF A ROTATING IMPELLER. (Zur Gasdynamik des drehenden Schaufelsterns). A. Busemann. March 1956. 16p. diagrs. (NACA TM 1385. Trans. from Zeitschrift für angewandte Mathematik und Mechanik, v. 18, no. 1, February 1938, p. 31-38)

It is shown that for a compressible flow with constant entropy the pressure rise maintains the direct relation to the circulation around the blades existing for incompressible flow. In contrast, however, the torque, and with it the power consumption, is increased because of sound waves traveling to infinity already at subsonic circumferential speeds.

NACA TM 1394

A FLAT WING WITH SHARP EDGES IN A SUPERSONIC STREAM. A. E. Donov. March 1956. 48p. diagrs. (NACA TM 1394. Trans. from Akademiia NAUK SSSR, Izvestiia, 1939, p. 603-626)

A basic treatment is given for the approximate solution of the problem of two-dimensional supersonic flow past a thin wing at small angles of attack. The pressure distribution at the surface, the lifting force, and the wave drag are determined.

NACA TM 1397

INTERIM REPORT ON FATIGUE CHARACTERISTICS OF A TYPICAL METAL WING. J. L. Kepert and A. O. Payne. March 1956. 80p. diagrs., photos., tabs. (NACA TM 1397. Originally issued as Report ARL/SM. 207, Aeronautical Research Laboratories, Australia)

Constant amplitude fatigue tests of seventy-two P-51D "Mustang" wings are reported. The tests were performed by a vibrational loading system and by an hydraulic loading device for conditions with and without varying amounts of pre-load. The results indicate that: (a) the frequency of occurrence of fatigue at any one location is related to the range of the loads applied, (b) the rate of propagation of visible cracks is more or less constant for a large portion of the life of the specimen, (c) the fatigue strength of the structure is similar to that of notched material having a theoretical stress concentration factor of more than 3.0, (d) the frequency distribution of fatigue life is approximately logarithmic normal, (e) the relative increase in fatigue life for a given pre-load depends on the maximum load of the loading cycle only, while the optimum pre-load value is approximately 85 percent of the ultimate failing load, and (f) that normal design procedure will not permit the determination of local stress levels with sufficient accuracy to determine the fatigue strength of an element of a redundant structure.

NACA TM 1398

FORMATION OF A VORTEX AT THE EDGE OF A PLATE. (Ausbildung eines Wirbels an der Kante einer Platte). Leo Anton. March 1956. 36p. diagrs. (NACA TM 1398. Trans. from Ingenieur-Archiv, v. 10, 1939, p. 411-427)

The flow about the plate of infinite width may be represented as a potential flow with discontinuity surfaces which extend from the plate edges. For prescribed form and vortex distribution of the discontinuity surfaces, the velocity field may be calculated by means of a conformal representation. One condition is that the velocity at the plate edges must be finite. However, it is not sufficient for determination of the form and vortex distribution of the surface. However, on the basis of a similitude requirement one succeeds in finding a solution of this problem for the plate of infinite width which is correct for the very beginning of the motion of the fluid. Starting from this solution, the further development of the vortex distribution and shape of the surface are observed in the case of a plate of finite width.

NACA TN 3272

GENERALIZED TABLES OF CORRECTIONS TO THERMODYNAMIC PROPERTIES FOR NONPOLAR GASES. Harold W. Woolley and William S. Benedict, National Bureau of Standards. March 1956. 62p. diagrs., tabs. (NACA TN 3272)

Tables are presented based on the Lennard-Jones 6-12 potential for nonpolar molecules for use in representation of second and third virial coefficients and equation-of-state corrections for enthalphy, entropy, specific heats at constant pressure and volume, specific-heat ratio, isentropic expansion coefficient, and sound velocity. The treatment for effects involving three molecules jointly uses an empirical adjustment of the Lennard-Jones parameters within a cluster of three independently of the value for an isolated pair. A graphical correlation of ratios of these parameters with the critical constants is also shown.

NACA TN 3528

A THEORETICAL STUDY OF THE AERODYNAMICS OF SLENDER CRUCIFORM-WING ARRANGEMENTS AND THEIR WAKES. John R. Spreiter and Alvin H. Sacks. March 1956. i, 67p. diagrs., photos., tabs. (NACA TN 3528)

A theoretical study is made of the pressures, loadings, forces, and vortex wake associated with certain cruciform wing arrangements. For 45° bank, the wake of a cruciform wing is treated numerically with 40 vortices and analytically with 4 vortices. Comparisons are made with water-tank measurements, and the calculation of loads on cruciform tails by reverse flow is considered.

NACA TN 3541

A METHOD FOR OBTAINING STATISTICAL DATA ON AIRPLANE VERTICAL VELOCITY AT GROUND CONTACT FROM MEASUREMENTS OF CENTER-OF-GRAVITY ACCELERATION. Robert C. Dreher. February 1956. 21p. diagrs., photo., tabs. (NACA TN 3541)

A method is presented whereby the contact vertical velocities of airplanes are obtained on a statistical basis from measurements of maximum incremental center-of-gravity acceleration. In order to evaluate this method, 268 landings have been made with a small trainer airplane. The vertical-velocity probability curve based on the velocities obtained by this method is compared with the probability curve based on velocities obtained from a trailing-arm velocity indicator. The agreement is very good. A limited amount of data for a medium bomber is presented; these data indicate that the method is probably applicable to large airplanes.

NACA TN 3555

A METHOD FOR CALCULATING THE CONTOUR OF BODIES OF REVOLUTION WITH A PRESCRIBED PRESSURE GRADIENT AT SUPERSONIC SPEED WITH EXPERIMENTAL VERIFICATION. Paige B. Burbank. March 1956. 64p. diagrs., photos., tabs. (NACA TN 3555)

A method using characteristics has been developed for computing the contour of bodies of revolution to give a prescribed pressure gradient in supersonic flow. The contour of a body with a constant pressure gradient at a Mach number of 3.13 was computed. A model was constructed and tested at Mach numbers of 3.05 and 3.13; the agreement with the computed pressure distribution was excellent and the effect of Reynolds number was negligible.

NACA TN 3558

HEAT CAPACITY LAG OF GASEOUS MIXTURES. Thomas D. Rossing, Robert C. Amme, and Sam Legvold, Iowa State College. March 1956. 35p. diagrs., tabs. (NACA TN 3558)

A study was made of the vibrational energy lag in heavy organic gases. Results of measurements of sonic dispersion made with an acoustic interferometer in a number of heavy gases are presented and certain fundamental properties of the vibrational excitation process in these gases are discussed.

NACA TN 3577

THE NICKEL DIP: A RADIOISOTOPE STUDY OF METALLIC DEPOSITS IN PROCELAIN ENAMELING. Joseph C. Richmond, Harry B. Kirkpatrick, and William N. Harrison, National Bureau of Standards. February 1956. 26p. diagrs., photos., tabs. (NACA TN 3577)

Radioisotope tracer techniques were used to study the effect of the nickel dip on the deposition of cobalt metal during firing of a cobalt-bearing ground coat on pickled and sandblasted iron, the effect of surface pretreatment on the amount and distribution of nickel deposited from the nickel dip on enameling iron, and the effect of application and firing of cobalt-free and cobalt-bearing enamels on the chemical form and physical distribution of nickel previously deposited on enameling iron by the nickel dip.

NACA TN 3603

THEORETICAL STUDY OF THE LATERAL FREQUENCY RESPONSE TO GUSTS OF A FIGHTER AIRPLANE, BOTH WITH CONTROLS FIXED AND WITH SEVERAL TYPES OF AUTOPILOTS. James J. Adams and Charles W. Mathews. March 1956. 46p. diagrs., tabs. (NACA TN 3603)

A theoretical approach is used to determine the lateral frequency response of a fighter airplane to side and rolling gusts at a Mach number of 0.7 and an altitude of 30,000 feet. The frequency response to gusts is determined for the airplane with controls fixed and for the airplane in combination with three different basic types of attitude autopilots. The power spectral density of the motion of the airplane in response to gusts is also presented. A discussion of the response of the airplane to command signals is included.

NACA TN 3606

TABULATION OF THE f_λ FUNCTIONS WHICH OCCUR IN THE AERODYNAMIC THEORY OF OSCILLATING WINGS IN SUPERSONIC FLOW. Vera Huckel. February 1956. 59p. tab. (NACA TN 3606)

The integrals which are denoted as the f_λ functions and which occur in the aerodynamic theory for wings oscillating in pure supersonic flow have been evaluated and tabulated for various Mach numbers and values of the reduced frequency. Specific values of parameters λ, M, and k for which tabulations of f_λ are presented are: λ = 0 to 11; Mach numbers of 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 2.0, 2.5, 3.0, 3.5, 4.0, and 5.0; and values of the reduced frequency k from 0 to 2.0 at the following intervals - 0(0.005)0.15, 0.15(0.01)0.2, 0.2(0.025)0.35, 0.35(0.05)1.0, and 1.0(0.1)2.0. The tabulated values are considered accurate to one in the last digit.

NACA TN 3607

EFFECT OF THICKNESS, CAMBER, AND THICKNESS DISTRIBUTION ON AIRFOIL CHARACTERISTICS AT MACH NUMBERS UP TO 1.0. Bernard N. Daley and Richard S. Dick. March 1956. 75p. diagrs., photos., tab. (NACA TN 3607. Supersedes RM L52G31a)

A modified open-throat type of wind tunnel developed for the purpose of obtaining two-dimensional-airfoil data at Mach numbers near 1.0 is presented and discussed. Tests of a group of related NACA airfoil sections varying in maximum thickness, design lift coefficient, and thickness distribution have been conducted in this wind tunnel at Mach numbers of 0.3 to about 1.0 and at corresponding Reynolds numbers from 0.7×10^6 to 1.6×10^6. Normal-force, drag, and pitching-moment coefficients are presented, together with representative schlieren photographs and pressure-distribution diagrams.

NACA TN 3615

AN EXPERIMENTAL INVESTIGATION OF THE SCALE RELATIONS FOR THE IMPINGING WATER SPRAY GENERATED BY A PLANING SURFACE. Ellis E. McBride. February 1956. 42p. diagrs., photos., tab. (NACA TN 3615)

An experimental investigation was made to determine the scale effects of the forces from water spray generated by a flat rectangular planing surface impinging on a collector plate representative of an aerodynamic surface or other part of a water-based airplane. Two models, one five times the linear dimensions of the other, were tested. The collector plate was located above, and aft of, the spray generator where spray could strike it. Lift and drag force coefficients for both the spray generator and spray collector are presented. Comparisons are made between the large and small models by the Froude scaling relations. An empirical method is presented for correcting the spray friction drag coefficients on a Reynolds number basis.

NACA TN 3616

CHARTS FOR ESTIMATING ROTOR-BLADE FLAPPING MOTION OF HIGH-PERFORMANCE HELICOPTERS. Robert J. Tapscott and Alfred Gessow. March 1956. 19p. diagrs. (NACA TN 3616)

Theoretically derived charts of flapping coefficients are presented for helicopter rotors having blades with a linear twist of 0°, -8°, and -16°. The charts, showing rotor flapping coefficients for combinations of inflow ratio and blade pitch angle, are presented for tip-speed ratios ranging from 0.05 to 0.50. Inasmuch as the theory on which the charts are based does not contain any small-angle assumptions regarding blade-section inflow angles and velocities, the charts are considered applicable, within the limits discussed, for flight conditions involving high inflow velocities and large regions of reversed velocity. The charts do not include stall or compressibility effects.

NACA TN 3617

THEORETICAL ANALYSIS OF LINKED LEADING-EDGE AND TRAILING-EDGE FLAP-TYPE CONTROLS AT SUPERSONIC SPEEDS. E. Carson Yates, Jr. March 1956. 40p. diagrs., tab. (NACA TN 3617)

The use of linked leading-edge and trailing-edge flap-type controls for the purpose of reducing hinge moments at supersonic speeds has been analytically investigated. A series of linked controls with supersonic leading and trailing edges on swept and unswept wings has been studied for Mach numbers of 1.414 and 1.960 by use of the linearized theory of supersonic flows. Variations of lift, rolling moment, and hinge moment with control deflection for these control combinations have been calculated, and the effect of finite wing thickness on these quantities has been estimated. Control characteristics have been tabulated for the condition of equal leading-edge and trailing-edge flap deflection, and the deflection ratios necessary for zero resultant hinge moment have also been listed.

NACA TN 3618

EXPERIMENTAL INVESTIGATION OF THE VIBRATIONS OF A BUILT-UP RECTANGULAR BOX BEAM. Eldon E. Kordes and Edwin T. Kruszewski. February 1956. 28p. diagrs., photos., tabs. (NACA TN 3618)

Experimental modes and frequencies of a uniform built-up box beam are presented and comparisons are made between experimental and theoretical frequencies. For bending vibrations, frequencies obtained from an analysis of a substitute-stringer structure which includes the influence of transverse shear deformation and shear lag were found to agree very well with those obtained experimentally. In the case of torsional vibrations, the frequencies obtained from either an elementary or a four-flange beam analysis which includes the effects of restraint of warping were found to be in satisfactory agreement with the experimental frequencies.

NACA TN 3619

EFFECT OF CARRIAGE MASS UPON THE LOADS AND MOTIONS OF A PRISMATIC BODY DURING HYDRODYNAMIC IMPACT. Melvin F. Markey. March 1956. 45p. diagrs. (NACA TN 3619)

Theoretical equations for the effect of a towing-carriage mass upon the loads and motions of a prismatic body during a hydrodynamic impact are presented. These equations apply to any prismatic-body impact depending only upon the variables substituted. The correction to the free-body case (the body without any horizontal or vertical restraints) is seen to vary with trim and carriage mass for a given model. The deeply immersed and the nonimmersed chines are treated separately. Curves comparing the condition of infinite carriage mass (constant horizontal velocity) with zero carriage mass (free-body case) are given to indicate the importance of the carriage-mass effect.

NACA TN 3620

THE DESIGN OF A MINIATURE SOLID-PROPELLANT ROCKET. Robert H. Heitkotter. March 1956. 13p. diagrs., photo., tab. (NACA TN 3620)

A miniature rocket motor was designed and developed to exert 3 ounces of thrust for a duration of 2 seconds. The rocket has reproducible performance and is simply constructed. The research that led to the development of the miniature rocket showed that compensatory measures must be used in designing extremely small rockets because of excessive heat-transfer rates.

NACA TN 3622

PRELIMINARY STUDY OF SOME FACTORS WHICH AFFECT THE STALL-FLUTTER CHARACTERISTICS OF THIN WINGS. A. Gerald Rainey. March 1956. 33p. diagrs., photo., tab. (NACA TN 3622. Supersedes RM L52D08)

The results of an exploratory, analytical, and experimental study of some of the factors which might be of importance in the stall flutter of thin wings are presented. The factors considered were Mach number, Reynolds number, density, aspect ratio, sweepback, structural damping, location of torsion nodal line, and concentrated weights.

NACA TN 3623

CORRELATION OF SUPERSONIC CONVECTIVE HEAT-TRANSFER COEFFICIENTS FROM MEASUREMENTS OF THE SKIN TEMPERATURE OF A PARABOLIC BODY OF REVOLUTION (NACA RM-10). Leo T. Chauvin and Carlos A. deMoraes. March 1956. 38p. diagrs., photo., tabs. (NACA TN 3623. Supersedes RM L51A18)

Free-flight tests at supersonic speeds have been made to determine the local convective heat-transfer coefficients, evaluated from measured skin temperatures along the body of a rocket-propelled fin-stabilized parabolic body of revolution (NACA RM-10). The Mach number range covered was 1.02 to 2.48 and the Reynolds number range was 3.18×10^6 to 163.85×10^6. The experimental values are compared with the results obtained from the V-2 research missile and also with several equations for heat transfer in a turbulent boundary layer.

NACA TN 3626

EXPERIMENTAL INVESTIGATION OF THE FLOW AROUND LIFTING SYMMETRICAL DOUBLE-WEDGE AIRFOILS AT MACH NUMBERS OF 1.30 AND 1.41. Paul B. Gooderum and George P. Wood. March 1956. 86p. diagrs., photos. (NACA TN 3626)

Measurements were made of the flow around a 10-percent-thick, doubly symmetrical, two-dimensional wedge at a Mach number of 1.30 and a 14.2-percent-thick wedge at Mach numbers of 1.30 and 1.41 for various angles of attack up to 5°. Pressure and Mach number distributions, lift and drag coefficients, center of lift, and pitching moment are presented for the angles of attack used. By means of the transonic similarity laws, the results are compared with each other, with small-disturbance theory, and with shock-expansion theory wherever possible. The data show that pressure distributions on wedges of different thickness and Mach number are similar at the same values of transonic similarity parameter and reduced angle of attack for angles of attack as large as the thickness ratio and that the lift-curve slope and chordwise position of the center of pressure are only roughly independent of angle of attack for the range of angles investigated.

NACA TN 3627

BOUNDARY-LAYER GROWTH AND SHOCK ATTENUATION IN A SHOCK TUBE WITH ROUGHNESS. Paul W. Huber and Donald R. McFarland. March 1956. 49p. diagrs., photos., tab. (NACA TN 3627)

Measurements of unsteady-flow turbulent boundary-layer characteristics using a new bullet technique involving study of the bullet bow-wave shape and of shock-wave attenuation have been made in a shock tube with wall roughness. The boundary-layer-thickness measurements agreed well with both steady-flow data and theory. The measured velocity profiles were considerably less full than the steady-flow theoretical profiles but agreed with some of the steady-flow data. The shock-attenuation measurements were in agreement with a simple theory at small values of displacement thickness but were much lower than theory at the large values.

NACA TN 3629

INVESTIGATION OF THE EFFECTS OF GROUND PROXIMITY AND PROPELLER POSITION ON THE EFFECTIVENESS OF A WING WITH LARGE-CHORD SLOTTED FLAPS IN REDIRECTING PROPELLER SLIPSTREAMS DOWNWARD FOR VERTICAL TAKE-OFF. Richard E. Kuhn. March 1956. 38p. diagrs., photos., tab. (NACA TN 3629)

Results are presented of an investigation of the effects of proximity to the ground on the effectiveness of large-chord slotted flaps in redirecting propeller slipstreams downward for vertical take-off. The model consisted of a semispan wing equipped with a 60-percent-chord and 30-percent-chord slotted flap operating in the slipstream of two large-diameter propellers. The tests were conducted at zero forward speed in a large room. The results indicate that the adverse effect of the ground can be reduced somewhat by mounting the propellers with their thrust axis below the wing chord plane.

NACA TN 3630

HOVERING-FLIGHT TESTS OF A MODEL OF A TRANSPORT VERTICAL-TAKE-OFF AIRPLANE WITH TILTING WING AND PROPELLERS. Powell M. Lovell, Jr., and Lysle P. Parlett. March 1956. 23p. diagrs., photo., tab. (NACA TN 3630)

An investigation of the take-off, landing, and hovering-flight characteristics of a four-engine transport vertical-take-off airplane with tilting wing and propellers has been conducted with a remotely controlled free-flight model. The model had four propellers distributed along the wing with the thrust axes in the wing-chord plane. In order to produce direct lift for hovering flight with the fuselage horizontal, the wing and propellers were rotated 90° relative to the fuselage. It was found that the model could be flown satisfactorily for the conditions covered in the investigations.

NACA TN 3631

RESULTS OF AXIAL-LOAD FATIGUE TESTS ON ELECTRO-POLISHED 2024-T3 AND 7075-T6 ALUMINUM-ALLOY-SHEET SPECIMENS WITH CENTRAL HOLES. Charles B. Landers and Herbert F. Hardrath. March 1956. 47p. diagrs., tabs. (NACA TN 3631)

Results are presented of axial-load fatigue tests at stress ratios of 0 and -1.0 on electropolished 2024-T3 (24S-T3) and 7075-T6 (75S-T6) aluminum-alloy-sheet specimens with central holes. The specimen widths and hole diameters were varied in order to provide data suitable for a study of notch-size effect. The data are compared with previously published results of tests on unnotched electropolished specimens and on unpolished specimens containing central holes.

NACA TN 3633

ANALYSIS OF THE ULTIMATE STRENGTH AND OPTIMUM PROPORTIONS OF MULTIWEB WING STRUCTURES. B. Walter Rosen. March 1956. 34p. diagrs., tabs. (NACA TN 3633)

A structural-efficiency analysis of multiweb wing structures is presented. Minimum structural weight is shown as a function of the design variables in a manner which makes comparisons possible with structures of different materials or with other types of construction. The structural-efficiency chart presented is based on equations developed to relate ultimate bending strength of multiweb beams which fail in the local buckling mode to beam proportions and material properties and is substantiated by the results of multiweb-beam bending tests.

NACA TN 3653

SOME EFFECTS OF BLUNTNESS ON BOUNDARY-LAYER TRANSITION AND HEAT TRANSFER AT SUPERSONIC SPEEDS. W. E. Moeckel. March 1956. 43p. diagrs. (NACA TN 3653)

Large downstream movements of transition observed when the leading edges of a hollow cylinder or a flat plate are slightly blunted are explained in terms of the reduction in Reynolds number at the outer edge of the boundary layer due to the detached shock wave. This Reynolds number reduction leads to a predicted downstream movement of transition which is in good agreement with the hollow-cylinder result at Mach 3.1. Application of this theory to other Mach numbers yields the result that blunting the tip of slender cones or the leading edge of thin wedges should produce downstream movements of transition by factors ranging from 2 at Mach number 3.0 to 30 at Mach number 15.

NACA TN 3657

FRICTION STUDIES OF GRAPHITE AND MIXTURES OF GRAPHITE WITH SEVERAL METALLIC OXIDES AND SALTS AT TEMPERATURES TO 1000° F. Marshall B. Peterson and Robert L. Johnson. February 1956. 16p. diagrs., photos. (NACA TN 3657)

Powdered graphite lubricated metal surfaces at temperatures in the vicinity of 1000° F when a metallic oxide film could be formed and maintained. Mixtures of soft metallic oxides such as lead oxide or cadmium oxide with graphite were effective lubricants at all temperatures from room temperature to 1000° F unless a chemical reaction occurred between the graphite and the oxide.

NACA TN 3659

EFFECT OF LEADING-EDGE GEOMETRY ON BOUNDARY-LAYER TRANSITION AT MACH 3.1. Paul F. Brinich. March 1956. 44p. diagrs., tabs. (NACA TN 3659)

The effect of leading-edge geometry on transition, recovery factor, boundary-layer profile, and the roughness required to induce transition was studied. A downstream displacement of transition and an increase in recovery factor with increasing leading-edge bluntness were found. These were associated with the formation of an inviscid shock-produced shear layer originating at the leading edge. The laminar boundary layer was found to develop within the low Mach number, low Reynolds number region of the shock-produced shear layer for appreciable distances, even when the degree of leading-edge blunting was small. Some effects of leading-edge blunting on roughness-induced transition and the effect of surface heat conductivity on measured temperature distributions were also studied.

NACA TN 3662

THEORETICAL LOSS RELATIONS FOR LOW-SPEED TWO-DIMENSIONAL-CASCADE FLOW. Seymour Lieblein and William H. Roudebush. March 1956. 46p. diagrs., tab. (NACA TN 3662)

A theoretical analysis is conducted of the relations existing between total-pressure defect and wake momentum thickness and form factor for the incompressible flow across a two-dimensional cascade. Both the loss at a plane of measurement and the complete loss after mixing are considered. The relative importance of the various factors entering the loss relations is evaluated. Relations are obtained for the mixing-loss ratio and for the effect of trailing-edge thickness. The application of the results of the analysis to the estimation of profile loss and to the correlation of loss data is discussed.

NACA TN 3664

SUMMARY OF SCALE-MODEL THRUST-REVERSER INVESTIGATION. John H. Povolny, Fred W. Steffen, and Jack G. McArdle. February 1956. 49p. diagrs., photos. (NACA TN 3664)

This report summarizes the results of a scale-model thrust-reverser investigation. Three basic types of thrust reversers, target, tail-pipe cascade, and ring cascade, were investigated. All three were found to have satisfactory reverse-thrust performance and thrust-modulation characteristics.

NACA TN 3668

PRELIMINARY INVESTIGATION OF A FAMILY OF DIFFUSERS DESIGNED FOR NEAR SONIC INLET VELOCITIES. Richard Scherrer and Warren E. Anderson. February 1956. 43p. diagrs., photo. (NACA TN 3668)

Empirical equations defining a family of diffusers were evolved and several shapes were tested with both separated and unseparated initial boundary layers. The results indicate these diffuser shapes to be satisfactory; however, initial boundary-layer thickness was found to be as important as duct shape. Extended throat lengths were advantageous only with separated initial boundary layers. Effects of duct center-line offset were found to be large and adverse but the effects of surface condition, in general, were small.

NACA TN 3679

INFLUENCE OF COPPER IONS ON ADHERENCE OF VITREOUS COATINGS TO STAINLESS STEEL. D. G. Moore and A. G. Eubanks, National Bureau of Standards. February 1956. 14p. diagrs., photos., tabs. (NACA TN 3679)

In another phase of an investigation of adherence of ceramic coatings to metals, the effect of copper oxide in promoting adherence of vitreous coatings to AISI type 321 stainless steel was studied. The goal of this particular study was to determine whether the action of the copper ions was similar to that of cobalt ions in coatings for iron or whether the two actions were entirely different.

MISCELLANEOUS

N-41203

EVALUATION AND CALIBRATION OF WIRE-STRAIN-GAGE WIND-TUNNEL BALANCES UNDER LOAD. Raymond M. Hansen. (Presented to Wind Tunnel and Model Test Panel of Advisory Group for Aeronautical Research and Development, Rome, Italy, February 20-25, 1956). 19p. diagrs., photos., tab.

This paper discusses the manner in which loads are applied to strain-gage balances in the laboratory and the reduction of the resulting data to a convenient form.

N-41204

MECHANICAL DESIGN AND FABRICATION OF STRAIN-GAGE BALANCES. Raymond M. Hansen. (Presented to Wind Tunnel and Model Test Panel of Advisory Group for Aeronautical Research and Development, Rome, Italy, February 20-25, 1956). 16p. diagrs.

Wire-strain-gage-balance design concepts are considered from a practical standpoint. A typical balance has been chosen to illustrate how the concepts were applied in practice.

C. Day

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N-41212

MODEL SELECTION AND DESIGN PRACTICES APPLICABLE TO THE DEVELOPMENT OF SPECIFIC AIRCRAFT. Donald D. Baals. (Presented to Wind Tunnel and Model Testing Panel of the Advisory Group for Aeronautical Research and Development, Rome, Italy, February 20-25, 1956). 29p. diagrs., photos.

The critical nature of transonic and supersonic flows has limited the generalization of research results and has led to a need for extensive specific model investigations. This paper discusses the pertinent background information relative to a specific model development program, the major aerodynamic and mechanical requirements of model design, and the array of models required for a typical development program in the U. S. This paper considers the aerodynamic problems of the airframe, including the influence of inlets, but excludes the internal aerodynamics of the engine proper.

NACA TN 2337

Errata on "APPROXIMATE CALCULATION OF TURBULENT BOUNDARY-LAYER DEVELOPMENT IN COMPRESSIBLE FLOW." Maurice Tucker. April 1951.

NACA TN 3652

Errata on "EXPERIMENTAL INVESTIGATION OF AIR-FLOW UNIFORMITY AND PRESSURE LEVEL ON WIRE CLOTH FOR TRANSPIRATION-COOLING APPLICATIONS." Patrick L. Donoughe and Roy A. McKinnon. January 1956.

UNPUBLISHED PAPERS

N-41557*

CONTRIBUTION OF THE STUDY OF SUPERSONIC AXIAL COMPRESSORS. (Contribution à l'etude des Compresseurs Axiaux Supersoniques). Pierre Schwaar. November 1955. 20p. diagrs. (Trans. from Zeitschrift für angewandte Mathematik und Physik, v. 5, no. 2, 1954, p. 136-150)

In studying the three-dimensional flow in a supersonic axial compressor, the normal-shock-in-stator case has been considered. It is shown that the kinematic and dynamic conditions which are necessary to produce a normal shock wave and a radially stable transonic flow are very restrictive. The radial distribution of the flow angles in front of the shock wave is found to be that of the classical irrotational gyratory flows. The radial equilibrium condition of the flow on both sides of the shock wave requires a well-determined radial distribution of the Mach numbers of the velocities approaching the shock, which results in a nonuniform radial energy distribution of the transonic flow. A numerical example shows the importance of the radial effects. Critical comments are made on the shock-in-rotor case.

N-41652*

ON RELATIONSHIPS BETWEEN THE GRAPHICAL AND THE ALGEBRAIC STABILITY CRITERIA. (Uber Zusammenhänge zwischen den graphischen und den algebraischen Stabilitätskriterien). Wolfgang Hahn. January 1956. 3p. (Trans. from Zeitschrift für angewandte Mathematik und Mechanik, v. 35, no. 3, March 1955, p. 119)

This derivation, which seems to be new, presents a very simple proof of the stability criterion of Routh, with the aid of that of Nyquist. It is well known that the criteria of Routh and of Hurwitz, on the one hand, those of Hyquist and of Leonhard, on the other, may be easily converted into one another so that the relationship between all four criteria becomes evident.

N-41661*

ON A METHOD FOR APPROXIMATE INTEGRATION OF ARBITRARY PARTIAL DIFFERENTIAL EQUATIONS. (Über ein Verfahren zur Naherungsweisen Integration Beliebiger Partieller Differentialgleichungen). Karl Bechert. January 1956. 6p. (Trans. from Mathematische Nachrichten, v. 8, 1952, p. 75-78)

If in an arbitrary partial differential equation for the dependent variable u the "initial condition" for the solution is given, this solution may be approximately constructed by calculation of the rate of progress of fixed values of u and possibly, depending on the differential equation, of the rate of progress of the differential quotients of u.

N-41758*

THEORETICAL METHODS OF BALLISTICS. SECOND PART: INTERNAL BALLISTICS. (Méthodes Théoriques de la Balistique, Deuxieme Partie, Balistique Intérieure). P. Carrière. February 1956. 14p. diagr. (Trans. from Actes du Colloque International de Mécanique, v. II, 1950, Étude sur la Mécanique des Fluides. Publications Scientifiques et Techniques du Ministére de l'Air, no. 250, 1951, p. 26-36)

Previous works are discussed and a brief sketch of a theory which was the subject of a communication to the VII Congress of Applied Mechanics in London is given. The simplifying hypotheses have been reduced to the mathematically indispensible minimum. The numerical or graphical calculations which this method requires remain still practical. An example of application is given. The velocity of the projectile at every instant can be calculated by this method.

N-41759*

THE NOZZLE CANNON. (Le Canon á Tuyére). M. Touchard. (Includes Conclusion by Mr. Cassagnou). February 1956. 17p. diagrs. (Trans. from Actes du Colloque International de Mécanique. v. II., 1950, Etude sur la Mécanique des Fluides. Publications Scientifiques et Techniques du Ministére de l'Air, no. 250, 1951, p. 95-107)

The term "nozzle cannon" is used to represent a cannon in which the combustion chamber containing the powder and the barrel containing the projectile are separated by a nozzle. The phenomena which take place in the cannon are described. A lower prèssure is artificially achieved in the barrel than in the chamber, with the twofold goal of permitting the firing of a rather fragile finned projectile and a reduction in the weight of the weapon.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification March 16, 1956.

NACA RM A7J27

EXPERIMENTAL INVESTIGATION AT SUPERSONIC SPEEDS OF TWIN-SCOOP DUCT INLETS OF EQUAL AREA. I. - AN INLET ENCLOSING 61.5 PERCENT OF THE MAXIMUM CIRCUMFERENCE OF THE FOREBODY. Wallace F. Davis and David L. Goldstein. January 21, 1948. 16p. diagrs., photos. (NACA RM A7J27)

This report contains the results of an investigation made at Mach numbers between 1.36 and 2.01 of the total pressure recovery attainable with a twin-scoop duct inlet. The results include an experimental study of the optimum ramp to be placed upstream of the inlet and also a comparison between the twin-scoop inlet and an annular inlet of the same entrance area. It was found that the maximum recovery of total pressure is attained with a ramp angle of 5°. This recovery is about 10 percent greater than that of the corresponding annular entrance or it is about four-fifths of that of a normal shock wave occurring at the same free-stream Mach number.

NACA RM A8C11

EXPERIMENTAL INVESTIGATION AT SUPERSONIC SPEEDS OF TWIN-SCOOP DUCT INLETS OF EQUAL AREA. II - EFFECTS OF SLOTS UPON AN INLET ENCLOSING 61.5 PERCENT OF THE MAXIMUM CIRCUMFERENCE OF THE FOREBODY. Wallace F. Davis and David L. Goldstein. June 9, 1948. 15p. diagrs., photos. (NACA RM A8C11)

This report contains the results of an investigation made at Mach numbers between 1.36 and 2.01 of the pressure recovery attainable with a twin-scoop duct inlet having slots in the walls of the duct contiguous to the forebody and immediately behind the inlet. It was found that boundary-layer air flowed out of the diffuser through the slots, thereby improving the flow stability. Because of this improvement, a greater ramp angle could be used than with the unslotted inlet. The maximum total-pressure ratio of a twin-scoop duct entrance having a 9° ramp and slots of which the width was 48.6 percent of the depth of a scoop was about seven-eighths of the pressure recovered through a normal shock wave occurring at the test Mach number.

NACA RM A8E04

EXPERIMENTAL INVESTIGATION AT SUPERSONIC SPEEDS OF TWIN-SCOOP DUCT INLETS OF EQUAL AREA. III - INLET ENCLOSING 37.2 PERCENT OF THE MAXIMUM CIRCUMFERENCE OF THE FOREBODY. Wallace F. Davis and Sherman S. Edwards. July 22, 1948. 25p. diagrs., photos. (NACA RM A8E04)

The results of an experimental investigation at supersonic speeds of the total-pressure recovery attainable after diffusion with twin-scoop duct inlets enclosing 37.2 percent of the circumference of the forebody are presented. Tests of the effects of inlet proportions, ramp angle, slot dimensions, and angles of attack and yaw upon the mass flow and pressure recovery at Mach numbers between 1.36 and 2.01 are discussed. The pressure recovery attained with a model having a slotted inlet with a 12° ramp was equal to that of a normal shock wave occurring at the test Mach number.

NACA RM A9A31

EXPERIMENTAL INVESTIGATION AT SUPERSONIC SPEEDS OF TWIN-SCOOP DUCT INLETS OF EQUAL AREA. IV - SOME EFFECTS OF INTERNAL DUCT SHAPE UPON AN INLET ENCLOSING 37.2 PERCENT OF THE FOREBODY CIRCUMFERENCE. Wallace F. Davis, Sherman S. Edwards, and George B. Brajnikoff. March 15, 1949. 21p. diagrs., photos. (NACA RM A9A31)

The total pressure recovery attainable at Mach numbers between 1.36 and 2.01 with models having twin-scoop inlets and two types of internal diffuser is compared. It is shown that a large increase in the maximum total-pressure ratio can be attained by improving the conditions for boundary-layer flow in the diffuser. At Mach numbers of 1.7 and less, the pressure recovery attained was within 2 percent of that associated with nose inlets.

NACA RM A51C12

CHARACTERISTICS OF FOUR NOSE INLETS AS MEASURED AT MACH NUMBERS BETWEEN 1.4 AND 2.0. George B. Brajnikoff and Arthur W. Rogers. June 25, 1951. 48p. diagrs., photos. (NACA RM A51C12)

The performance characteristics of two open-nose and two conical-shock diffusers were measured at supersonic speeds between $M_0 = 1.4$ and 2.0 at angles of attack of 0°, 3°, 6°, and 9°. Schlieren photographs of flow about the models at 0° angle of attack were used to calculate external wave drag; these values of drag agreed well with those obtained by direct force measurements after addition of skin-friction drag, except in cases of reduced mass-flow ratios.

NACA RM A51C13

A COMPARISON OF THE EXPERIMENTAL AND THEORETICAL LOADING OVER TRIANGULAR WINGS IN SIDESLIP AT SUPERSONIC SPEEDS. John W. Boyd. May 18, 1951. 58p. diagrs., photo., tabs. (NACA RM A51C13)

The results of an experimental investigation of the load distribution over two triangular wings in sideslip at Mach numbers from 1.20 to 1.70 are presented and compared with theory. The two wings tested have identical plan form, 45° sweepback of the leading edge, and an aspect ratio of 4.0. One model was composed of round-nose airfoil sections and the other of sharp-nose, biconvex sections. For both wings the maximum thickness of streamwise sections was 6 percent and was located at the 30-percent chord.

NACA RM A51C27

DRAG INTERFERENCE BETWEEN A POINTED CYLINDRICAL BODY AND TRIANGULAR WINGS OF VARIOUS ASPECT RATIOS AT MACH NUMBERS OF 1.50 AND 2.02. Elliott D. Katzen and George E. Kaattari. May 23, 1951. 45p. diagrs., photos., tabs. (NACA RM A51C27)

The drag of a body alone, six triangular wings of various aspect ratios, and the combinations were measured at Mach numbers of 1.50 and 2.02 at a Reynolds number of 5.5 million (based on the body length). The experimental drag-interference results were in accordance with calculations based on NACA RM A9E19, 1949, with skin-friction effects taken into account, the interference effect being principally the result of fixing transition on the body by adding a wing.

NACA RM A52C14

AN ANALYTICAL STUDY OF THE COMPARATIVE PERFORMANCE OF FOUR AIR-INDUCTION SYSTEMS FOR TURBOJET-POWERED AIRPLANES DESIGNED TO OPERATE AT MACH NUMBERS UP TO 1.5. James R. Blackaby. June 1952. 38p. diagrs. (NACA RM A52C14)

A design study was made to determine some of the operational characteristics of four air-induction systems with scoop-type inlets for an angle of attack of 0°. The systems were designed for operation with free-stream Mach numbers from 0.85 to 1.50 at an altitude of 35,332 feet. They included examples with and without oblique shock ramps ahead of the inlets, with both fixed and variable inlet geometry, and with divergent diffusers. A comparative evaluation of the four systems was made on the basis of a summation of three drag factors. These factors were calculated for additive drag, the thrust loss accompanying the assumed total-pressure loss, and the energy loss associated with bypassing excess air taken in by the air-induction systems.

NACA RM A53B02

AN EXPERIMENTAL INVESTIGATION OF THE ZERO-LIFT-DRAG CHARACTERISTICS OF SYMMETRICAL BLUNT-TRAILING-EDGE AIRFOILS AT MACH NUMBERS FROM 2.7 TO 5.0. Clarence A. Syvertson and Hermilo R. Gloria. April 1953. 31p. diagrs., photos., tabs. (NACA RM A53B02)

The zero-lift-drag characteristics of nine symmetrical airfoils were investigated experimentally at Mach numbers from 2.7 to 5.0 and Reynolds numbers (based on the chord) from 0.35 million to 3.63 million. Eight of these airfoils had blunt trailing edges and were designed to have minimum pressure drag at a Mach number of 3 or 5 for a given torsional rigidity or a given bending strength. The ninth airfoil was a conventional biconvex section having a torsional rigidity equal to that of three of the minimum-drag airfoils. Section thickness ratios varied from 3.74 to 6.10 percent.

NACA RM A54C31

THE EFFECT OF BLUNT-TRAILING-EDGE MODIFICATIONS ON THE HIGH-SPEED STABILITY AND CONTROL CHARACTERISTICS OF A SWEPT-WING FIGHTER AIRPLANE. Melvin Sadoff, Frederick H. Matteson, and Rudolph D. Van Dyke, Jr. May 1954. 55p. diagrs., photos., tab. (NACA RM A54C31)

An investigation was conducted on a 35° swept-wing fighter airplane to determine the effects of several blunt-trailing-edge modifications to the wing and tail on the stability and control characteristics and tracking performance. Significant improvement in the pitch-up and roll-off characteristics for the blunt-aileron modification was noted at high Mach numbers.

NACA RM A55A07

DOWNWASH SURVEY BEHIND TWO LOW-ASPECT-RATIO VARIABLE-INCIDENCE WINGS IN COMBINATION WITH THREE DIFFERENT SIZE FUSELAGES AT A MACH NUMBER OF 0.25. Edward J. Hopkins and Norman E. Sorensen. March 1955. 54p. diagrs., photos., tab. (NACA RM A55A07)

Measurements were made of the downwash fields behind six wing-body combinations at a Mach number of 0.25. A triangular wing (aspect ratio 2.0) and a trapezoidal wing (aspect ratio 3.0) were tested in combination with three geometrically similar bodies of revolution. The ratios of maximum body diameter to wing span were 0.196, 0.259, and 0.343. The wings were set at several angles of incidence from 0° to 10°.

NACA RM E8C17

NACA RM E8C22

SOME EFFECTS OF GUTTER FLAME-HOLDER DIMENSIONS ON COMBUSTION-CHAMBER PERFORMANCE OF 20-INCH RAM JET. Fred A. Wilcox, Eugene Perchonok, and George Wishnek. July 30, 1948. 39p. diagrs., photos., tab. (NACA RM E8C22)

Operational characteristics of 20-inch ram jet with four different gutter-grid flame holders and an adjustable three-gutter flame holder were investigated. Best overall operation was obtained with one gutter-grid flame holder operated to maximum combustion-chamber-inlet velocity of 201 feet per second. Double-scale, three-quarter-scale, and 1.4-spaced versions of this flame holder generally gave unsatisfactory operation. Results obtained with adjustable three-gutter flame holder indicate that the flame holder should block about 50 percent of combustion-chamber frontal area to attain operation at choking conditions at exhaust-nozzle outlet for configuration investigated.

NACA RM E51C05

PRELIMINARY INVESTIGATION OF HELMHOLTZ RESONATORS FOR DAMPING PRESSURE FLUCTUATIONS IN 3.6-INCH RAM JET AT MACH NUMBER 1.90. Jerome L. Fox. May 22, 1951. 24p. diagrs., photos. (NACA RM E51C05)

The feasibility of damping pressure pulsations in a typical ram-jet configuration by means of attached Helmholtz resonators was investigated at Mach number 1.90. With one of the two resonators used a reduction in movement of the shock at the inlet was noted, together with an increase of 4 percent in total-pressure recovery when the ram jet was operating near peak pressure recovery. Neither resonator was successful in damping oscillations over the entire range of operating conditions.

NACA RM E51C06

AERODYNAMIC CHARACTERISTICS OF FOUR BODIES OF REVOLUTION SHOWING SOME EFFECTS OF AFTERBODY SHAPE AND FINENESS RATIO AT FREE-STREAM MACH NUMBERS FROM 1.50 TO 1.99. Robert J. Cohen. May 22, 1951. 31p. diagrs., tabs. (NACA RM E51C06)

The effects of fineness ratio (14.2 and 12.2) and boattailing on aerodynamic characteristics of four bodies of revolution at Mach numbers from 1.50 to 1.99 within a range of angles of attack from 0° to 10° at an approximate Reynolds number of 35×10^6 based on body length were investigated. A comparison of experimental data with available theory is included. At zero angle of attack, fineness ratio has no appreciable effect on model characteristics while boattailing and boattail convergence significantly affect fore drag and base drag. At angle of attack the effects are singular. The theory presented by H. J. Allen is a significant improvement over linearized potential theory in predicting aerodynamic characteristics.

NACA RM E52J16

INVESTIGATION OF EFFECTS OF ADDITIVES ON STORAGE PROPERTIES OF FUMING NITRIC ACIDS. Charles E. Feiler and Gerald Morrell. December 1952. 25p. photos., diagrs., tabs. (NACA RM E52J16)

The storage properties of fuming nitric acids, with and without additives, were investigated at a temperature of 170° F in closed containers of approximately 100-milliliter capacity. It was found that at equal ullages the peak decomposition pressures of white fuming nitric acid are of an order of magnitude greater than those of red fuming nitric acid. Addition of 1 percent potassium fluoride dihydrate was found to be the most effective of the additives investigated in reducing the rate of pressure rise and in reducing corrosion on aluminum and stainless steel surfaces. This additive had no effect on the ignition delay of a representative fuel at 70° F even after 100 hours of storage.

NACA RM E53C25

COMPARATIVE TENSILE STRENGTHS AT 1200° F OF VARIOUS ROOT DESIGNS FOR CERMET TURBINE BLADES. Andre J. Meyer, Jr., Albert Kaufman, and Howard F. Calvert. June 1953. 23p. diagrs., photos., tabs. (NACA RM E53C25)

Tensile tests were conducted on five roots designed for use with brittle materials and the results are compared with the strength of the conventional fir-tree type blade root. Three of the roots tested were found superior to the fir-tree design and are suitable for application in the turbine of aircraft jet engines. The turbine-rotor segments for these blade roots were also evaluated and established as satisfactory for normal operation in a J33-A-33 engine. A ductile material inserted between the blade root and the rotor recess proved beneficial.

NACA RM E53L17b

INVESTIGATION OF EFFECT OF FLUORIDE ON CORROSION OF 2S-0 ALUMINUM AND 347 STAINLESS STEEL IN FUMING NITRIC ACID AT 170° F. Charles E. Feiler and Gerald Morrell. February 1954. 22p. diagrs., photos., tabs. (NACA RM E53L17b)

The effect of small additions of fluoride on the corrosion of 2S-0 aluminum and 347 stainless steel by fuming nitric acid at 170° F has been evaluated quantitatively by the determination of the weight loss of metal specimens immersed in the acid. The ratio of metal surface area to volume of acid was approximately 7.5 inch^{-1} in all cases. It was found that for acids containing no fluorides the weight loss of aluminum was approximately 1/5 that of stainless steel. Addition of 1 percent fluoride ion to the acid reduced the weight loss of both metals to practically zero even after 26 days of exposure to the acid at 170° F.

The minimum quantity of fluoride ion required to inhibit corrosion was found to be approximately 0.25 and 0.5 percent for aluminum and stainless steel, respectively, in white fuming nitric acid and 0.5 and 1 percent for aluminum and stainless steel, respectively, in red fuming nitric acid (18 percent nitrogen dioxide). These fluoride percentages were based on the total weight of acid. Provided the concentration of fluoride ion was sufficient to inhibit corrosion, the source of these ions was immaterial. Additional information concerning the effect of fluorides on corrosion was obtained by measuring the electrode potentials of the metals against a platinum reference electrode.

NACA RM L9C03

PLANING CHARACTERISTICS OF THREE SURFACES REPRESENTATIVE OF HYDRO-SKI FORMS. Kenneth L. Wadlin and John R. McGehee. March 29, 1949. 94p. diagrs., photos., tab. (NACA RM L9C03)

The planing characteristics as determined by tank tests, are presented for three surfaces representative of hydro-ski forms. One surface was of rectangular plan form with a flat bottom; the second surface had a rectangular plan form with transversely curved bottom; and the third surface had a flat bottom but was triangular in plan form. The range of trims investigated was 4° to 20°. The data are presented in the form of plots of the total load, resistance, trimming moment, and draft against wetted area. Plots of wetted length, wetted area forward of the observed wetted length at the chine, and aerodynamic tare forces are included.

NACA RM L9C31

LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A SEMISPAN WIND-TUNNEL MODEL OF A TAILLESS AIRPLANE AND A COMPARISON WITH COMPLETE-MODEL WIND-TUNNEL TESTS AND SEMISPAN-MODEL WING-FLOW TESTS. Kenneth W. Goodson and Thomas J. King, Jr. October 10, 1949. 63p. diagrs., photos. (NACA RM L9C31)

An investigation was conducted on a semispan model of a tailless airplane in the Langley high-speed 7- by 10-foot tunnel in the Mach number range from 0.40 to 0.97. The results are compared with those obtained with sting-mounted complete model tested in the same tunnel and with a semispan model tested by the wing-flow method.

NACA RM L9J06

EXPERIMENTAL INVESTIGATION OF VARIOUS WING-MOUNTED EXTERNAL STORES ON A WING-FUSELAGE COMBINATION HAVING A SWEPTBACK WING OF INVERSE TAPER RATIO. Kenneth P. Spreemann and H. Norman Silvers. September 15, 1950. 29p. diagrs., photos., tab. (NACA RM L9J06)

An investigation was conducted in the Langley high-speed 7- by 10-foot tunnel to determine the effects of several wing-mounted external-store configurations on the aerodynamic characteristics of a small-scale model of a sweptback wing-fuselage combination. The external-store configurations investigated included inboard under-wing installations (pylon-suspended and flush-wing stores) and wing-tip installations (forward-tip and central-tip stores).

NACA RM L51C08

RESULTS OF TWO FREE-FALL EXPERIMENTS ON FLUTTER OF THIN UNSWEPT WINGS IN THE TRANSONIC SPEED RANGE. William T. Lauten, Jr., and Herbert C. Nelson. May 8, 1951. 26p. diagrs., photo., tabs. (NACA RM L51C08)

Results of four thin unswept flutter airfoils attached to two freely falling bodies are reported. Two airfoils fluttered at a Mach number of 0.85, a third airfoil fluttered at a Mach number of 1.03, and a fourth fluttered at a Mach number of 1.07. Results of calculations of flutter speed using incompressible and compressible air-force coefficients, including Mach number of 1.0, are presented.

NACA RM L51C30

LOW-SPEED LONGITUDINAL AND WAKE AIRFLOW CHARACTERISTICS AT A REYNOLDS NUMBER OF 5.5×10^{6} OF A CIRCULAR-ARC 52° SWEPTBACK WING WITH A FUSELAGE AND A HORIZONTAL TAIL AT VARIOUS VERTICAL POSITIONS. Gerald V. Foster and Roland F. Griner. June 19, 1951. 44p. diagrs., tabs. (NACA RM L51C30)

The results of a low-speed investigation are presented to determine the effects of a fuselage and horizontal tail on the longitudinal characteristics of a circular-arc 52° sweptback wing at a Reynolds number of 5.5×10^{6}. The paper also presents the characteristics of the air flow behind the wing at one station representative of a horizontal tail location. These results were obtained with the plain wing configuration and with the wing equipped with leading-edge and trailing-edge flaps.

NACA RM L51H20

COMPARISON OF NACA 65-SERIES COMPRESSOR-BLADE PRESSURE DISTRIBUTIONS AND PERFORMANCE IN A ROTOR AND IN CASCADE. Willard R. Westphal and William R. Godwin. November 1951. 53p. diagrs., photos. (NACA RM L51H20)

An investigation has been conducted to compare the performance of NACA 65-series compressor blades in two-dimensional cascade to that in an axial flow compressor. Blade pressure distributions were obtained by the use of a mercury-seal pressure transfer device. The comparison indicated that cascade data accurately predicted the turning angle and blade pressure distribution obtained in the compressor at design conditions.

NACA RM L51J16

EFFECT OF SECTION THICKNESS AND TRAILING-EDGE RADIUS ON THE PERFORMANCE OF NACA 65-SERIES COMPRESSOR BLADES IN CASCADE AT LOW SPEEDS. L. Joseph Herrig, James C. Emery, and John R. Erwin. December 1951. 66p. diagrs., tabs. (NACA RM L51J16)

NACA 65-series compressor blades cambered to an isolated airfoil lift coefficient of 1.2 have been tested in a low-speed porous-wall cascade with maximum section thicknesses of 6, 8, 10, 12, and 15 percent of the chord to obtain the effect of maximum section thickness on section operating characteristics. A 10-percent-thick section tested with a trailing-edge radius of 1 and 2 percent chord was compared with data for a similar section having the usual 0.15 percent radius to determine the penalties incurred with more practical trailing edges. The low-speed operating range increases about 50 percent and the low-speed turning angle decreases 2° to 4° as the section thickness is increased from 6 percent to 15 percent chord. Sections having trailing-edge radii of 1 percent chord are recommended for practical construction.

NACA RM L52C10

USE OF AN AERODYNAMICALLY PULSED ALL-MOVABLE HORIZONTAL TAIL TO OBTAIN LONGITUDINAL CHARACTERISTICS OF ROCKET-POWERED MODELS IN FREE FLIGHT AND SOME INITIAL RESULTS FROM AN ARROW-WING-BODY-TAIL CONFIGURATION. Warren Gillespie, Jr., and Albert E. Dietz. May 1952. 31p. diagrs., photos. (NACA RM L52C10)

Data at lifting conditions from continuous longitudinal pitching motions may be obtained through use of an aerodynamic pulsing horizontal tail moving between fixed tail deflections. A description of the method and results of an initial flight test of a configuration having an arrow wing of 67.5° leading-edge sweep, and aspect ratio 1.85 with an unswept tail of aspect ratio 2.3 are presented.

NACA RM L52C13

SOME WIND-TUNNEL RESULTS OF AN INVESTIGATION OF THE FLUTTER OF SWEPTBACK- AND TRIANGULAR-WING MODELS AT MACH NUMBER 1.3. W. J. Tuovila. May 1952. 12p. diagrs., tab. (NACA RM L52C13)

Flutter tests of untapered, low-aspect-ratio, sweptback wing models and of triangular-wing models of solid magnesium, aluminum, and steel construction have been made in an intermittent supersonic wind tunnel at Mach number 1.3. Flutter data are presented for 31 untapered-wing models with 0°, 30°, 45°, and 60° sweepback and for 24 triangular-wing models. Flutter boundaries are indicated on plots of streamwise thickness ratio and aspect ratio. No attempt has been made to correlate the results with analytical developments.

NACA RM L52C28

CHORDWISE PRESSURE DISTRIBUTION AT HIGH SUBSONIC SPEEDS NEAR MIDSEMISPAN OF A TAPERED 35° SWEPTBACK WING OF ASPECT RATIO 4 HAVING NACA 65A006 AIRFOIL SECTIONS AND EQUIPPED WITH VARIOUS SPOILER AILERONS. Alexander D. Hammond and Barbara M. McMullan. June 1952. 76p. diagrs., tabs. (NACA RM L52C28)

This paper presents the chordwise-pressure distribution at the 46-percent-semispan station over a solid plug-type spoiler aileron, a fingered spoiler, and a perforated spoiler on a tapered 35° sweptback wing of aspect ratio 4 with NACA 65A006 airfoil section. The tests were made at angles of attack from 0° to 20° and at Mach numbers from 0.60 to 0.93.

NACA RM L53B26a

A COMPARISON OF TYPICAL NATIONAL GAS TURBINE ESTABLISHMENT AND NACA AXIAL-FLOW COMPRESSOR BLADE SECTIONS IN CASCADE AT LOW SPEED. A. Richard Felix and James C. Emery. May 1953. 46p. diagrs., photo., tabs. (NACA RM L53B26a)

Comparative cascade tests of the NGTE (National Gas Turbine Establishment of Great Britain) 10C4/30C50 and NACA 65-(12)10 axial-flow compressor blade sections were conducted in a 5-inch low-speed cascade tunnel at the Langley Laboratory at air-inlet angles of 30°, 45°, and 60° and a solidity of 1.0 by using the porous-wall technique. These NACA data for the NGTE 10C4/30C50 section were also compared with data from NGTE design charts for the same section. British and NACA incompressible cascade force-analysis equations are included.

NACA RM L53C09

INVESTIGATION OF THE EFFECTS OF WING AND TAIL MODIFICATIONS ON THE LOW-SPEED STABILITY CHARACTERISTICS OF A MODEL HAVING A THIN 40° SWEPT WING OF ASPECT RATIO 3.5. Joseph Weil, William C. Sleeman, Jr., and Andrew L. Byrnes, Jr. April 1953. 95p. diagrs., photos., tab. (NACA RM L53C09)

This paper presents the basic low-speed longitudinal and lateral stability characteristics of a model having a thin 40° swept wing of aspect ratio 3.5. Information is presented to show the effects of wing modifications (such as fences and leading-edge chord extensions) and changes in horizontal-tail location on the stability characteristics of the model. Longitudinal data were also obtained with an enlarged root inlet for the basic configuration and with several wing and tail modifications.

NACA RM L53C13

PRESSURE AND FORCE CHARACTERISTICS AT TRANSONIC SPEEDS OF A SUBMERGED DIVERGENT-WALLED AIR INLET ON A BODY OF REVOLUTION. John A. Braden and P. Kenneth Pierpont. May 1953. 65p. photos., diagrs., tabs. (NACA RM L53C13)

Results in terms of pressure recovery, lift, pitching moment, and external drag are presented of an investigation of a twin submerged divergent-walled inlet configuration mounted on a body of revolution. The minimum inlet area was about 16 percent of the frontal area and the diffuser had an area ratio of about 2.4/1. Data were obtained over a Mach number and angle-of-attack range from 0.6 to 1.09 and 0° to 10.6°, respectively. The results indicated that the total-pressure recovery, adversely affected by angles of attack, was inferior to a forward-located underslung scoop. Lift and pitching moments were substantially the same as for the basic body for all test conditions. External drag at high mass-flow ratios was approximately the same as for the basic body.

NACA RM L53C17

LARGE-SCALE FLIGHT MEASUREMENTS OF ZERO-LIFT DRAG AND LOW-LIFT LONGITUDINAL CHARACTERISTICS OF A DIAMOND-WING—BODY COMBINATION AT MACH NUMBERS FROM 0.725 TO 1.54. Harvey A. Wallskog and John D. Morrow. April 1953. 18p. diagrs., photo., tab. (NACA RM L53C17)

A large-scale diamond-wing—body configuration has been flown by the Langley Pilotless Aircraft Research Division at Mach numbers from 0.725 to 1.54 and Reynolds numbers, based on the wing mean aerodynamic chord, up to 35×10^6. The diamond-plan-form wing had an NACA 65A003 airfoil section, a total aspect ratio of 2.31, and a leading-edge sweep of approximately 41°. Drag-coefficient values of a 3-percent-thick 60° delta-wing configuration are shown for comparison. The results of this free-flight investigation showed that the diamond-wing configuration had lower wing-plus-interference drag up to a Mach number of 1.02 but about 17 percent greater drag above a Mach number of 1.3 than did a similar 60° delta-wing model.

NACA RM L53C18

LOW-SPEED INVESTIGATION OF THE AERODYNAMIC, CONTROL, AND HINGE-MOMENT CHARACTERISTICS OF TWO TYPES OF CONTROLS ON A DELTA-WING-FUSELAGE MODEL WITH AND WITHOUT NACELLES. William I. Scallion. May 1953. 47p. diagrs., photos., tabs. (NACA RM L53C18)

Results are presented of an investigation to determine the low-speed longitudinal control, lateral control, and hinge-moment characteristics at zero yaw of a 60° sweptback delta-wing-fuselage combination with 65A003 airfoil sections equipped with half-delta and horn-balance-type tip controls having areas of 5.2 and 10.2 percent of the wing area, respectively. Comparison is made between controls, and effects of wing-mounted nacelles on control and hinge-moment characterisitcs are presented.

NACA RM L53C23

THE EFFECT AT HIGH SUBSONIC SPEEDS OF A FLAP-TYPE AILERON ON THE CHORDWISE PRESSURE DISTRIBUTION NEAR MIDSEMISPAN OF A TAPERED 35° SWEPTBACK WING OF ASPECT RATIO 4 HAVING NACA 65A006 AIRFOIL SECTION. Alexander D. Hammond and Barbara M. Keffer. May 1953. 89p. diagrs., tab. (NACA RM L53C23)

This paper presents effects of the deflection of a flap-type aileron on the chordwise pressure distribution at the 46-percent-semispan station of a tapered 35° sweptback wing of aspect ratio 4 with an NACA 65A006 airfoil section. The tests were made at angles of attack from 0° to 20° and at Mach numbers from 0.60 to 0.95 for aileron deflections from -30° to 30°.

NACA RM L53C30

INVESTIGATION AT LOW SPEED OF THE FLOW FIELD BEHIND THE LIFTING SURFACES OF A MODEL EQUIPPED WITH A 60° TRIANGULAR WING AND A 60° TRIANGULAR CANARD TAIL. Ernest E. Newman and Jones F. Cahill. June 1953. 44p. diagrs., photos., tab. (NACA RM L53C30)

An investigation has been made at a Reynolds number of 9×10^6 and a Mach number of 0.14 of the flow field behind the lifting surfaces of a model equipped with a 60° triangular wing and a 60° triangular canard tail. Downwash, sidewash, and dynamic-pressure measurements were made through a range of angle of attack for two stations behind the wing without the canard tail, for a station behind the canard tail at the location of the leading edge of the wing mean aerodynamic chord (wing removed), and at $0.25\bar{c}$ forward of the wing trailing edge (wing in place).

NACA RM L53C31

FREE-FALL MEASUREMENTS OF THE EFFECTS OF WING-BODY INTERFERENCE ON THE TRANSONIC DRAG CHARACTERISTICS OF SWEPT-WING-SLENDER-BODY CONFIGURATIONS. Max C. Kurbjun and Jim Rogers Thompson. May 1953. 34p. diagrs., photos., tabs. (NACA RM L53C31)

The present paper contains free-fall measurements of the pressure distribution and transonic drag characteristics for a wing-body combination consisting of a body of fineness ratio 12 and a 45° sweptback wing located behind the maximum diameter of the body. The results do not confirm those reported previously (in NACA RM L7I01). Results are compared with results of previously tested models and analysis revealed that an unfavorable interference effect on the body drag due to the presence of the wing occurred at transonic speeds and did not vary appreciably with location of the wing on the body. The pressure measurements showed that the mechanism of the drag rise occurred at a lower Mach number because of the lower critical Mach number of the wing-body combination.

NACA RM L54H18a

SUMMARY OF 65-SERIES COMPRESSOR-BLADE LOW-SPEED CASCADE DATA BY USE OF THE CARPET-PLOTTING TECHNIQUE. A. Richard Felix. November 1954. 9p. diagrs. (NACA RM L54H18a)

The carpet-plotting technique is presented in this paper as a more useful and concise method of summarizing cascade data on the 65-series compressor blades given in NACA RM L51G31. Carpet plots included permit the selection of the blade camber and the design angle of attack required to fulfill a design vector diagram. Other carpet plots provide means for the prediction of off-design turning angles. Also presented are carpet plots of an isentropic pressure-rise coefficient as a function of inlet-air angle, turning angle, and entering Mach number.

NACA RM SL9J06
NACA RM SL51B20
NACA RM SL54A28

This is authority for those possessing copies of the following research report to declassify it from Secret Restricted Data. Effective date of declassification March 16, 1956.

NACA RM E54A27

DYNAMIC CORROSION IN AN IRON-STAINLESS STEEL TOROID BY SODIUM AT 900° F. Robert A. Lad. January 15, 1954. 9p. diagrs., tabs. (NACA RM E54A27)

A corrosion investigation was conducted with molten sodium blowing at a velocity of 25 feet per second in a toroid of AISI type 347 stainless steel with an insert consisting of seven Globeiron tubes in parallel at the hot zone. A 500-hour test was run at a nominal outer wall temperature of 900° F with a temperature difference between the hot and cold sections of 40° F. Chemical analysis of the toroid contents indicated attack of the stainless steel as well as the Globeiron. Metallographic examination of a section from the cold zone showed the presence of a porous mass-transfer deposit 0.001 inch thick.

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1224

EFFECTS OF WING POSITION AND FUSELAGE SIZE ON THE LOW-SPEED STATIC AND ROLLING STABILITY CHARACTERISTICS OF A DELTA-WING MODEL. Alex Goodman and David F. Thomas, Jr. 1955. ii, 31p. diagrs., photos., tabs. (NACA Rept. 1224. Supersedes TN 3063)

Results are presented of an investigation made to determine the effects of wing position and fuselage size on the low-speed static and rolling stability characteristics of models having a triangular wing and vertical tail surfaces. Interference increments between the various components are evaluated, and the variation of the vertical-tail lift-curve slopes and the efficiency factors with angle of attack as affected by wing position and body size are presented. Tuft-grid pictures of the flow at the vertical tail as affected by wing-fuselage interference are also presented.

NACA Rept. 1225

DETERMINATION OF LATERAL-STABILITY DERIVATIVES AND TRANSFER-FUNCTION COEFFICIENTS FROM FREQUENCY-RESPONSE DATA FOR LATERAL MOTIONS. James J. Donegan, Samuel W. Robinson, Jr., and Ordway B. Gates, Jr. 1955. i, 19p. diagrs., tabs. (NACA Rept. 1225. Supersedes TN 3083)

A method is presented for calculating the lateral-stability derivatives and lateral transfer-function coefficients from frequency-response data for a rigid airplane. Two examples are used to illustrate the method. Accurate lateral-stability derivatives can be obtained only when accurate frequency-response data are available.

NACA Rept. 1230

GENERALIZED INDICIAL FORCES ON DEFORMING RECTANGULAR WINGS IN SUPERSONIC FLIGHT. Harvard Lomax, Franklyn B. Fuller and Loma Sluder. 1955. ii, 27p. diagrs., tab. (NACA Rept. 1230. Supersedes TN 3286)

A method is presented for determing the time-dependent flow over a rectangular wing moving with a supersonic forward speed and undergoing small vertical distortions expressible as polynomials involving spanwise and chordwise distances. Results are expressed in terms of generalized indicial forces. Numerical results for Mach numbers of 1.1 and 1.2 are given for polynomials of the first and fifth degree in the chordwise and spanwise directions, respectively, on a wing of aspect ratio 4.

NACA Rept. 1235

STANDARD ATMOSPHERE—TABLES AND DATA FOR ALTITUDES TO 65,800 FEET. International Civil Aviation Organization, Montreal, Canada and Langley Aeronautical Laboratory, Langley Field, Va. 1955, v, 114p. tabs. (NACA Rept. 1235. Supersedes TN 3182; Rept. 218)

The physical constants and basic equations defining the International Civil Aviation Organization (ICAO) Standard Atmosphere are presented together with tables and diagrams of the properties of the ICAO Standard Atmosphere computed by the National Advisory Committee for Aeronautics in both metric and English units for altitudes from -5,000 meters to 20,000 meters and from -16,500 feet to 65,800 feet.

NACA Rept. 1237

A FLIGHT EVALUATION OF THE LONGITUDINAL STABILITY CHARACTERISTICS ASSOCIATED WITH THE PITCH-UP OF A SWEPT-WING AIRPLANE IN MANEUVERING FLIGHT AT TRANSONIC SPEEDS. Seth B. Anderson and Richard S. Bray. 1955. ii, 12p. diagrs., photo., tab. (NACA Rept. 1237. Supersedes RM A51I12)

Flight measurements on a swept-wing jet aircraft showed that the pitch-up encountered in a wind-up turn at transonic Mach numbers was due principally to an unstable break in the wing pitching moment associated with flow separation near the wing tip. The pitch-up encountered in slowing down in a dive-recovery maneuver was due chiefly to a reduction in wing-fuselage stability. An increase in down load for the horizontal tail was indicated with increase in Mach number for normal force-coefficient values in excess of approximately 0.2.

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NACA RM L55H04a

SUMMARY OF LOCATIONS AND EXTENTS OF TURBULENT AREAS ENCOUNTERED DURING FLIGHT INVESTIGATIONS OF THE JET STREAM FROM OCTOBER 1953 TO MAY 1954 AND NOVEMBER 1954 TO JULY 1955. Mary W. Fetner. April 1956. 10p. tab. (NACA RM L55H04a)

The locations and extents of turbulent areas encountered during flights of a Boeing B-47B airplane engaged in an investigation of the jet stream and the Sierra Mountain Wave are presented. The data were obtained from NACA VGH time-history records in cooperation with the Air Force Cambridge Research Center.

NACA TM 1392

ON THE BUCKLING OF BARS AND PLATES IN THE PLASTIC RANGE. PART II. (Over het knikvraagstuk in het plastische gebied bij staven en platen. (Deel)). J. P. Benthem. March 1956. 79p. diagrs., tabs. (NACA TM 1392. Trans. of Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport S. 423, Jan. 1954)

A review is made of existing literature concerning comparison with experiment of various theoretical formulas for buckling of plates in the plastic region. The significance and relative merits of various theories are discussed.

NACA TN 3271

THERMODYNAMIC PROPERTIES OF GASEOUS NITROGEN. Harold W. Woolley, National Bureau of Standards. March 1956. 114p. diagrs., tabs. (NACA TN 3271)

The NBS-NACA tables of thermal properties of gaseous nitrogen are grouped together in this report for convenient use. They include the thermodynamic functions for the gas, both real and ideal, the transport properties for the gas, and the vapor pressure of the liquid and the solid. The tables are in dimensionless form and conversion factors to frequently used units are given. Deviation plots or tables indicating the agreement or discordance of the experimental data are included.

NACA TN 3543

SOME EFFECTS OF FUSELAGE FLEXIBILITY ON LONGITUDINAL STABILITY AND CONTROL. Bernard B. Klawans and Harold I. Johnson. April 1956. 42p. diagrs., tab. (NACA TN 3543)

Some effects of fuselage flexibility on longitudinal stability and control of a large high-speed airplane were determined by application of a semirigid analysis. The dynamic characteristics are examined by studying the period and damping of the fuselage and airplane short-period longitudinal modes of oscillation. The static characteristics are examined by studying the longitudinal stability margins and the elevator-control deflections required for balance in straight or steady maneuvering flight.

NACA TN 3597

ANALYSIS OF A VANE-CONTROLLED GUST-ALLEVIATION SYSTEM. Robert W. Boucher and Christopher C. Kraft, Jr. April 1956. 45p. diagrs., tabs. (NACA TN 3597)

A theoretical study, using an electronic analog computer, is made of the response to step gusts of an airplane equipped with a system in which modified wing flaps and a modified elevator are operated to reduce accelerations in rough air. These surfaces are actuated by an automatic control system in response to the indications of an angle-of-attack vane. The effect of interconnection of the flap operating mechanism with the pilot's control system is also included.

NACA TN 3609

LINEARIZED LIFTING-SURFACE AND LIFTING-LINE EVALUATIONS OF SIDEWASH BEHIND ROLLING TRIANGULAR WINGS AT SUPERSONIC SPEEDS. Percy J. Bobbitt. March 1956. 63p. diagrs. (NACA TN 3609)

The sidewash in the vertical plane of symmetry behind steady-rolling triangular wings traveling at supersonic speeds has been derived by use of both linearized lifting-surface and lifting-line methods. The lifting-surface results are limited by the condition that the wing leading edges must be subsonic. Variations of the sidewash with vertical and longitudinal distances are presented in graphical form for a number of combinations of Mach number and leading-edge sweep. Sidewash computed by the lifting-line method showed good agreement with lifting-surface results except close behind the trailing edge when the leading edge approached the sonic condition. An illustrative calculation has been made of the force induced by the sidewash behind a triangular wing on a vertical tail located in various longitudinal positions. The approximate lifting-line expression may be used to compute the sidewash behind rolling wings of arbitrary plan form and span loading.

NACA TN 3611

ANALYSIS OF A SPIN AND RECOVERY FROM TIME HISTORIES OF ATTITUDES AND VELOCITIES AS DETERMINED FOR A DYNAMIC MODEL OF A CONTEMPORARY FIGHTER AIRPLANE IN THE FREE-SPINNING TUNNEL. Stanley H. Scher. April 1956. 54p. diagrs., photos., tabs. (NACA TN 3611)

A technique for determining time histories of the attitudes and velocities of free-spinning-tunnel models during spins and recoveries is presented and applied to a model representative of a contemporary fighter airplane. One spin and the recovery therefrom are investigated, and discussions as to the nature of the spin and recovery motions and some factors affecting them are presented along with the time histories.

NACA TN 3612

INITIAL RESULTS OF A FLIGHT INVESTIGATION OF A GUST-ALLEVIATION SYSTEM. Christopher C. Kraft, Jr. April 1956. 19p. diagrs., photos., tabs. (NACA TN 3612)

A flight investigation of a gust-alleviation system designed to improve passenger comfort in flight through turbulent air has been recently initiated. The system is designed to maintain constant lift in rough air by means of trailing-edge wing flaps operated by an automatic control system which is controlled by signals from an angle-of-attack vane located at the nose of the airplane. The gust-alleviation system is at least capable of reducing the normal accelerations due to gusts by 50 percent in the range of the natural frequency of the airplane.

NACA TN 3624

INVESTIGATION OF THE USE OF THE THERMAL DECOMPOSITION OF NITROUS OXIDE TO PRODUCE HYPERSONIC FLOW OF A GAS CLOSLY RESEMBLING AIR. Alexander P. Sabol and John S. Evans. March 1956. 36p. diagrs., tabs. (NACA TN 3624)

A method is presented for producing hypersonic flow in a wind tunnel by using the hot gaseous products obtained from the thermal decomposition of nitrous oxide. Comparable experimental results were obtained when pressures in a divergent conical hypersonic nozzle operated by this method at a Mach number of about 7 were compared with those of heated air. The design of the reactor used to operate the nozzle was based on results of constant-volume and constant-pressure decomposition tests which are described. Decomposition temperatures up to 1859° K (3346° R) at pressures up to 1930 atmospheres were obtained for the constant-volume process, whereas theory indicated a temperature of 2507° K (4510° R). Temperatures up to 1726° K (3107° R) at pressures up to 70 atmospheres were obtained for the constant-pressure process, whereas theory indicated a temperature of 2165° K (3898° R).

NACA TN 3635

ANALYTICAL STUDY OF MODIFICATIONS TO THE AUTOPILOT OF A FIGHTER AIRPLANE IN ORDER TO REDUCE THE RESPONSE TO SIDE GUSTS. Charles W. Mathews and James J. Adams. March 1956. 35p. diagrs., tabs. (NACA TN 3635)

Results of some calculations of the roll and yaw responses to side gusts of an airplane-autopilot system are presented. Course responses to lateral-steering commands are also presented. A comparison is made between the basic autopilot and one in which the rudder channel is modified specifically in order to alleviate the effects of side gusts. The results indicate that, through fairly minor modifications to the rudder channel, the response to side gusts can be noticeably reduced.

NACA TN 3645

WIND-TUNNEL INVESTIGATION OF EFFECTS OF FUSELAGE CROSS-SECTIONAL SHAPE, FUSELAGE BEND, AND VERTICAL-TAIL SIZE ON DIRECTIONAL CHARACTERISTICS OF NONOVERLAP-TYPE HELICOPTER FUSELAGE MODELS WITHOUT ROTORS. James L. Williams. March 1956. 39p. diagrs., photos. (NACA TN 3645)

This paper presents the results of a low-speed wind-tunnel investigation to determine the effect of fuselage cross section, fuselage bend, and vertical tail size on the directional stability characteristics of nonoverlap-type helicopter fuselage models.

NACA TN 3660

INVESTIGATION OF THE Ni_3Al PHASE OF NICKEL-ALUMINUM ALLOYS. Edward M. Grala. April 1956. 24p. diagrs., photos., tabs. (NACA TN 3660)

The stoichiometric Ni_3Al intermetallic had an as-cast room-temperature tensile strength of 28,650 psi with 1.0-percent elongation; after homogenization at 1800° F this strength decreased to 20,350 psi with 0.2-percent elongation. A 14-percent-aluminum alloy in the same phase field had better tensile properties than the stoichiometric composition, with an as-cast room-temperature tensile strength of 39,250 psi, and a homogenized tensile strength of 32,100 psi; at 1500° F the tensile strength was 19,600 psi. The stress-rupture strength was evaluated at 1500°, 1600°, and 1700° F for the 14-percent-aluminum alloy; the 100-hour rupture strength was interpolated as 8,600 psi at 1500° F. The stoichiometric Ni_3Al had no hot-workability and only moderate impact strength.

NACA TN 3661

SELF SHIELDING IN RECTANGULAR AND CYLINDRICAL GEOMETRIES. Harold Schneider, Paul G. Saper, and Charles F. Kadow. April 1956. 40p. diagrs., tabs. (NACA TN 3661)

The steady-state diffusion approximation and the P_3 approximation of transport theory have been applied for a comparison of the neutron flux distributions and self-shielding factors for multiregion cells of rectangular and cylindrical geometries. These cells represent a given arrangement of moderator, fuel, and cladding; usually considered to be homogeneous. The effects of chemical binding in the water region of the cells were also studied and the results were compared with the cases where chemical binding was neglected. An electromechanical differential analyzer was used to solve the flux equations.

NACA TN 3663

DISCHARGE COEFFICIENTS FOR COMBUSTOR-LINER AIR-ENTRY HOLES. I - CIRCULAR HOLES WITH PARALLEL FLOW. Ralph T. Dittrich and Charles C. Graves. April 1956. 39p. diagrs. (NACA TN 3663)

An experimental investigation was conducted to determine the effects of hole diameter, wall thickness at hole, duct height, parallel-flow velocity, pressure ratio, boundary-layer thickness, and static-pressure level on the discharge coefficient for circular holes having flow parallel to the plane of the hole. Discharge coefficients, corrected for pressure-ratio effects, were correlated with a flow parameter. Within the ranges investigated, only the parallel-flow velocity and the static-pressure ratio across the hole had large effects on discharge coefficient.

NACA TN 3665

PERFORMANCE AND OPERATIONAL STUDIES OF A FULL-SCALE JET-ENGINE THRUST REVERSER. Robert C. Kohl. April 1956. 38p. diagrs., photo. (NACA TN 3665)

An axial-flow turbojet engine equipped with a hemispherical target thrust reverser was pylon-mounted beneath the wing of a cargo airplane. A maximum reverse-thrust ratio of 58 percent was produced. Reingestion of the reversed hot gases into the engine inlet overheated the engine and reduced the reverse-thrust ratio by as much as 25 percentage points. Taxi tests indicated that ground speeds up to 62 knots were required to overcome reingestion. Temperatures of nearly 400° F above ambient were measured on a simulated wing surface above the thrust reverser. The maximum rate of temperature rise was 28° F per second.

BRITISH REPORTS

N-41381*

Royal Aircraft Establishment (Gt. Brit.)
FORMULAE AND APPROXIMATIONS FOR AERODYNAMIC HEATING RATES IN HIGH SPEED FLIGHT. R. J. Monaghan. October 1955. 53p. diagrs. (RAE Tech. Note Aero 2407)

Formulas are based on the "intermediate enthalpy" approximation which has given good agreement with theoretical and experimental evidence. In the general flight case they could be used in conjunction with an analog computer or a step-by-step method of integration to predict the variations of heat flow and skin temperature with time. In the restricted case of flight at constant altitude and Mach number, simple analytical methods and results are given which include the effects of radiation and can be applied to "thick" as well as "thin" skins.

N-41383*

Royal Aircraft Establishment (Gt. Brit.)
FLOW SEPARATION IN THREE DIMENSIONS. E. C. Maskell. November 1955. 20p. diagrs. (RAE Aero 2565)

A generalized concept of flow separation is presented, and the conditions in the neighborhood of a line of separation are deduced. The resulting flow is shown to be composed of two basic elements (i) the free vortex layer and (ii) the bubble, each of which is identified by a characteristics pattern formed in the solid surface by the family of limiting streamlines. From the results of the analysis the physical structures of possible three-dimensional flows are readily inferred.

N-41393*

Royal Aircraft Establishment (Gt. Brit.)
SOME PROPERTIES OF CURVED PLANFORMS FOR SWEPTBACK WINGS AT SUBSONIC AND SUPERSONIC SPEEDS. G. G. Brebner and W. T. Lord. November 1955. 17p. diagrs. (RAE Tech. Note Aero 2417)

Entirely independent considerations of spanwise C_L distribution at subsonic speeds and of zero-lift wave drag at supersonic speeds suggest that curved plan forms may have advantages over conventional straight-edged plan forms for sweptback wings. Examples are constructed in which curved wings with nearly constant spanwise C_L distribution at subsonic speeds are shown to have theoretical zero-lift wave drags which are much more plausible than those calculated for comparable straight-edged wings over a wide range of Mach number.

N-42169*

Royal Aircraft Establishment (Gt. Brit.)
THEORY OF ASTRO-NAVIGATION AND DEVELOPMENT OF EQUIPMENT UP TO 1945. D. Martin. September 1955. 31p. diagrs., photos. (RAE IAP 1466; Monograph 2.5.07)

This monograph discusses the basic problems of aerial Astro-Navigation and describes the equipment used by the Royal Air Force during the war.

N-42170*

Royal Aircraft Establishment (Gt. Brit.)
DEVELOPMENT OF R.A.E. AIR AND OIL CHARGING VALVE. I. J. Vaughan. January 1955. 20p. diagrs., photo. (RAE Tech.Note Mech.Eng. 195)

The valve described was developed to replace the current A.G.S. 1200 inflation valve, for use in hydraulic and pneumatic systems at pressures up to 4,000 psi. A short account of previous designs and their disadvantages is given. Several new types are considered and the results of tests on them presented. The selection and testing of the final design are described and production difficulties discussed. Recommendations are made for the final testing of the valve with a view to full approval.

N-42171*

Royal Aircraft Establishment (Gt. Brit.)
SUPERSONIC FLOW PAST QUASI-CYLINDRICAL BODIES OF ALMOST CIRCULAR CROSS-SECTION. D. G. Randall. November 1955. 26p. diagrs., tabs. (RAE Tech.Note Aero 2404)

The supersonic flow over bodies for which the surface boundary condition may be satisfied on a circular cylinder is considered. The method is based on the linearized small-perturbation theory of supersonic flow. The disturbance velocity potential is obtained as a Fourier series each term of which contains a certain basic function and the first 11 of these functions are evaluated. The pressure distribution and wave drag have been calculated for some bodies consisting of circular cylinders surmounted by canopies. An extension of the method to solve certain wing-body interference problems is also described, but no numerical results have yet been obtained.

N-42172*

Royal Aircraft Establishment (Gt. Brit.)
MEASUREMENT OF THE CROSS FLOW AROUND AN INCLINED BODY AT A MACH NUMBER OF 1.91. D. J. Raney. January 1955. 29p. diagrs., photos. (RAE Tech. Note Aero 2357)

Measurements have been made in the upper (leeward) half of the cross flow plane of the upwash and sidewash around a body of revolution at 5 and 13 calibers downstream of the nose. Diagrams are given showing the resultant crossflow distribution at these two positions. At the rear position the crossflow caused by the vortex pair shed from the body, and their images has been derived by subtracting the incompressible potential crossflow around a two-dimensional circular cylinder from the measured crossflow. A corresponding theoretical crossflow due to the vortices has been estimated assuming infinitely long subsonic vortices of constant strength. The absolute magnitudes of the derived and theoretical crossflows could not be compared directly as the vortex circulation could not be reliably estimated. However, the direction and relative magnitude throughout the flow field of these derived and theoretical crossflows are in good agreement, except close to the vortices and at positions where very large crossflows existed. Experimental accuracy was inadequate at these positions. Results of these tests do not explain recent normal force measurements which showed a reduction in slope near 10° incidence of the curve of normal force on a control mounted on a body, due to the presence of the body.

N-42173*

Royal Aircraft Establishment (Gt. Brit.)
SOME TESTS OF THE SPREAD OF VELOCITY IN A COLD JET DISCHARGING WITH EXCESS PRESSURE FROM A SONIC EXIT INTO STILL AIR. J. Seddon and L. Haverty. November 1955. 16p. diagrs., photos. (RAE Tech.Note Aero 2400)

The spread of the half-velocity circle in a jet discharging with excess pressure from a length of parallel pipe into still air has been examined over the range 40 to 200 diameters from the exit. Jet pressure ratios (outside static pressure ÷ jet total pressure) were from 0.479 to 0.042, corresponding to isentropic Mach numbers from 1.08 to 2.72. It is found that rates of spread are not greatly different from that for a subsonic jet. The effective exit of an underexpanded jet is, however, displaced some distance downstream of the actual exit. For a jet of isentropic Mach number 1.51, the effective exit position is about 8 diameters downstream and the half-velocity circles lie on a cone of semiangle 5.7^{o} from the center of the effective exit.

N-42174*

Royal Aircraft Establishment (Gt. Brit.)
IMPINGEMENT OF WATER DROPLETS ON AEROFOILS. F. J. Bigg and J. E. Baughen. September 1955. 60p. diagrs., tabs. (RAE Tech.Note Mech. Eng. 208)

An analysis of published American data on the catch of droplets on airfoils in cloud shows that the collection efficiency is a function of a dimensionless parameter, the thickness/chord ratio and the frontal projected thickness of the airfoil, and this is used to extrapolate the existing data.

N-42175*

Royal Aircraft Establishment (Gt. Brit.)
AEROELASTIC NUMBER. S. Neumark, A. S. Taylor, and H. H. B. M. Thomas. August 1955. 11p. (RAE Tech.Note Aero 2389)

A proposal is made for the introduction of a non-dimensional aeroelastic number (ϵ) which, used in conjunction with Mach number and Reynolds number, permits the development of a consistently non-dimensionalized expression for the static margin (K_n) of an aircraft in the case where the aerodynamic coefficients are dependent on speed through compressibility, viscosity and aeroelastic distortion effects. Although ϵ may not appear explicitly in the corresponding expressions for other stability and control criteria, such as the maneuver margin (H_m), the various derivatives appearing in such expressions will, like those occurring in K_n, usually be functions of ϵ. Accordingly, the general use of the aeroelastic number in the presentation of the results of aeroelastic calculations and measurements is advocated.

N-42176*

Royal Aircraft Establishment (Gt. Brit.)
THE CALCULATION OF THE SPANWISE LOADING OF SWEPTBACK WINGS WITH FLAPS OR ALL-MOVING TIPS AT SUBSONIC SPEEDS. G. G. Brebner and D. A. Lemaire. September 1955. 54p. diagrs., tabs. (RAE Aero 2553)

The results of some electric tank tests by Duquenne and Grandjean on wings of 45° sweepback with trailing edge flaps have been analyzed to provide the basis for a method of calculating the spanwise loading. The analysis yielded information about the effect of sweep on the equivalent incidence of a section with flap, on the downwash factor and on the spanwise loading distribution with an incidence discontinuity. Interpolation formulas are developed to extend the results to wings of any sweep and flap span, and thus a complete calculation method is presented for the spanwise loading with this type of control. The calculation method is tentatively extended to a wing with all-moving tip control, and the results compared with those of Thomas and Mangler. There is a marked discrepancy between the two calculations. Further electric tank tests to fill this and other gaps are suggested.

N-42179*

Marine Aircraft Experimental Establishment (Gt. Brit.) WIND TUNNEL TESTS ON SEAPLANE HULLS IN THE R. A. E. 5FT DIAMETER OPEN JET TUNNEL AND THE N. P. L. COMPRESSED AIR TUNNEL. A. G. Smith. January 1955. 76p. diagrs., photos., tabs. (MAEE F/Res/266)

Results of research work done in Britain and the following reports on the measurement and analysis of the air drag of seaplane hulls are collected in this report. Wind tunnel and tank tests on the drag of seaplane hulls, by K. W. Clark and D. Cameron. Resistance measurements on seaplane hulls in the compressed air tunnel, by R. Jones, A. H. Bell, and E. Smyth. Tests on a flying boat hull with faired steps in the compressed air tunnel, by R. Jones and A. F. Brown. Drag measurements on a model of a flying boat hull in the c. a. t. by R. Jones, A. H. Bell, and A. F. Brown.

N-42180*

Royal Aircraft Establishment (Gt. Brit.)
PREPARATION AND PROPERTIES OF HIGH TEMPERATURE PYROLYTIC CARBON. A. R. G. Brown. June 1955. 59p. diagrs., photos., tabs. (RAE Met. 87)

A method for preparing massive specimens of carbon by the breakdown of hydrocarbon gases at various temperatures and subatmospheric pressures is described. The rate of deposition, density, electrical resistivity, and thermal conductivity of the deposits are found to be dependent on temperature of deposition. For deposits produced at 1800° C the density is 1.35 g/cm^3, the electrical resistivity 22 x 10^{-6} ohm cms, and thermal conductivity 0.06 g cal cm/cm^2 °C sec; the corresponding values for material formed at 2100° C are 2.23 g/cm^3, 200 x 10^{-6} ohm cms, and 1.3 g cal cm/cm^2 °C sec. The structure of the deposits is of layer planes of hexagonally arranged carbon atoms lying parallel to the surface of the original substrate, but otherwise randomly oriented.

N-42181*

National Gas Turbine Establishment (Gt. Brit.) TRANSIENT THERMAL STRESSES IN BRITTLE CIRCULAR CYLINDERS. E. Glenny and P. W. H. Howe. January 1956. 33p. diagrs., photos., tabs. (NGTE Memo. M. 259)

A method of calculating the transient thermal stresses produced in brittle circular cylinders by rapid cooling has been developed. The validity of the theory has been tested by experiment, using high-alumina cylinders of varying diameter and a fluidized bed as the cooling medium. The preliminary tests show that the theory is substantially correct. Further experiments are necessary to determine whether the theory can be used to predict the thermal shock behavior of brittle circular cylinders in a variety of materials.

N-42182*

Royal Aircraft Establishment (Gt. Brit.)
THE PRESSURE DISTRIBUTION ON AN UNSWEPT WING WITH VARIOUS ARRANGEMENTS OF SPLIT FLAP. J. A. Lawford. July 1955. 62p. diagrs., tabs. (RAE Tech.Note Aero 2384)

This note presents pressure plotting data for a 5-percent chord flap on a two-dimensional wing at various angles of incidence. The angle, aspect ratio, and chordwise position of the flap are varied. A few measurements are also given for a flap of 2-1/2 percent chord at an angle of 90°, at one chordwise position. The data are available for checking any theoretical work on the interaction between wing and flap pressure fields. It is shown that the work needs supplementing by further measurements on each side of the flap, and by some velocity measurements. These will follow.

N-42183*

Royal Aircraft Establishment (Gt. Brit.)
SEBALKYD DOUGHS. A. C. Cornwell. October 1955. 11p. tabs. (RAE Tech.Note Chem.1265)

A gap-filling material which will expand and harden in situ without external heating has been developed for cases where the cavity to be filled renders the normal technique of pouring or injection difficult. By loading the foam with inorganic filler and using an alkyd resin with an acid number of 5-25, a dough-like material can be made which has a working life of 15-60 minutes and which will expand 2-3 times in a few hours after mixing, giving a material with a density ranging from 25-65 lb/cu ft. After mixing, the dough can be frozen by immersion in liquid air or powdered solid carbon dioxide. The resulting hard solid can be kept in the freezing mixture for a few days and will only expand and complete its cure when allowed to warm up.

N-42184*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF WATER ON THE POROSITY OF PARACHUTE FABRICS. PART 2. J. E. Swallow. October 1955. 11p. diagrs., tabs. (RAE Tech.Note Chem. 1268)

The porosity of wet fabrics has been measured by introducing a water spray into the airstream of the testing instrument. For nylon (plain and mock-leno weave), Fortisan and Terylene, the pressure on wet fabric exceeded that on dry fabric at the same air flow by an amount equal to, or slightly greater than, the threshold pressure determined by surface tension and pore size.

N-42193*

Royal Aircraft Establishment (Gt. Brit.)
SOME ELECTRICAL AND ELECTRONIC CIRCUITS IN FLIGHT TEST INSTRUMENTATION. G. E. Bennett. September 1955. 48p. diagrs. (RAE Tech. Note Instn.149)

When an electromechanical transducer is used as the sensing device in instrumentation, an electrical or electronic circuit is usually either essential or desirable to modify the transducer output, with or without amplification, before it is recorded. The operations required include the conversion of the transducer output into a voltage or current, the combination of two or more outputs, amplification, removal of unwanted frequencies, integration and differentiation, and the extension of the frequency range of the transducer. The note deals, in a general way, with each of these operations and indicates the relative merits of the basic circuits used. No treatment of the detailed design of any of the circuits is given.

N-42194*

Royal Aircraft Establishment (Gt. Brit.)
A VISIT TO SWITZERLAND TO ATTEND THE XIVth INTERNATIONAL CONGRESS OF PURE AND APPLIED CHEMISTRY. E. J. P. Fear and N. J. L. Megson. Appendix 2: VAPOUR PHASE FLUORINATION OF HYDROCARBONS WITH MANGANIC FLUORIDE. E. J. P. Fear, J. Thrower, and J. Veitch. (Appendix read at Congress, July 21-27, 1955). October 1955. 15p. (RAE Tech.Note Chem. 1266)

This note is an account of a visit made by the authors to Switzerland as representatives of the Ministry of Supply at the XIVth International Congress of Pure and Applied Chemistry. Brief notes are given of certain scientific papers read at the Congress and of a visit to J. R. Geigy, Ltd., Basle. Some general impressions of the whole proceedings are presented.

N-42195*

Royal Aircraft Establishment (Gt. Brit.)
THE COMPRESSION STRENGTH OF ALUMINUM ALLOY SHEET MATERIALS TO SPECIFICATIONS D.T.D.546B, D.T.D.646B, AND D.T.D.687A. M. J. Henwood. October 1955. 22p. diagrs., tabs. (RAE Tech.Note Structures 176)

Compression strength tests on aluminum alloy sheet materials to specifications D.T.D.546B, D.T.D.646B, and D.T.D.687A are described and the results analyzed statistically. Typical compression stress-strain curves and curves of tangent modulus are presented for each material.

N-42196*

Royal Aircraft Establishment (Gt. Brit.)
FORMULAE AND DIAGRAMS FOR THE CALCULATION OF OPEN IMPELLER CENTRIFUGAL PUMPS. U. M. Barske. September 1955. 16p. diagrs. (RAE Tech.Note RPD 127)

The principles underlying the design of open impeller centrifugal pumps have been described in a previous note. Here the formulas developed are briefly recapitulated, and charts to facilitate the determination of the dimensions of a pump for a specified duty are given; among these is a chart for rapid estimation of the impeller disk friction losses for liquids over a wide range of physical properties.

N-42298*

Royal Aircraft Establishment (Gt. Brit.)
AN OSCILLATOR, POWER AMPLIFIER AND ELECTRONIC FILTER USED FOR DETERMINING THE TRANSFER FUNCTIONS OF ELECTRICAL MACHINES. R. J. K. Splatt. August 1955. 10p. diagrs. (RAE Tech.Note EL.96)

This note describes some auxiliary electronic circuits used for determining transfer functions of electrical machines, by superimposing various sinusoidal alternating currents on a steady d-c value, and includes details of a sharply tuned electronic filter which has been found necessary in this kind of measurement, and which may have application elsewhere.

N-42302*

Royal Aircraft Establishment (Gt. Brit.)
THE AXIAL DECAY AND RADIAL SPREAD OF A SUPERSONIC JET EXHAUSTING INTO AIR AT REST. J. H. Frauenberger and J. G. Forbister. December 1955. 32p. diagrs., photos., tabs. (RAE RPD 34)

The distribution of total pressure, stagnation temperature and gas velocity is determined for the subsonic region of a supersonic jet emerging from a solid propellant rocket motor into air at rest. Measurements of pitot pressures in the supersonic flow region have shown that the flow follows the axis of an inclined nozzle within the order of accuracy of the measurements. Nozzle cone angle and probably the expansion ratio affect the jet distribution significantly.

N-42305*

Royal Aircraft Establishment (Gt. Brit.)
THE STRUCTURAL EFFECTS OF KINETIC HEATING IN SUPERSONIC FLIGHT. Percy B. Walker. (Presented at 5th General Assembly of AGARD, Ottawa, Canada, June 1955 and published in the Journal of the Royal Aeronautical Society, September 1955). October 1955. 14p. diagrs., photo. (RAE Structures 189)

The structural problems presented by kinetic heating are reviewed in broad terms. A simplified structure with a simplified thermal system is first assumed. The adverse effects of kinetic heating are listed and analyzed. The difficulties to be encountered are discussed together with possible remedial measures. The prospects for thermal insulation and artificial cooling are given particular consideration. Some notes are also given on developments in thermal-structural testing. Finally the prospects of extending the thermal frontiers of speed are reviewed.

N-42306*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF SODIUM STANNATE AND OTHER STABILIZERS ON THE PHOTOLYTIC DECOMPOSITION OF H.T.P. (85 PERCENT W/W HYDROGEN PEROXIDE). D. Sutton. December 1955. 13p. diagrs. (RAE Tech.Note RPD 137)

The photolytic decomposition of 85 percent w/w hydrogen peroxide in the presence of small amounts of various stabilizers has been studied. Sodium stannate was found to be the only stabilizer which appreciably reduced the rate of the photolytically induced decomposition. It is inferred from this that sodium stannate is effective as a radical chain terminator probably by adsorption of free radicals on the surface of the colloidal hydrated stannic oxide which is known to be formed when sodium stannate is added to strong solutions of hydrogen peroxide. The rates of decomposition of 85 percent w/w hydrogen peroxide solutions containing small amounts of catalytic ions and stabilizers have also been studied.

N-42314*

Royal Aircraft Establishment (Gt. Brit.)
THE DETERMINATION OF VANADIUM IN TITANIUM ALLOYS. E. G. Cobb and H. J. Allsopp. November 1955. 8p. diagr., tabs. (RAE Tech.Note Met.230)

The method describes a rapid and accurate volumetric determination of Vanadium in Titanium Alloys using an internal indicator. The effect of various alloying constituents has been studied.

N-42332*

Royal Aircraft Establishment (Gt. Brit.)
THE FLAME PHOTOMETRIC DETERMINATION OF LITHIUM USING INFRA-RED BARRIER-LAYER CELLS. H. J. Allsopp and P. M. Wingfield. October 1955. 15p. diagrs., photo., tabs. (RAE Met.90)

Lithium is determined using potassium as an internal standard with a town-gas and air flame. The report describes a double-beam instrument modified to incorporate infra-red barrier-layer cells which have peak response in the region of the lithium and potassium major lines. Long-term stability tests on the photo-cells were carried out and the effects of alloying constituents and acidity in the final solution have been studied. A method for determining lithium in magnesium-lithium-zinc alloys is given.

N-42334*

National Gas Turbine Establishment (Gt. Brit.)
AN INVESTIGATION OF THE TIME RESPONSE OF THE N.G.T.E. SONIC PYROMETER.
D. W. Willshire. November 1955. 26p. diagrs., photos. (NGTE Memo.M.254)

Time constants of the pyrometer with a chromel-alumel thermocouple of 0.01 inch diameter have been computed over a pressure range of 5 to 120 lb/in.^{2} abs and a temperature range of 300° to 1500° K. Validity of these theoretical results has been checked by experimental tests on two models of the pyrometer, the "rig" and "aircraft" types, over a range of pressures and using air at ambient temperature as the gas. Time constants of a pyrometer with a platinum, platinum-rhodium thermocouple of 0.01 inch diameter have also been computed over a pressure range of 5 to 120 lb/in.^{2} abs and a temperature range of 900° to 1800° K. Graphs of the computed results, the comparison between experimental and theoretical values, and the variation of time constant with wire diameter are shown.

N-42335*

Royal Aircraft Establishment (Gt. Brit.)
SOME OBSERVATIONS ON THE DEFORMATION OF GRAINS AND BOUNDARIES IN PURE ALUMINUM AND THREE BINARY ALUMINUM ALLOYS.
P. J. E. Forsyth and J. C. Terry. July 1955. 14p. diagr., photos. (RAE Tech.Note Met.225)

A small straining device has been constructed which can apply a tensile stress to an electropolished specimen at room temperature, or if required, immersed in liquid nitrogen. With this device variations in deformation behavior with temperature have been investigated. The effect of grain size has also been studied and comparisons made with the deformation produced by fatigue stresses.

N-42336*

National Gas Turbine Establishment (Gt. Brit.) MIXING AND THE JET FLAP. B. S. Stratford and N. A. Dimmock. October 1955. 45p. diagrs., photos., tabs. (NGTE Memo.M.250)

The "Jet Flap" is a means for producing high lift on aircraft. One of the main problems associated with the jet flap concerns the differences in thrust between idealized theory and experimental results. These differences are attributable to the mixing (with the surrounding flow) of the thin two-dimensional jet, this mixing occurring very close to the airfoil. To a first approximation the effect of the mixing on the thrust may be calculated from a simple formula, derivable from first principles. Second order effects, which can be significant, may be considered quantitatively.

N-42337*

Marine Aircraft Experimental Establishment (Gt. Brit.) INVESTIGATION OF HIGH LENGTH/BEAM RATIO SEAPLANE HULLS WITH HIGH BEAM LOADINGS. HYDRODYNAMIC STABILITY. PART 20. THE EFFECT OF SLIPSTREAM ON STABILITY AND SPRAY CHARACTERISTICS. D. M. Ridland. September 1955. 56p. diagrs., photos., tabs. (MAEE F/Res/256)

The effects of slipstream on longitudinal stability, spray and elevator effectiveness are deduced from tests on four configurations of the basic model of the series which differed only in aerodynamic details. It was found that in general increases in thrust coefficient improved longitudinal stability, spray characteristics and elevator effectiveness. A method of applying the detailed results to the stability limits of other models of the series is outlined.

MISCELLANEOUS

N-41796

Advisory Group for Aeronautical Research and Development. DYNAMIC MEASUREMENTS IN WIND TUNNELS. Lee Arnold, Lee Arnold Associates, Inc. August 1955. (v), 68p. diagrs. (AGARDograph 11)

The state of the art of measuring unsteady aerodynamic forces and of testing dynamically similar models in the wind tunnel, both from the standpoint of dynamic stability and flutter, is presented. Model construction, instrumentation, and scale effects are discussed. Accepted procedures developed in the various NATO countries are described and possible alternate procedures suggested.

N-41828

NOTES ON CORRELATION OF MODEL AND FULL-SCALE SPIN AND RECOVERY CHARACTERISTICS. Melvin N. Gough. (Presented to Joint Meeting of AGARD Flight Test and Wind-Tunnel Panels, Rome, Italy, February 1956). 23p. diagrs., photos., tabs.

N-41829

TIRE-RUNWAY BRAKING FRICTION COEFFICIENTS. Melvin N. Gough, Richard H. Sawyer and James P. Trant, Jr. (Presented to Joint Meeting of AGARD Flight Test and Wind-Tunnel Panels, Rome, Italy, February 1956). 32p. diagrs., photos.

N-41866

Advisory Group for Aeronautical Research and Development. PROCEEDINGS OF THE FIFTH AGARD GENERAL ASSEMBLY, JUNE 15 AND 16, 1955. (Presented at Canadian AGARD Conference, June 10-17, 1955). 157p. diagrs., photos., tabs. (Advisory Group for Aeronautical Research and Development. AG20/P10)

Contents: History of aeronautical research and development in Canada. J. H. Parkin, National Aeronautical Establishment. RCAF development of automatic navigation system. J. G. Wright, Royal Canadian Air Force. Advancing temperature frontiers. (Round table discussion.) Aerodynamic heating versus speed: Thermodynamic aspects of the struggle. (Aspects thermodynamiques de la lutte pour surmonter les obstacles thermiques a la progression de la vitesse.) Maurice Roy, O.N.E.R.A. The structural effects of kinetic heating in supersonic flight. Percy B. Walker, Royal Aircraft Establishment. Man's response to temperature extremes. A. P. Gagge, United States Air Force. Where are the limits of combustion intensity? J. J. Broeze, Royal Dutch/Shell Laboratory. Aerolastic effects of aerodynamic heating. Hugh L. Dryden and John E. Duberg, National Advisory Committee for Aeronautics. Increasing the NATO research and development potential. (Round table discussion.) Reports of panel chairmen.

NACA TN 3202

Errata on "OSCILLATING PRESSURES NEAR A STATIC PUSHER PROPELLER AT TIP MACH NUMBERS UP TO 1.20 WITH SPECIAL REFERENCE TO THE EFFECTS OF THE PRESENCE OF THE WING." Harvey H. Hubbard and Leslie W. Lassiter.

NACA TN 3591

Errata on "INVESTIGATION OF FAR NOISE FIELD OF JETS. II - COMPARISON OF AIR JETS AND JET ENGINES." Willard D. Coles and Edmund E. Callaghan. January 1956.

UNPUBLISHED PAPERS

N-43013*

COMPLETE REPRESENTATION OF THE TURBULENT VELOCITY DISTRIBUTION IN SMOOTH PIPES. (Vollständige Darstellung der turbulenten Geschwindigkeits-verteilung in glatten Leitungen). H. Reichardt. February 1956. 23p. diagrs. (Trans. from Zeitschrift für angewandte Mathematik und Mechanik, v. 31, no. 7, July 1951, p. 208-219)

On the basis of experimental investigations of turbulent exchange of momentum, a formula has been derived for the velocity of turbulent flows in pipes and channels. This formula gives a complete representation of the velocity distribution over a radius, that is, it is approximately valid for the immediate vicinity of the wall as well as for the core of the flow cross section.

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NACA MR L5L03

SEMINAR HELD AT WRIGHT FIELD ON SEPTEMBER 6, 1945.

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NACA MR L5L12a
NACA MR L6D05
NACA MR L6D15
NACA MR L6F25
NACA RM 9D06
NACA RM 50L11

NACA RM A50D06

FLIGHT DETERMINATION OF THE EFFECTS OF RUDDER-PEDAL-FORCE CHARACTERISTICS ON THE AIMING ERROR IN AZIMUTH OF A CONVENTIONAL FIGHTER AIRPLANE. Lee Winograd and Rudolph D. Van Dyke, Jr. July 5, 1950. 32p. diagrs., photos., tab. (NACA RM A50D06)

The effect on pilot-azimuth tracking ability of a change in the rudder-pedal-force characteristics of a conventional fighter airplane was studied. Simulated gunnery runs were made on both stationary and moving targets with the normal rudder and with a rudder modified to produce approximately zero pedal-force variation with sideslip. The effect of the modification on mean azimuth tracking error was insignificant, but it was fatiguing to fly the airplane for any length of time.

NACA RM A51C19

AN ANALYSIS OF THE EFFECTS OF AEROELASTICITY ON STATIC LONGITUDINAL STABILITY AND CONTROL OF A SWEPT-BACK-WING AIRPLANE. Richard B. Skoog. August 1951. 45p. diagrs. (NACA RM A51C19)

A theoretical analysis of the effects of aeroelasticity on the stick-fixed static longitudinal stability and elevator angle required for balance of an airplane is presented together with calculated effects for a swept-wing bomber of relatively high flexibility. Although large changes in stability due to certain parameters are indicated for the example airplane, the overall stability change after considering all parameters was quite small, compared to the individual effects, due to the counterbalancing of wing and tail contributions. The effect of flexibility on longitudinal control for the example airplane was found to be of little real importance.

NACA RM A51D27

CHARACTERISTICS THROUGHOUT THE SUBSONIC SPEED RANGE OF A PLANE WING AND OF A CAMBERED AND TWISTED WING, BOTH HAVING 45° OF SWEEPBACK. Ben H. Johnson, Jr., and Harry H. Shibata. July 1951. 122p. diagrs., photos. (NACA RM A51D27)

Presented in this report are results of tests at Mach numbers from 0.25 to 0.94 of two 45° sweptback wings of identical plan form. The plane wing had NACA 64A010 sections normal to the quarter-chord line and the cambered and twisted wing had NACA 64A810, a = 0.8 modified sections normal to the quarter-chord line, and 8.7° of washout at the tip. At Mach numbers between 0.70 and 0.94, the maximum Reynolds number was 2,000,000 and at a Mach number of 0.25, the maximum Reynolds number was 10,000,000. The effects of the addition of a fuselage, of chordwise fences, and of surface roughness were also investigated.

NACA RM A52D01

AN INVESTIGATION THROUGHOUT THE SUBSONIC SPEED RANGE OF A FULL-SPAN AND A SEMI-SPAN MODEL OF A PLANE WING AND OF A CAMBERED AND TWISTED WING, ALL HAVING 45° OF SWEEPBACK. Harry H. Shibata, Angelo Bandettini, and Joseph Cleary. June 1952. 65p. diagrs., photos. (NACA RM A52D01)

This report presents results of tests of full-span and semispan models at Mach numbers from 0.25 to 0.92 of two 45° sweptback wings of identical plan form. The plane wing had NACA 64A010 sections normal to the quarter-chord line and the cambered and twisted wing had NACA 64A810, a = 0.8 modified sections normal to the quarter-chord line, and 9.4° of washout at the tip. The test Reynolds number was varied from 1,000,000 to 10,000,000 at a Mach number of 0.25, and the Mach number was varied from 0.25 to 0.92 at constant Reynolds numbers of 1,000,000 and 2,000,000. In addition, the full-span model was tested throughout the same Mach number range at Reynolds numbers varying from 2,000,000 to 4,900,000. The effect of surface roughness was also investigated.

NACA RM A53D14

THE LOW-SPEED LIFT AND DRAG CHARACTERISTICS OF A SERIES OF AIRPLANE MODELS HAVING TRIANGULAR OR MODIFIED TRIANGULAR WINGS. David Graham. June 1953. 49p. diagrs., photo., tabs. (NACA RM A53D14)

Three triangular wings of aspect ratios 2, 3, and 4 and two modified triangular wings of aspect ratio 2 having taper ratios of 0.20 and 0.33 were each tested in combination with a high-fineness-ratio fuselage, a triangular vertical tail, and an unswept, all-movable horizontal tail. The tests were conducted in the Ames 40- by 80-foot wind tunnel at Reynolds numbers from approximately 11×10^6 to 15×10^6. The experimental lift and drag characteristics are compared with existing theory. The relative merits of the models with respect to wing loading attainable at given landing conditions are investigated.

NACA RM A53D21

TESTS IN THE AMES 40- BY 80-FOOT WIND TUNNEL OF AN AIRPLANE CONFIGURATION WITH A VARIABLE-INCIDENCE TRIANGULAR WING AND AN ALL-MOVABLE HORIZONTAL TAIL. David G. Koenig. June 1953. 42p. diagrs., photo., tabs. (NACA RM A53D21)

Force tests were made for various wing incidences with and without the horizontal tail. Characteristics at zero sideslip for four wing incidences were obtained with the tail off and with the tail located at each of three vertical positions. Characteristics of the model in sideslip were obtained with the wing at 10° incidence for two combinations of flap and horizontal-tail settings. The average Reynolds number based on the mean aerodynamic chord was 14.7 million, and the Mach number was 0.13.

NACA RM E9K30

EXPERIMENTAL INVESTIGATION OF THRUST AUGMENTATION OF 4000-POUND-THRUST AXIAL-FLOW-TYPE TURBOJET ENGINE BY INTERSTAGE INJECTION OF WATER-ALCOHOL MIXTURES IN COMPRESSOR. John H. Povolny, James W. Useller, and Louis J. Chelko. April 6, 1950. 42p. diagrs., photos., tab. (NACA RM E9K30)

Experimental thrust-augmentation investigation of 4000-pound-thrust axial-flow-type turbojet engine by interstage injection of water-alcohol mixtures in the compressor was conducted at sea-level, zero-ram conditions. The number, size, and arrangement of interstage nozzles were varied to produce satisfactory augmentation system of minimum complication. Four water-alcohol mixtures with varying alcohol concentration were investigated. An augmented thrust ratio of 1.22 was obtained with injection of 6.5 pounds per second of water-alcohol mixture for a corrected engine inlet-air temperature of 80° F when using a simple injection system, which introduced no loss in normal thrust.

NACA RM E50D17

EXPERIMENTAL INVESTIGATION OF THRUST AUGMENTATION OF 4000-POUND-THRUST CENTRIFUGAL-FLOW-TYPE TURBOJET ENGINE BY BLEEDOFF. William L. Jones and Louis J. Bogdan. July 3, 1950. 30p. diagrs., photo. (NACA RM E50D17)

Thrust augmentation by bleedoff was investigated at zero flight-speed, sea-level conditions on a 4000-pound-thrust centrifugal-flow-type turbojet engine. In the bleedoff cycle, the secondary combustion air was bled off from the combustion chambers and ducted into an auxiliary combustion chamber where it was heated to a high temperature and discharged through an auxiliary nozzle. Augmented thrust of 1.8 times the normal thrust was obtained by this method with a total liquid flow of about 13 times the unaugmented fuel flow.

#NACA RM E51C21

NACA RM E53D15

CARBON DEPOSITION OBTAINED WITH MIL-F-5624A FUELS IN A SINGLE COMBUSTOR AND IN THREE FULL-SCALE ENGINES. Jerrold D. Wear. June 1954. 20p. diagrs., photo., tabs. (NACA RM E53D15)

Investigations were conducted in a full-scale single turbojet combustor and in three full-scale engines with several MIL-F-5624A grade JP-3 and JP-4 fuels. Fuels that gave an increase in carbon deposition in the single combustor also gave an increase in the corresponding full-scale engine. Fuels producing deposits in excess of 7 to 9 grams in the single combustor (1) operated satisfactorily with respect to combustor deposit in the corresponding full-scale engine, (2) caused marginal operation in one of the two additional full-scale engines, and (3) caused excessive exhaust smoke in both the additional full-scale engines.

NACA RM E53E18

EXPERIMENTAL INVESTIGATION OF AIR-COOLED TURBINE BLADES IN TURBOJET ENGINE. XIII - ENDURANCE EVALUATION OF SEVERAL PROTECTIVE COATINGS APPLIED TO TURBINE BLADES OF NONSTRATEGIC STEELS. Edward R. Bartoo and John L. Clure. July 1953. 40p. photos., diagrs., tabs. (NACA RM E53E18)

Four types of protective coatings (ceramic, nickel, Nicrobraz, and aluminized) were applied to 20 air-cooled turbine blades of either SAE 4130 or Timken 17-22A(S) steel and endurance-tested in a turbojet engine at maximum rated speed and turbine inlet temperature. Coolant-flow ratios between 0.030 and 0.048 were employed. Ceramic, aluminized, Nicrobraz, and a combination of nickel and Nicrobraz coatings each provided corrosion and erosion protection to at least one blade for periods of operation totaling 100 hours or more.

NACA RM L8D16

FREE-FLIGHT INVESTIGATION OF THE ROLLING EFFECTIVENESS OF SEVERAL DELTA WING - AILERON CONFIGURATIONS AT TRANSONIC AND SUPERSONIC SPEEDS. Carl A. Sandahl. August 27, 1948. 19p. diagrs., photos., tab. (NACA RM L8D16)

The rolling-effectiveness characteristics of several delta-wing—aileron configurations, obtained by means of rocket-propelled test vehicles in free flight at transonic and supersonic speeds, are presented. The experimental results are compared with calculated results from methods based on the linearized supersonic-flow equations.

NACA RM L9D12

EFFECTS OF SOME AIRFOIL-SECTION VARIATIONS ON WING-AILERON ROLLING EFFECTIVENESS AND DRAG AS DETERMINED IN FREE FLIGHT AT TRANSONIC AND SUPERSONIC SPEEDS. Carl A. Sandahl, William M. Bland, Jr., and H. Kurt Strass. July 22, 1949. 29p. diagrs., photos., tabs. (NACA RM L9D12)

An experimental investigation has been made in free flight of the rolling effectiveness of plain ailerons in conjunction with wings employing several airfoil sections having 0° and 45° sweepback. The total drag of the test vehicles was also obtained.

NACA RM L50C01

WING-DROPPING CHARACTERISTICS OF SOME STRAIGHT AND SWEPT WINGS AT TRANSONIC SPEEDS AS DETERMINED WITH ROCKET-POWERED MODELS. David G. Stone. May 26, 1950. 12p. diagrs., tab. (NACA RM L50C01)

Lateral-trim change or wing dropping has occurred on several rocket-powered models used in roll investigations at transonic speeds. The wing configurations investigated show the effects of airfoil section, aspect ratio, and sweepback on wing dropping.

NACA RM L50D17

ROLLING EFFECTIVENESS OF A THIN TAPERED WING HAVING PARTIAL-SPAN AILERONS AS DETERMINED BY ROCKET-POWERED TEST VEHICLES. Carl A. Sandahl and H. Kurt Strass. May 23, 1950. 12p. diagrs., photo. (NACA RM L50D17)

The rolling effectiveness of partial-span plain ailerons on an essentially unswept wing having a thickness ratio of 0.045, a taper ratio of 0.4, and an aspect ratio of 2.91 has been determined by means of rocket-powered test vehicles. Good agreement was obtained with theoretical results from NACA TN 1890 which considers the effects of wing elasticity.

NACA RM L50D26

LARGE-SCALE FLIGHT MEASUREMENTS OF ZERO-LIFT DRAG AT MACH NUMBERS FROM 0.86 TO 1.5 OF A WING-BODY COMBINATION HAVING A 60° TRIANGULAR WING WITH NACA 65A003 SECTIONS. Robert L. Nelson. June 1, 1950. 10p. diagrs., photos., tab. (NACA RM L50D26)

Flight tests were made at high-subsonic and supersonic speeds and at high Reynolds numbers to determine the zero-lift drag of a fin-stabilized body and a wing-body configuration. The 60° triangular wing had NACA 65A003 airfoil sections. The body was parabolic in profile, had a fineness ratio of 10 and a ratio of body frontal area to wing area of 0.0306.

NACA RM L51C22

COMPARISONS OF THE EFFECTIVENESS AND HINGE MOMENTS OF ALL-MOVABLE DELTA AND FLAP-TYPE CONTROLS ON VARIOUS WINGS. David G. Stone. April 19, 1951. 13p. diagrs. (NACA RM L51C22)

A comparative evaluation was made for all-movable delta and flap-type controls on several wing plan forms. Comparison of these experimental results from various test facilities shows the effectiveness on various wing plan forms and an evaluation of hinge-moment characteristics of all-movable delta controls, swept trailing-edge flap, and straight trailing-edge flap-type controls.

NACA RM L51D13

AERODYNAMIC CHARACTERISTICS OF FOUR WINGS OF SWEEPBACK ANGLES 0°, 35°, 45°, AND 60°, NACA 65A006 AIRFOIL SECTION, ASPECT RATIO 4, AND TAPER RATIO 0.6 IN COMBINATION WITH A FUSELAGE AT HIGH SUBSONIC MACH NUMBERS AND AT A MACH NUMBER OF 1.2. Arvo A. Luoma. June 6, 1951. 59p. diagrs., photo., tab. (NACA RM L51D13)

Aerodynamic characteristics of a series of swept-back wings mounted on a common fuselage without tail surfaces at subsonic Mach numbers up to approximately 0.95 and at a Mach number of 1.2 are presented. All the wings had NACA 65A006 airfoil sections, an area of 1 square foot, an aspect ratio of 4, and a taper ratio of 0.6.

NACA RM L51D18a

SOME EFFECTS OF SPANWISE AILERON LOCATION AND WING STRUCTURAL RIGIDITY ON THE ROLLING EFFECTIVENESS OF 0.3-CHORD FLAP-TYPE AILERONS ON A TAPERED WING HAVING 63° SWEEPBACK AT THE LEADING EDGE AND NACA 64A005 AIRFOIL SECTIONS. H. Kurt Strass, E. M. Fields, and Eugene D. Schult. June 1951. 25p. diagrs., photo., tab. (NACA RM L51D18a)

This paper presents some effects of aileron spanwise location and wing structural rigidity on the rolling power of 0.3-chord plain, flap-type ailerons on a wing with a taper ratio of 0.25, aspect ratio of 3.5, and swept back 63° at the leading edge. The results show that for rigid wings the aileron spanwise location is an important consideration, with the maximum rolling effectiveness per unit span occurring at approximately midexposed span. The large effect of wing flexibility on rolling effectiveness for this wing is demonstrated by the fact that for solid aluminum alloy construction the loss of control effectiveness of an outboard 0.50-semispan aileron exceeds 30 percent of the rigid-wing value at $M \approx 1.4$.

NACA RM L51D25

SOME EFFECTS OF FUSELAGE INTERFERENCE, WING INTERFERENCE AND SWEEPBACK ON THE DAMPING IN ROLL OF UNTAPERED WINGS AS DETERMINED BY TECHNIQUES EMPLOYING ROCKET-PROPELLED VEHICLES. William M. Bland, Jr., and Albert E. Dietz. October 1951. 27p. diagrs., photos. (NACA RM L51D25)

Some effects of fuselage interference, wing interference, and sweepback on the damping-in-roll characteristics of untapered wings with an aspect ratio of 3.7 and NACA 65A009 airfoil sections were obtained in the Mach number range between 0.6 and 1.7 by use of techniques which employed rocket-propelled test vehicles. It is shown that the damping in roll of configurations with either straight or sweptback wings was essentially unchanged by the presence of a fuselage having a fuselage-diameter—wing-span ratio of 0.191, that increasing the number of either straight or 45° sweptback semispan wings decreased the damping-in-roll coefficients at supersonic Mach numbers, and that changing the angle of sweepback from 0° to 45° decreased the damping in roll, particularly at supersonic speeds.

NACA RM L51D26

COMPARISON OF ZERO-LIFT DRAG DETERMINED BY FLIGHT TESTS AT TRANSONIC SPEEDS OF PYLON, UNDERSLUNG, AND SYMMETRICALLY MOUNTED NACELLES AT 40 PERCENT SEMISPAN OF A 45° SWEPTBACK WING AND BODY COMBINATION. Sherwood Hoffman. June 1951. 18p. diagrs., photos., tabs. (NACA RM L51D26)

The drag of a 45° sweptback wing and body configuration with nacelles has been obtained through transonic flight tests at zero lift. Nacelle positions were investigated at 40 percent of the semispan for the following arrangements: a nacelle mounted on a sweptforward (from wing) pylon, an underslung nacelle, and a symmetrically mounted nacelle.

NACA RM L51J08

EFFECT OF VERTICAL LOCATION OF A HORIZONTAL TAIL ON THE STATIC LONGITUDINAL STABILITY CHARACTERISTICS OF A 45° SWEPTBACK-WING - FUSELAGE COMBINATION OF ASPECT RATIO 8 AT A REYNOLDS NUMBER OF 4.0×10^6. Reino J. Salmi and William A. Jacques. January 1952. 42p. diagrs., photos. (NACA RM L51J08)

The results of a wind-tunnel investigation to determine the effects of a horizontal tail on the static longitudinal stability characteristics of a 45° sweptback-wing—fuselage combination of aspect ratio 8.0 are presented. The tests were made at a Reynolds number of 4.0×10^6 and a Mach number of 0.19 with various tail positions, with and without high-lift and stall-control devices, and at two wing incidence angles.

NACA RM L52D04a

TRANSONIC FLIGHT TESTS TO COMPARE THE ZERO-LIFT DRAGS OF UNDERSLUNG NACELLES VARIED SPANWISE ON A 45° SWEPTBACK WING AND BODY COMBINATION. Sherwood Hoffman. July 1952. 16p. diagrs., photos. (NACA RM L52D04a)

The effect on zero-lift drag at transonic speeds of varying the spanwise location of an underslung nacelle on a high-aspect-ratio, 45° sweptback wing and body combination has been determined by use of rocket-propelled models. Favorable interference effects were obtained for the underslung nacelles at the wing tips throughout the speed range.

NACA RM L52D18

WIND-TUNNEL INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS IN PITCH OF WING-FUSELAGE COMBINATIONS AT HIGH-SUBSONIC SPEEDS. SWEEP SERIES. James W. Wiggins and Richard E. Kuhn. July 1952. 41p. diagrs., photos. (NACA RM L52D18)

This paper presents the aerodynamic characteristics of wing-fuselage combinations of aspect ratio 4 and taper ratio of 0.6 with sweep angles ranging from 3.6° to 60° at the quarter-chord line. The tests covered a Mach number range from 0.4 to 0.95 at Reynolds number of 2,000,000 to 3,500,000 and an angle-of-attack range from -2° to 26°.

NACA RM L52D21a

AN ANALYSIS OF THE PRESSURE DISTRIBUTION MEASURED ON A BODY OF REVOLUTION AT TRANSONIC SPEEDS IN THE SLOTTED TEST SECTION OF THE LANGLEY 8-FOOT TRANSONIC TUNNEL. Bruce B. Estabrooks. June 1952. 42p. diagrs. (NACA RM L52D21a)

An analysis is presented of the pressure distributions measured in the Langley 8-foot transonic tunnel on a body of revolution of fineness ratio 10. Flow phenomena are discussed and the normal-force, pitching-moment, and pressure-drag data are presented at angles of attack from 0° to 20° for a range of Mach numbers from 0.89 to 1.13.

NACA RM L52D22a

DAMPING IN ROLL OF MODELS WITH 45°, 60°, AND 70° DELTA WINGS DETERMINED AT HIGH SUBSONIC, TRANSONIC, AND SUPERSONIC SPEEDS WITH ROCKET-POWERED MODELS. E. Claude Sanders, Jr. June 1952. 18p. diagrs., photos. (NACA RM L52D22a)

Rocket-powered models have been flown to determine the damping in roll at zero lift of some delta wings which were swept 45°, 60°, and 70° at the leading edge and had NACA 65A006 and hexagonal airfoil sections. The effects of leading-edge sweep and number of wings on the damping in roll are presented. Total drag coefficient at zero lift is also shown.

NACA RM L52D24a

LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS FROM A FLIGHT INVESTIGATION OF A CRUCIFORM CANARD MISSILE CONFIGURATION HAVING AN EXPOSED WING-CANARD AREA RATIO OF 16:1. Martin T. Moul and Andrew R. Wineman. June 1952. 32p. diagrs., photos. (NACA RM L52D24a)

A 60° delta-wing canard missile configuration having an exposed wing-canard area ratio of 16:1 was flight-tested at the Langley Pilotless Aircraft Research Station at Wallops Island, Va. Longitudinal stability and control derivatives and drag characteristics were obtained at transonic and supersonic velocities, and were compared with a similar canard configuration differing only in control area.

NACA RM L52D24b

RESULTS OF TWO EXPERIMENTS ON FLUTTER OF HIGH-ASPECT-RATIO SWEPT WINGS IN THE TRANSONIC SPEED RANGE. W. T. Lauten, Jr., and Burke R. O'Kelly. July 1952. 22p. diagrs., photos., tabs. (NACA RM L52D24b)

Flutter data in the transonic speed range for four high-aspect-ratio swept wings have been obtained by use of rocket-propelled vehicles. Two wings, swept 45°, fluttered at a Mach number of 0.89 and the other two wings, swept 60°, fluttered at a Mach number of 1.09. The experimental flutter speeds compared favorably with the flutter speeds calculated from a theory which includes effects of mode shape and sweep and is based on two-dimensional incompressible flow.

NACA RM L52J03

EFFECTS OF TWIST AND CAMBER, FENCES, AND HORIZONTAL-TAIL HEIGHT ON THE LOW-SPEED LONGITUDINAL STABILITY CHARACTERISTICS OF A WING-FUSELAGE COMBINATION WITH A 45° SWEPTBACK WING OF ASPECT RATIO 8 AT A REYNOLDS NUMBER OF 4.0 x 10^6. Gerald V. Foster. December 1952. 30p. diagrs., photo. (NACA RM L52J03)

A wind-tunnel investigation was made at a Reynolds number of 4.0 x 10^6 and Mach number of 0.19 to determine the effects of twist and camber, fences, and horizontal-tail height on the longitudinal stability of an airplane configuration having a 45° sweptback wing of aspect ratio 8. The results indicate that large improvements in longitudinal stability can be obtained through the combined effects of twist and camber, a suitable arrangement of fences, and a properly located horizontal tail.

NACA RM L53D08

LONGITUDINAL STABILITY AND WAKE-FLOW CHARACTERISTICS OF A TWISTED AND CAMBERED WING-FUSELAGE COMBINATION OF 45° SWEEPBACK AND ASPECT RATIO 8 WITH A HORIZONTAL TAIL AND STALL-CONTROL DEVICES AT A REYNOLDS NUMBER OF 4.0 x 10^6. Gerald V. Foster. June 1953. 51p. diagrs., photos., tab. (NACA RM L53D08)

A wind-tunnel investigation was made to determine the low-speed static longitudinal stability characteristics of a twisted and cambered wing having sweepback of 45° and an aspect ratio of 8 in combination with a fuselage and horizontal tail. The results include the effect of a horizontal tail located at various vertical positions on the stability of the airplane configuration with and without fences, leading-edge flaps, and extended split flaps. The results of airflow surveys in the region of the horizontal tail are also presented.

NACA RM L53D17

WIND-TUNNEL INVESTIGATION AT HIGH SUBSONIC SPEEDS OF A SPOILER-SLOT-DEFLECTOR COMBINATION ON AN NACA 65A006 WING WITH QUARTER-CHORD LINE SWEPT BACK 32.6°. Raymond D. Vogler. May 1953. 24p. diagrs. (NACA RM L53D17)

Results are presented of a wind-tunnel investigation at high subsonic speeds and angles of attack up to 20° to determine the lateral control characteristics of a spoiler, a deflector, and a spoiler-slot-deflector combination. The wing-fuselage combination had a wing with quarter-chord line swept back 32.6° and an NACA 65A006 section.

NACA RM L53D29

ESTIMATION OF WATER LANDING LOADS ON HYDRO-SKI-EQUIPPED AIRCRAFT. Emanuel Schnitzer. July 1953. 14p. diagrs. (NACA RM L53D29)

A summary of available methods developed at NACA for estimation of water landing loads on hydro-ski-equipped aircraft is presented. Two approaches to the problem of calculating landing loads are covered along with a modification to take into account the effect of shock strut mounting of the skis. A procedure is given for estimating hydro-ski pressure distributions during water landings. Pertinent references covering this material in detail are included.

NACA RM L54D06

DRAG AND HEAT TRANSFER ON A PARABOLIC BODY OF REVOLUTION (NACA RM-10) IN FREE FLIGHT TO MACH NUMBER 2 WITH BOTH CONSTANT AND VARYING REYNOLDS NUMBER AND HEATING EFFECTS ON TURBULENT SKIN FRICTION. Joseph P. Maloney. June 1954. 34p. diagrs., photo. (NACA RM L54D06)

Skin-friction drag, base drag, total drag, and heat transfer have been measured on a parabolic body of revolution in free flight for Mach numbers from 1.35 to 2.01 and Reynolds numbers from 5.7×10^6 to 111.3×10^6. Average skin-friction-drag coefficients were determined when the heating effect on the skin friction was (a) constant and (b) varying. Heat-transfer coefficients determined from measured skin temperatures along the body were compared with the measured skin-friction coefficients by means of a modified Reynolds analogy.

NACA RM L54D13

EFFECT AT TRANSONIC SPEEDS OF INBOARD SPOILERS ON THE STATIC LONGITUDINAL STABILITY CHARACTERISTICS OF A 45° SWEPTBACK WING-BODY COMBINATION HAVING A LEADING-EDGE CHORD-EXTENSION. James H. Henderson. June 1954. 24p. diagrs., photo. (NACA RM L54D13)

This paper presents the effects at transonic speeds of inboard spoilers located along the 20- and 30-percent-wing-chord lines on the static longitudinal stability characteristics of a 45° sweptback wing-body combination having a leading-edge chord-extension. The effect of the chord-extension on longitudinal stability characteristics and of the spoilers on rolling-moment characteristics is also presented. The model was tested through a Mach number range from 0.86 to 0.99 and an angle-of-attack range from about -4° to about 14°. Reynolds number varied from about 1.25×10^6 to 1.60×10^6.

NACA RM L54D16a

LARGE-SCALE LOW-SPEED WIND-TUNNEL TESTS OF A MODEL HAVING A 60° DELTA HORIZONTAL CANARD CONTROL SURFACE AND WING TO OBTAIN STATIC-LONGITUDINAL-STABILITY AND CANARD-SURFACE HINGE-MOMENT DATA. Dale L. Burrows. June 1954. 21p. diagrs. (NACA RM L54D16a)

A wind-tunnel investigation was made of a model equipped with a 60° delta wing and a 60° delta horizontal canard surface to determine the static longitudinal stability, control, and canard-surface hinge-moment characteristics at low speeds and at a Reynolds number of 9×10^6. Two longitudinal canard-surface positions were tested. Data of lift, drag, pitching moments, and canard-surface hinge moments are presented through an angle-of-attack range of -10° to 45° and a canard-surface deflection range of -5° to 20°.

NACA - Langley Field, Va.

NACA RM L54D23

AN INVESTIGATION OF A METHOD FOR OBTAINING HYDRODYNAMIC DATA AT VERY HIGH SPEEDS WITH A FREE WATER JET. Bernard Weinflash and John R. McGehee. June 1954. 28p. diagrs., photos., tabs. (NACA RM L54D23)

Information is presented on the feasibility of using a rectangular free water jet to obtain hydrodynamic data at very high speeds. The 3-inch by 3/4-inch jet investigated was actuated by compressed air which forced the water through a nozzle at speeds from about 80 to 200 feet per second. Total-head pressure distributions in the jet up to 8 inches downstream of the nozzle exit are presented and experimental hydrodynamic lift data are given for two models planing on the 3-inch-wide surface of the jet. These planing data are compared with similar data obtained in the Langley towing tanks. The data obtained in this investigation indicate that it is feasible to use a free water jet as a hydrodynamic test facility for obtaining planing data at very high speeds.

#NACA RM SL53D28

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1206

A REVISED GUST-LOAD FORMULA AND A RE-EVALUATION OF V-G DATA TAKEN ON CIVIL TRANSPORT AIRPLANES FROM 1933 TO 1950. Kermit G. Pratt and Walter G. Walker. 1954. ii, 9p. diagrs., tabs. (NACA Rept. 1206. Supersedes TN 2964; TN 3041)

A revised gust-load formula with a new gust factor is derived to replace the gust-load formula and alleviation factor widely used in gust studies. The revised formula utilizes the same principles and retains the same simple form of the original formula but provides a more appropriate and acceptable basis for gust-load calculations. The gust factor is calculated on the basis of a one-minus-cosine gust shape and is presented as a function of a mass-ratio parameter in contrast to the ramp gust shape and wing loading, respectively, used for the alleviation factor. A summary of gust-velocity data from V-G records taken on civil transport airplanes from 1933 to 1950, reevaluated by the revised formula, is also presented.

NACA Rept. 1213

MINIMUM-DRAG DUCTED AND POINTED BODIES OF REVOLUTION BASED ON LINEARIZED SUPERSONIC THEORY. Hermon M. Parker. 1955. ii, 9p. diagrs. (NACA Rept. 1213. Supersedes TN 3189)

The linearized-drag integral for bodies of revolution at supersonic speeds is presented in a double-integral form which is not based on slender-body approximations but which reduces to the usual slender-body expression in the proper limit. With the aid of a suitably chosen auxiliary condition, the minimum-external-wave-drag problem is solved for a transition section connecting two semi-infinite cylinders. The projectile tip is a special case and is compared with the Von Kármán projectile tip. Calculations are presented which indicate that the method of analysis gives good first-order results in the moderate supersonic range.

NACA Rept. 1227

AN INVESTIGATION OF THE MAXIMUM LIFT OF WINGS AT SUPERSONIC SPEEDS. James J. Gallagher and James N. Mueller. 1955. ii, 28p. diagrs., photos., tabs. (NACA Rept. 1227. Supersedes RM L7J10)

Results of an investigation are presented for a variety of wing plan forms of random thickness distributions tested at Mach numbers of 1.55, 1.90, and 2.32 and at angles of attack ranging from zero up through the angle at which maximum lift occurred. In general, at these Mach numbers the value of maximum lift coefficient was approximately 1.05 ± 0.05; it appeared to be independent of plan form and decreased slightly with increasing Mach number. No discontinuities in lift occurred from zero angle of attack through maximum lift, which was attained at an angle of attack of approximately 40°. Lift-drag ratios at maximum lift were of the order of 1.0.

NACA Rept. 1241

THEORETICAL AND ANALOG STUDIES OF THE EFFECTS OF NONLINEAR STABILITY DERIVATIVES ON THE LONGITUDINAL MOTIONS OF AN AIRCRAFT IN RESPONSE TO STEP CONTROL DEFLECTIONS AND TO THE INFLUENCE OF PROPORTIONAL AUTOMATIC CONTROL. Howard J. Curfman, Jr. 1955. ii, 21p. diagrs. (NACA Rept. 1241. Supersedes RM L50L11)

Through theoretical and analog results the effects of two nonlinear stability derivatives on the longitudinal motions of an aircraft have been investigated. Nonlinear functions of pitching-moment and lift coefficients with angle of attack were considered. Analog results of aircraft motions in response to step elevator deflections and to the action of the proportional control systems are presented. The occurrence of continuous hunting oscillations was predicted and demonstrated for the attitude stabilization system with proportional control for certain nonlinear pitching-moment variations and autopilot adjustments.

NACA RM 56B07

ELEVATED-TEMPERATURE FATIGUE PROPERTIES OF TWO TITANIUM ALLOYS. William K. Rey. April 1956. 28p. diagrs., photo., tabs. (NACA RM 56B07)

The unnotched fatigue properties of two titanium alloys were evaluated at temperatures from room

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temperature to 1,000° F. The results are presented in tabular form and as curves of stress versus cycles to failure for each test temperature. The decrease in endurance strength with an increase in temperature is shown by a curve of endurance strength versus temperature for each alloy.

NACA RM A56B10

REDUCTION OF WAVE DRAG OF WING-BODY COMBINATIONS AT SUPERSONIC SPEEDS THROUGH BODY DISTORTIONS. William C. Pitts. April 1956. 9p. diagrs. (NACA RM A56B10)

Several methods for the reduction of the wave drag of wing-body combinations by axisymmetric and nonaxisymmetric body distortions are discussed. Experimental results for several wing plan forms show sizable reductions in drag for aspect ratios of current interest. A significant part of the drag reduction is due to the nonaxisymmetric distortion.

NACA RM E56A27

THEORETICAL PERFORMANCE OF JP-4 FUEL AND LIQUID OXYGEN AS A ROCKET PROPELLANT. I - FROZEN COMPOSITION. Vearl N. Huff and Anthony Fortini. April 1956. 35p. diagrs., tabs. (NACA RM E56A27)

Theoretical rocket performance parameters were calculated for JP-4 fuel with liquid oxygen. Frozen composition was assumed during the isentropic expansion process. Data were calculated for equivalence ratios of 1 to 3, chamber pressures of 300 and 600 pounds per square inch, and pressure ratios of 1 to 1500. A correlation is given which permits the determination of performance for a wide range of chamber pressures. The maximum values of specific impulse for chamber pressures of 300 and 600 pounds per square inch absolute and an exit pressure of 1 atmosphere were 271.8 and 250.4, respectively, at 32 weight percent fuel.

NACA TM 1403

ON THE INSTABILITY OF METHODS FOR THE INTEGRATION OR ORDINARY DIFFERENTIAL EQUATIONS. (Über die Instabilität von Methoden zur Integration gewöhnlicher Differentialgleichungen). Heinz Rutishauser. April 1956. 15p. (NACA TM 1403. Trans. from Zeitschrift für angewandte Mathematik und Physik, v.3, 1952, p.65-74)

In the numerical solution of a differential equation as a difference equation, the latter is usually of higher order and therefore has more solutions than the original differential equation. It may well be that some of these "extra" solutions grow faster than any solution of the given equation; in this case the computational solution has the tendency to follow one of these and has after a certain number of integration steps nothing to do with the original differential equation. The author gives some examples and a criterion for stability of integration methods. This criterion is then applied to some well-known integration formulas.

NACA TN 3579

VAPOR-PHASE OXIDATION AND SPONTANEOUS IGNITION - CORRELATION AND EFFECT OF VARIABLES. Donald E. Swarts and Milton Orchin, University of Cincinnati. April 1956. 32p. diagrs., tabs. (NACA TN 3579)

The spontaneous ignition temperatures of eight structurally different hydrocarbons were determined and correlated with the behavior of the same hydrocarbons toward vapor-phase oxidation. Since good correlation of the two phenomena was obtained, it is likely that similar oxidative mechanisms are operative in both.

NACA TN 3628

AN ANALYSIS OF ESTIMATED AND EXPERIMENTAL TRANSONIC DOWNWASH CHARACTERISTICS AS AFFECTED BY PLAN FORM AND THICKNESS FOR WING AND WING-FUSELAGE CONFIGURATIONS. Joseph Weil, George S. Campbell and Margaret S. Diederich. April 1956. 92p. diagrs., photos., tabs. (NACA TN 3628. Supersedes RM L52I22)

This paper presents a summary of the effects of changes in wing plan form and thickness ratio on the downwash characteristics of wing and wing-fuselage configurations in the Mach number range between 0.6 and 1.1. Data obtained by the transonic-bump technique at two tail heights have been compared with theoretical estimations made in the subsonic and supersonic Mach number range.

NACA TN 3634

CALCULATIONS OF THE RATE OF THERMAL DISSOCIATION OF AIR BEHIND NORMAL SHOCK WAVES AT MACH NUMBERS OF 10, 12, AND 14. George P. Wood. April 1956. 40p. diagrs., tabs. (NACA TN 3634)

Calculations of the rate of dissociation of air have been based on available theory and available experimental results with other gases. The results show that the distance behind a normal shock wave required for a moderately large fraction of the oxygen to dissociate varies widely with Mach number and density, from approximately hundreds of meters to a fraction of a millimeter. The distance required for a significant portion of the nitrogen to dissociate (outside the boundary layer) is shown to be greater than the length of a vehicle at any density and at any Mach number less than 14.

NACA TN 3636

THE ACCURACY OF THE SUBSTITUTE-STRINGER APPROACH FOR DETERMINING THE BENDING FREQUENCIES OF MULTISTRINGER BOX BEAMS. William W. Davenport. April 1956. 28p. diagrs., tab. (NACA TN 3636)

The accuracy of the substitute-stringer approach for including the effects of shear lag in the calculation of the transverse modes and frequencies of multistringer box beams is investigated. Box beams, the

covers of which consist of normal-stress-carrying stringers on sheets which carry not only shear but also normal stress, are analyzed exactly. Frequencies of beams with various numbers of stringers, obtained by means of this exact analysis, serve to determine the possible accuracy of the frequencies obtained by the substitute-stringer approach.

NACA TN 3637

FLIGHT INVESTIGATION OF THE EFFECTIVENESS OF AN AUTOMATIC AILERON TRIM CONTROL DEVICE FOR PERSONAL AIRPLANES. William H. Phillips, Helmut A. Kuehnel and James B. Whitten. April 1956. 42p. diagrs., photos., tab. (NACA TN 3637)

An analytical and flight investigation has been made to determine the effectiveness of an automatic aileron trim control device in conjunction with preloaded aileron centering springs in improving spiral stability characteristics of a personal airplane. The results indicate that the device can maintain the airplane in level flight under instrument conditions despite disturbances due to moderate turbulence or trim changes with airspeed and flight condition.

NACA TN 3638

ON PANEL FLUTTER AND DIVERGENCE OF INFINITELY LONG UNSTIFFENED AND RING-STIFFENED THIN-WALLED CIRCULAR CYLINDERS. Robert W. Leonard and John M. Hedgepeth. April 1956. 52p. diagrs. (NACA TN 3638)

A preliminary theoretical investigation of the panel flutter and divergence of infinitely long, unstiffened and ring-stiffened thin-walled circular cylinders is described. Analytical criteria for the location of stability boundaries are presented along with a limited number of computed results.

NACA TN 3642

EFFECT OF SHALLOW WATER ON THE HYDRODYNAMIC CHARACTERISTICS OF A FLAT-BOTTOM PLANING SURFACE. Kenneth W. Christopher. April 1956. 36p. diagrs., photos., tab. (NACA TN 3642)

The effects on the planing characteristics of the clearance between a flat-bottom planing surface and the tank bottom are presented. The range of trims investigated was from 4° to 20° for wetted-length—beam ratios of 0.4 to 6.4. Each condition was investigated over a range of clearances of from 0.2 to 1.6 beams. All the measured values increased with decreasing clearance. A description of the monorail and its associated apparatus is included.

NACA TN 3646

A THEORY FOR THE ELASTIC DEFLECTIONS OF PLATES INTEGRALLY STIFFENED ON ONE SIDE. Robert F. Crawford. April 1956. 21p. diagrs. (NACA TN 3646)

An elastic-deflection theory is presented for anisotropic plates which exhibit coupling between bending and stretching. In particular, the theory provides a basis for analyzing plates integrally stiffened on one side. The effect of coupling is responsible for the presence of added terms in the potential-energy expression, the small- and large-deflection equations of equilibrium, and the boundary conditions which do not occur in ordinary plate theory. Example calculations show that, in the case of a simply supported square plate loaded in compression and having equal flexural stiffnesses in the principal directions, coupling may significantly lower the in-plane compressive load at which deflections grow rapidly.

NACA TN 3650

RESULTS OF A FLIGHT INVESTIGATION TO DETERMINE THE ZERO-LIFT DRAG CHARACTERISTICS OF A 60° DELTA WING WITH NACA 65-006 AIRFOIL SECTION AND VARIOUS DOUBLE-WEDGE SECTIONS AT MACH NUMBERS FROM 0.7 TO 1.6. Clement J. Welsh. April 1956. 13p. diagrs., photo. (NACA TN 3650. Supersedes RM L50F01)

Results of an exploratory free-flight investigation at zero lift of several rocket-powered drag-research models equipped with 60° sweptback delta wings are presented for a Mach number range from about 0.70 to 1.60. The airfoil sections tested included the NACA 65-006 and a series of double-wedge sections with various positions of maximum thickness.

NACA TN 3655
National Advisory Committee for Aeronautics.
METHOD OF CALCULATING CORE DIMENSIONS OF CROSSFLOW HEAT EXCHANGER WITH PRESCRIBED GAS FLOWS AND INLET AND EXIT STATES. E. R. G. Eckert and Anthony J. Diaguila. April 1956. 25p. diagrs. (NACA TN 3655)

A calculation procedure is presented for determining the dimensions of a heat-exchanger core with a prescribed heat-transfer surface. The procedure is applicable when the gas-flow quantities as well as the inlet and outlet gas conditions on both sides of the heat exchanger are specified. The procedure is applied to a numerical example.

NACA TN 3669

PERFORATED SHEETS AS A POROUS MATERIAL FOR DISTRIBUTED SUCTION AND INJECTION. Robert E. Dannenberg, Bruno J. Gambucci, and James A. Weiberg. April 1956. 27p. diagrs., photos. (NACA TN 3669)

Measurements were made of the resistance to air flow through a series of perforated metal sheets with open areas ranging from less than 1 percent up to 41 percent. The use of punch-perforated sheets as a

porous material for boundary-layer-control applications by means of distributed suction is discussed.

NACA TN 3670

DETERMINATION OF VORTEX PATHS BY SERIES EXPANSION TECHNIQUE WITH APPLICATION TO CRUCIFORM WINGS. Alberta Y. Alksne. April 1956. 40p. diagrs., photos. (NACA TN 3670)

A series method is applied to the computation of vortex positions behind a slender equal-span cruciform wing at any angle of bank as a function of the distance behind the trailing edge. Calculated paths are compared with the results of water-tank experiments and of a closed expression given in NACA TN 2605. The forces on an equal-span interdigitated cruciform tail behind a slender equal-span cruciform wing are calculated for four angles of bank from the vortex positions found by use of the series.

NACA TN 3672

INVESTIGATION AT HIGH SUBSONIC SPEEDS OF A BODY-CONTOURING METHOD FOR ALLEVIATING THE ADVERSE INTERFERENCE AT THE ROOT OF A SWEPTBACK WING. John B. McDevitt and William M. Haire. April 1956. 38p. diagrs., photos. (NACA TN 3672. Supersedes RM A54A22)

An experimental investigation was made of a body-contouring method for alleviating at subsonic speeds the adverse interference at the root of a 35° sweptback wing in combination with various bodies. Modifying the body shape did not significantly affect the aerodynamic characteristics at subcritical speeds. At Mach numbers above the critical, improved aerodynamic characteristics were evidenced by large reductions of drag, an increase in lift-curve slope, and a reduced change of pitching-moment-curve slope with increasing Mach number.

NACA TN 3674

THEORETICAL PRESSURE DISTRIBUTIONS FOR SOME SLENDER WING-BODY COMBINATIONS AT ZERO LIFT. Paul F. Byrd. April 1956. 39p. diagrs. (NACA TN 3674. Supersedes RM A54J07)

Theoretical calculations are made of the pressure distributions for some slender, symmetrical wing-body combinations in subsonic and supersonic flow. The combinations consist first of nonlifting, sweptback wings mounted on a circular cylinder and second of such wings mounted on a body indented so that the local cross-sectional area of the combination is constant. The results indicate that indentation straightens out the isobars along the wing and diminishes the maximum perturbation velocities.

NACA TN 3678

INFLUENCE OF ALLOYING UPON GRAIN-BOUNDARY CREEP. F. N. Rhines, W. E. Bond and M. A. Kissel, Carnegie Institute of Technology. April 1956. 16p. diagrs., tab. (NACA TN 3678)

Grain-boundary displacement, occurring in bicrystals during creep at elevated temperature (350° C), was measured as a function of the copper content (0.1 to 3 percent) in a series of aluminum-rich aluminum-copper solid-solution alloys. Because alloying effects alone were to be investigated, the conditions of observation were limited to a single temperature and range of stress.

NACA TN 3689

INVESTIGATION BY THE TRANSONIC-BUMP METHOD OF A 35° SWEPTBACK SEMISPAN MODEL EQUIPPED WITH A FLAP OPERATED BY A SERIES OF SERVOVANES LOCATED AHEAD OF AND GEARED TO THE FLAP. William H. Phillips and Robert F. Thompson. April 1956. 39p. diagrs., photo. (NACA TN 3689. Supersedes RM L51J10)

Lift, drag, pitching-moment, rolling-moment, and yawing-moment data in the Mach number range from 0.6 to 1.0 obtained from wind-tunnel tests of a low-aspect-ratio sweptback airfoil model with a servovane control are presented. The control utilizes the drag force and spoiler action of a set of vanes to deflect a flap-type control. Comparison of lift increment and center-of-pressure location is made with previously published data from tests of a conventional flap-type control.

NACA TN 3690

NORMAL COMPONENT OF INDUCED VELOCITY IN THE VICINITY OF A LIFTING ROTOR WITH A NONUNIFORM DISK LOADING. Harry H. Heyson and S. Katzoff. April 1956. i, 45p. diagrs. (NACA TN 3690)

Part I presents a method for computing, from available calculations for uniform disk loading, the effect of nonuniform circularly symmetrical disk loading on the normal component of induced velocity in the vicinity of a lifting rotor. Charts of the normal component of induced velocity are given for the longitudinal plane of symmetry and for the major axes of rotors with two different, nonuniform, circularly symmetrical disk-load distributions. Part II develops certain symmetry relations for the induced velocities in the plane of a uniformly loaded rotor and also develops relations between the radial load distribution of the rotor and the radial variation of induced velocities in the wake.

NACA TN 3691

ANALYSIS AND COMPARISON WITH THEORY OF FLOW-FIELD MEASUREMENTS NEAR A LIFTING ROTOR IN THE LANGLEY FULL-SCALE TUNNEL. Harry H. Heyson. April 1956. 162p. diagrs., photos., tab. (NACA TN 3691)

Measurements of stream angles and velocities were made in several planes both near and behind a single rotor in four different flight conditions in the Langley full-scale tunnel. These measurements indicate that available theory may be used to calculate with reasonable accuracy the induced flow over the forward three-quarters of the disk for these flight conditions if the rotor disk-load distribution is accounted for. Rearward of this point, calculations of the induced velocity are increasingly inaccurate due to the rolling up of the trailing-vortex system. Farther rearward, well behind the rotor, the flow may be represented more accurately by the flow behind a uniformly loaded wing.

NACA TN 3711

SOME EFFECTS OF GUIDE-VANE TURNING AND STATORS ON THE ROTATING STALL CHARACTERISTICS OF A HIGH HUB-TIP RATIO SINGLE-STAGE COMPRESSOR. Eleanor L. Costilow and Merle C. Huppert. April 1956. 52p. diagrs., tab. (NACA TN 3711)

The rotating stall characteristics of several guide-vane - rotor and guide-vane - rotor - stator configurations were investigated. Guide vanes having turning angles of -22.5°, 0°, 22.5°, and 40° were used. The stage hub-tip ratio was 0.9. Results indicate that the initial rotating stall point, number of stall zones formed, and stall propagation rate of a configuration depend not only upon blade-row inlet angle and pressure-rise characteristic, but also upon the overall characteristics of the multiblade row unit as well. The number of stall zones formed in the annulus did not appear to depend upon guide-vane turning or the presence of stators.

BRITISH REPORTS

N-42316*

National Gas Turbine Establishment (Gt. Brit.)
THE DEVELOPMENT OF A FLOW VISUALIZATION TECHNIQUE. E. C. Roberson. November 1955. 39p. diagrs., photos. (NGTE R. 181)

A number of flow visualization techniques were examined and from them the water analogy was chosen for its ability to give more complete, rapid and accurate information on the nature of flow regimes. In the variant of the technique developed, synthetic resin spheres having suitable optical properties were used as markers. Precautions were taken to make the particle/fluid density ratio fall within limits indicated by mathematical analysis. This was checked experimentally. A rig was designed to meet flow requirements of a wide range of combustion system models and in it rubber linings were used to obviate turbidity produced by fluid corrosion on metal parts. Lighting systems were devised to provide adequate illumination for photography and a technique was developed for measuring quickly and accurately the flow angles and velocities recorded in photographs.

N-42317*

Royal Aircraft Establishment (Gt. Brit.)
VISUAL AIDS AND THEIR EFFECT ON LANDING SUCCESS AND SAFETY. E. S. Calvert. (Lecture delivered to Wissenschaftliche Gesellschaft fur Luftfahrt, Augsberg, October 1955). October 1955. 17p. diagrs. (RAE EL. 1486)

It is shown that the installation of the Crossbar System of approach lighting at London Airport enables the operating limits there to be lowered to about one-third. It also reduced the failure rate in first attempts to land by about 15 times in meteorological visibilities of the order of half a mile. One main problem, which is largely one of safety, still remains. This is to devise some simple means of improving visual guidance during the flare-out, that is, from a height of about 100 feet downwards. This is necessary on noninstrument runways as well as on instrument runways in order to reduce the number of undershoots and enable improved approach couplers to be used to lower heights.

N-42328*

Royal Aircraft Establishment (Gt. Brit.)
THE VELOCITY OF PROPAGATION OF STRAIN IN TEXTILE CABLES. B. J. Brinkworth. November 1955. 15p. diagrs., tab. (RAE Tech. Note Mech. Eng. 211)

Existing data are examined, and it is concluded that the conditions under which cables are used in practice and the complex constructions employed are so different from those of the laboratory tests previously made that no reliable interpretation is possible. An experimental method devised to obtain values in actual cables is described, and typical values for flax and nylon are given. The value of strain velocity is found to increase with impact velocity and thus the effective modulus of elasticity with dynamic strain. Extensions to the present investigation are proposed, covering a wider range of materials and construction and the effect of initial static loading.

N-42329*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF STRESS WAVES ON THE STRENGTH OF BRAKE PARACHUTE CABLES. B. J. Brinkworth. July 1955. 31p. diagrs., tabs. (RAE Tech. Note Mech. Eng. 202)

Equations of transient tension are derived for both ends of a cable under longitudinal impact by a finite mass, and the results are presented in a form readily applicable to brake parachute systems. A comparison is made with the strain-energy solution in common use. The particular case of an air-launched body is examined with certain basic assumptions, and the solutions are again presented in

graphical form. Consideration is given to possible effects of attenuation in braided cables and the influence of material properties on the velocity of stress propagation and the maximum elastic stress under impact.

N-42330*

Royal Aircraft Establishment (Gt. Brit.)
RESULTS OF A FLIGHT INVESTIGATION ON CLEAR AIR TURBULENCE AT LOW ALTITUDE USING A METEOR MK.7 AIRCRAFT. R. M. Allan. September 1955. 16p. diagrs., photo., tabs. (RAE Tech. Note Aero 2390)

Low level runs were made over a given route at heights below 1000 feet above ground and at an airspeed of 400 knots. A distance of 6080 nautical miles was covered and the accelerations due to gusts were recorded by a continuous trace accelerometer. The results of all the runs showed that, on the average, a 1g gust or greater occurred every 7.06 minutes. Comparison with other information on this subject showed that the results from this investigation fitted in with existing data. There were considerably more positive than negative gusts, the factor being 18 at 1.2g or greater. It would appear that for the area in which the flights were made, turbulence near the ground is not isotropic. A consideration of meteorological factors showed that on this route wind is far more powerful in producing turbulence at low altitude than the effect of sun.

N-42333*

Royal Aircraft Establishment (Gt. Brit.)
LUBRICATION BY FILMS OF SOLID MATERIALS. E. B. Bielak, E. Kay and E. W. J. Mardles. December 1955. 17p. diagrs., photos., tab. (RAE Tech. Note Chem. 1271)

Lubricants such as graphite, molybdenum disulphide, lithium stearate are investigated between various metal bearing surfaces, before and after treatment. Results of measurement of coefficients of friction under different conditions are given in tables and figures. Although benefit is obtainable with solid lubricants, especially under extreme temperature conditions, their lubricating properties are sensitive to rate of movement, thickness of film, atmospheric conditions, presence of oil, etc., so that considerable effort is required to determine the optimum conditions of application for any bearing or instrument. Some improvement in the lubricating properties of solid powders is obtained by surface treating the powder with a lyophobic film.

N-42338*

Royal Aircraft Establishment (Gt. Brit.)
A PRELIMINARY STUDY OF THE EFFECTS OF KINETIC HEATING ON THE DESIGN AND TESTING OF AIRCRAFT STRUCTURES. W. H. Horton. October 1955. 48p. diagrs., photos., tab. (RAE Tech. Note Structures 177)

This paper discusses the changes in methods of stress analysis which may be expected to occur with the introduction of kinetic heating, including new problems in creep and thermal fatigue. New techniques of structural testing are discussed. Automatic ground simulation of kinetic heating is described. This is a reproduction of a paper read at the Centennial Celebrations of the Polytechnic Institute of Brooklyn under the title "The Influence of Kinetic Heating on the Design and Testing of Aircraft Structures," and published in the Proceedings of the Conference in 1955. Issued as an RAE Technical Note with the concurrence of Polytechnic Institute of Brooklyn, USA.

N-42457*

Royal Aircraft Establishment (Gt. Brit.)
FLAME SPEEDS IN HYDRAZINE VAPOUR AT LOW PRESSURES. A. R. Hall. September 1955. 15p. diagr., photo. (RAE Tech.Note RPD 129)

The burning velocity of the self-decomposition flame of 97-percent hydrazine (N_2H_4) vapor at 120° C has been determined by a burner method at pressures of 3, 7, and 15 cm of mercury. The velocity remains relatively constant over this range at around 185 cm sec^{-1} and is thus little different from the value previously found at atmospheric pressure. It is concluded that the rate-determining process is close to a second-order reaction and that the combustion proceeds by a chain mechanism. Some visual and spectrographic observations have been made on flames of hydrazine, hydrazine/oxygen, hydrazine/nitric oxide and ammonia/nitric oxide at low pressure. These suggest that the combustion of hydrazine and oxygen takes place in what may be regarded as two stages.

N-42458*

Royal Aircraft Establishment (Gt. Brit.)
THE THEORY OF THE AIRCRAFT HEIGHT AND AIRSPEED COMPUTER. D. Martin. September 1955. 17p. (RAE Tech. Memo. IAP 624)

Expressions are derived relating true height to indicated height as given by a barometric altimeter calibrated to the I. C. A. N. law and relating true airspeed to indicated airspeed, true outside air temperature, and indicated height. Approximations to these expressions employed in height and airspeed computers in use up to 1945 are discussed. Possible sources of error of the computers, due both to the approximations made and to variations from I. C. A. N. conditions, are considered and evaluations made of the order of the errors. Developments of this type of computer in the immediate years following 1945 are outlined.

N-42460*

Royal Aircraft Establishment (Gt. Brit.)
AN AUTOMATIC SELF-BALANCEING CAPSULE MANOMETER. G. F. Midwood and R. W. Hayward. July 1955. 22p. diagrs., photos. (RAE Tech. Note Aero 2382)

This note contains a brief description of an automatic self-balancing capsule manometer which has been developed primarily for the measurement of pressures encountered in the operation of supersonic wind tunnels. A remote indicating system is em-

ployed which is suitable for use with digital recording and card punching apparatus. The instrument has been designed to cover a range of 0-2 atmospheres absolute and has been adjusted and calibrated to give an accuracy of 0.01 in. Hg over the range 0.5 in. Hg to 60 in. Hg absolute.

N-42461*

Royal Aircraft Establishment (Gt. Brit.)
IMPURITIES IN TITANIUM: PHOSPHORUS. D. A. Sutcliffe. September 1955. 11p. diagrs., photos., tabs. (RAE Tech. Note Met. 227)

Binary titanium phosphorus alloys containing up to 3.8 percent phosphorus have been prepared by arc melting. All the alloys have been hardness tested; tensile and impact tests have been made at room temperature on the alloys containing up to 1.13 percent phosphorus. The results show that the addition of 0.25 phosphorus causes a marked rise in hardness and tensile strength with a corresponding loss in percentage elongation and impact strength. Further additions of phosphorus up to 1.13 percent caused a continuation of these trends though not so rapidly as at first. Titanium phosphorus alloys in the "as cast" condition exhibited a eutectic structure.

N-42462*

Royal Aircraft Establishment (Gt. Brit.)
A THREE-PHASE VIBRATOR CONVERTOR. R. H. Evans. September 1955. 16p. diagrs. (RAE Tech. Note EL 106)

This note describes a proposed method of power conversion from direct current to a three-phase alternating-current supply of constant frequency by means of vibrator converters with their driving systems electrically interconnected. The alternating current may be used directly or it may be rectified, in which case it is expected that, compared with the single-phase vibrator converter, the power rating and life will be increased and the amount of smoothing required considerably reduced.

N-42463*

Royal Aircraft Establishment (Gt. Brit.)
FATIGUE TESTS ON SPECIMENS FROM ALUMINIUM ALLOY B.S. L.40 METEOR TAIL PLANE SPAR BOOM EXTRUSION. M. S. Binning and J. T. Ballett. September 1955. 11p. diagrs., tabs. (RAE Tech. Note Met. 229)

Fatigue tests have been made on specimens from extruded angle section in aluminum alloy B.S. L40 to provide information on the effect on fatigue strength of mean stress, surface conditions and a stress raiser in the form of a rivet hole. The tests, made in Haigh fatigue machines, indicated that polishing the extruded surface of plain specimens gave an increase of approximately 15 percent in the fatigue strength. With "as extruded" material the ratio of fatigue strength of plain specimens to that of specimens incorporating the stress raiser (1/8-in. diameter hole) was about 1.7, and polishing such specimens made little, if any, improvement.

N-42464*

Royal Aircraft Establishment (Gt. Brit.)
AN EXTENSION OF THE THEORY OF THERMAL EXPLOSION AND ITS APPLICATION TO THE OSCILLATORY BURNING OF EXPLOSIVES. D. M. Clemmow and J. D. Huffington. September 1955. 28p. diagrs., tabs. (RAE Tech. Note RPD 128)

The critical conditions for the explosion of a slab of explosive, subject to self-heating and with one face maintained at a fixed temperature and the other heated at a constant rate, are obtained by modification and extension of existing theory on thermal explosion. Critical thicknesses and surface temperatures at the initiation of explosion are calculated for cordite and methyl nitrate, and it is shown that the critical thicknesses decrease with increasing rate of surface heat transfer, being of the order of 1 micron or less for a surface temperature gradient of 10^7 °C/cm. The results are used to help interpret observations of the oscillatory burning of cordite which are consistent with the view that combustion is partly due to the successive explosion of discrete layers of thickness decreasing with increasing pressure, and therefore with surface heat transfer rate.

N-42465*

Royal Aircraft Establishment (Gt. Brit.)
A.C. CONTROLLED TRANSDUCTORS.
A. G. Milnes and T. S. Law. September 1955. 38p. diagrs. (RAE Tech. Note EL 93)

An analysis of the behavior of the single, auto-self-excited, transductor element is made for the condition when the control circuit has finite resistance. Consideration is given to control by direct voltage signal as an introduction to the performance with an alternating voltage signal of the same frequency as the supply. Factors influencing the output characteristic are examined and methods of improvement, such as phase shift and special bias arrangements, are discussed. Reference is made to the A.C. control of full-wave transductors and some push-pull circuits with half-wave and full-wave outputs. The behavior of a typical push-pull four-element design is examined experimentally and its performance when the control is by alternating-voltage signal is compared with that for direct-voltage control.

N-42466*

Royal Aircraft Establishment (Gt. Brit.)
ON THE USE OF A TENSOR TRANSFORMATION TO DESCRIBE THE ROTATION OF A RIGID BODY; WITH APPLICATIONS TO A WING OF VARIABLE SWEEP AND A RETRACTABLE UNDERCARRIAGE. Edward Hugh Bateman. October 1955. 20p. diagrs. (RAE Structures 190)

A general solution, which depends on a tensor transformation derived in a previous note (RAE TN Structures 121), is presented for defining the position of a rigid body after rotation on a known axis, and conversely for finding the direction of the axis when a body is transposed from one position to another, in a single rotation. Expressions are derived for the angles of sweep, incidence and dihedral, when a wing of variable sweep is rotated about any axis fixed in the aircraft. A method is given in detail for finding

the axis of rotation of an undercarriage when the extended and retracted orientations are defined in plan and elevation on an engineering drawing.

N-42467*

Royal Aircraft Establishment (Gt. Brit.)
THE CHEMISTRY AND TECHNOLOGY OF FLEXIBLE POLYURETHANE (FLEXALKYD) FOAMS. L. N. Phillips. December 1955. 24p. diagr., photos., tabs. (RAE Chem. 503)

The type of alkyd required for producing flexible polyurethane foams has been investigated in some detail. The composition and the esterification conditions for a suitable resin (Flexalkyd) are given. Bubble modifiers, accelerators and a proportion of water are necessary for the production of uniform light-weight products. The heat resistance, chemical resistance and stress/strain behavior in compression of such foams have been examined. Important applications for polyurethane foams are as industrial sponges, upholstery, and as packaging materials. A technique has been developed for moulding packaging units by the foamed-in-place method.

N-42468*

Royal Aircraft Establishment (Gt. Brit.)
THE INFLUENCE OF PLAIN BEARINGS ON SHAFT WHIRLING. E. Downham. October 1955. 45p. diagrs., photos., tabs. (RAE Structures 192)

Experiments are described which show the effects of bearing length, bearing clearance, and lubricant viscosity on the critical whirling speeds of a single shaft rotor system supported in plain bearings. The critical speed of a two-bearing shaft-rotor system is shown to depend upon rotor unbalance for bearings of normal clearance. When the clearance is small relative to the bearing length, unsymmetric stiffness characteristics are obtained and produce two critical speeds instead of one. The lubricant in a drip-feed bearing is shown to have a stiffening effect, with consequent increase of critical whirling speed. It is also shown that the critical whirl amplitudes with dry bearings can be appreciably larger than those obtained with lubricated bearings.

N-42469*

Royal Aircraft Establishment (Gt. Brit.)
SOME FATIGUE CHARACTERISTICS OF A TWO SPAR LIGHT ALLOY STRUCTURE (METEOR 4 TAILPLANE). K. D. Raithby and Jennifer Longson. January 1956. 31p. diagrs., photos., tabs. (RAE Structures 195)

Results are given for fatigue tests on 61 Meteor tailplanes, treated as representative small-scale wing systems and tested under a variety of loading conditions. The object of the investigation was to study the fatigue characteristics of a typical aircraft structure, in particular the effects of mean load and alternating load on the endurance. The effects of preloading, periodic overloading, and low temperatures were also investigated. Endurance curves are given for different mean loads; the results indicate that, for a given alternating load, the endurance is roughly inversely proportional to mean load. Substantial improvements in endurance may be obtained by preloading and by periodic overloading. The endurance at low temperatures is higher than at room temperature.

N-42470*

Marine Aircraft Experimental Establishment (Gt. Brit.) INVESTIGATION OF HIGH LENGTH/BEAM RATIO SEAPLANE HULLS WITH HIGH BEAM LOADINGS. HYDRODYNAMIC STABILITY PART 14. THE EFFECT OF A TAILORED AFTERBODY ON STABILITY AND SPRAY CHARACTERISTICS WITH TEST DATA ON MODEL J. D. M. Ridland. October 1955. 40p. diagrs., photos., tabs. (MAEE F/Res/249)

The effects of a tailored afterbody on longitudinal stability, spray, directional stability, and elevator effectiveness are deduced from the results of tests on two models of length/beam ratio 11, which were alike in every respect except that of afterbody shape; one afterbody was of standard form and the other was tailored. It was found that tailoring the afterbody considerably improved stability characteristics, both longitudinal and directional, improved spray characteristics and slightly impaired elevator effectiveness. The detailed test results for the tailored afterbody model are also included and discussed.

N-42479*

Forest Products Research Lab. (Gt. Brit.)
COMPOSITE WOOD SECTION. TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. CEIBA - CEIBA PENTANDRA - GOLD COAST. (22 POUNDS PER CUBIC FOOT AT 15 PER CENT MOISTURE CONTENT). (PROGRESS REPORT THIRTY-THREE). November 1955. 12p. tabs. (Forest Products Research Lab.)

Veneers from a tree grown in the Enchi area of the Gold Coast were studied. Processing data, yield measurements and classification are given.

N-42480*

Forest Products Research Lab., Dept. of Scientific and Industrial Research (Gt. Brit.)
THE EFFICIENCY OF ADHESIVES. SUMMARY ONE. R. A. G. Knight. December 1955. 21p. tabs. (Forest Products Research Lab., DSIR)

The results which are presented for plywood joints tested over the last 10-year period include a summary of the history of the work, kind of test piece, types of adhesives, exposure environments employed, system of assessing degrade, and the definition of failure.

N-42497*

Aeronautical Research Council (Gt. Brit.)
SPRING TAB FLUTTER. PART I. A THEORETICAL INVESTIGATION ON WING-AILERON-TAB FLUTTER. R. A. Frazer and W. P. Jones. PART II. EXPERIMENTS ON BINARY AILERON-TAB FLUTTER. C. Scruton, J. Williams, and C. J. W. Miles. 1955. 95p. diagrs., tabs. (ARC R & M 2952. Supersedes ARC 5668; ARC 0.251; ARC 6290; ARC 0.251a; ARC 5917; ARC 0.275)

A theoretical discussion is given of wing-aileron-tab flutter, with special reference to influence of spring tab control. Numerical applications of the theory are made to two representative types of spring tab, and with the aid of special stability diagrams certain conclusions are drawn regarding conditions for flutter prevention. In relation to binary aileron-tab flutter it is shown that certain restrictions on aileron-tab density ratio should be observed, and that when a balancing mass for the tab is fitted its arms should be limited to a certain length. Calculations relating to ternary flutter indicate that the possibility of ternary flutter occurring when all the possible binary types are absent is very remote.

N-42498*

Aeronautical Research Council (Gt. Brit.)
PRESSURE DISTRIBUTIONS: AXIALLY SYMMETRIC BODIES IN OBLIQUE FLOW. I. J. Campbell and R. G. Lewis. 1955. 23p. diagrs., tab. (ARC CP 213)

A simple picture, known from the work of I. Lotz, of the flow over the forward part of a body of revolution in oblique flow is derived from entirely elementary considerations. Pressure at any point of the (forward part of the) body at any angle of attack depends on three parameters whose values vary along the body. Variation of these parameters along the body can be determined from a relatively small number of wind tunnel or water tunnel measurements. Necessary water tunnel measurements have been made for four axially symmetric head shapes. Additional measurements have been made to illustrate the theoretical conclusions. Data for each head shape are adequate for a determination of the pressure coefficient at any point on the head shapes at any angle of attack (up to 6°, say). In particular, they can be used to determine the peak suction at any angle of attack and so the conditions for the onset of cavitation on the head.

N-42499*

Aeronautical Research Council (Gt. Brit.)
ON THE LAMINAR BOUNDARY LAYER SEPARATION FROM THE LEADING EDGE OF A THIN AEROFOIL. P. R. Owen and L. Klanfer. 1955. 19p. diagrs., tabs. (ARC CP 220)

It is suggested that the length of bubble depends primarily on the Reynolds number based on the displacement thickness at the separation point; if the RN exceeds 400-500, the bubble is short: if less than this band of values, the bubble may be long. The RN in turn depends on the distance of the velocity peak on the upper surface of the airfoil from the front stagnation point and it is inferred that, at a given RN based on chord, a long bubble is more likely to form when the velocity peak is close to the stagnation point: but a scale effect, such as to cause the bubble to change from long to short as the RN is increased beyond a critical value, can also be expected. These observations are used to comment on certain peculiarities in the stalling behavior of thin sweptback wings.

N-42500*

Aeronautical Research Council (Gt. Brit.)
THE GEARED ELEVATOR TAB AND TAIL-UNIT STIFFNESS REQUIREMENTS. Ll. T. Niblett. 1955. 18p. diagrs., tabs. (ARC R & M 2848; ARC 14,125. Supersedes RAE Structures 106)

The effect of a flexible, geared, elevator tab upon the validity of the stiffness criteria for tail units and rear fuselages is examined. To this end, the distortions of a hypothetical, semirigid tail unit under the air loads induced when the elevator is displaced are calculated for various arrangements of tab and forward aerodynamic balance of the elevator. Notice is also taken of the loss of control effectiveness and change in elevator hinge moment resulting from these distortions. A torsional-stiffness criterion for tabs is proposed.

N-42501*

Aeronautical Research Council (Gt. Brit.)
MODEL TESTS ON THE ASYMMETRY OF AIRFLOW OCCURRING IN TWIN-INTAKE SYSTEMS AT SUBSONIC SPEEDS. J. Seddon and W. J. G. Trebble. 1955. 15p. diagrs., tabs. (ARC R & M 2910; ARC 13,932. Supersedes RAE Aero 2411)

The tests have shown that asymmetry of flow occurs in typical twin-intake systems under conditions which may be encountered in a dive, or at lower speeds on reducing the engine air flow. Intake loss theory provides a simple formula for estimating the critical flow value of a given arrangement. The chief factors affecting the critical value have been demonstrated in the analysis.

N-42502*

Aeronautical Research Council (Gt. Brit.)
NEUTRAL HOLES IN PLANE SHEET: REINFORCED HOLES WHICH ARE ELASTICALLY EQUIVALENT TO THE UNCUT SHEET. E. H. Mansfield. 1955. 34p. diagrs., photos., tab. (ARC R & M 2815; ARC 13,728. Supersedes RAE Structures 90)

In a plane sheet under any particular loading system, certain reinforced holes may be made which do not alter the stress distribution in the main body of the sheet. These reinforced holes necessarily have exactly the same stiffness and at least the same strength as the portion of the sheet that has been cut out. The weight of the reinforcement is usually greater than the weight of the sheet that has been cut out, though there are cases where it is less. The Airy stress function is used throughout because it admits of great generality and because the properties of a neutral hole can be expressed simply in terms of the function and its derivatives. Indeed, the stress function assumes a new and special significance in determining the shape of a neutral hole.

N-42503*

Aeronautical Research Council (Gt. Brit.)
FLUTTER PROBLEMS OF HIGH-SPEED AIRCRAFT. E. G. Broadbent. 1955. 23p. diagrs., tabs. (ARC R & M 2828; ARC 12,398. Supersedes RAE Structures 37)

Flutter problems of high-speed aircraft are considered generally, and specific consideration is then given to new problems introduced by use of new wing plan forms. Theoretical and experimental results on the coupled ("classical") symmetrical flutter of swept (including "barbed" and cranked forms) and delta wings are reviewed and presented to show the effect and importance of body freedoms of aircraft on critical flutter speed and frequency. A criterion is proposed for deciding the "dangerous type" of fundamental normal mode to be considered in flutter calculations. The danger here is that the fundamental normal mode can combine with the body freedoms and give rise to a form of flutter which is independent of wing torsional stiffness. It is suggested that the deciding feature is the shape of the nodal line in the fundamental mode. If it is such as to indicate rotation of the fore-and-aft wing sections near the tip, then the mode is considered to be dangerous.

N-42504*

Aeronautical Research Council (Gt. Brit.)
HELICOPTER ROTOR BEHAVIOUR AFTER ENGINE FAILURE IN FORWARD FLIGHT. W. Stewart and M. F. Burle. 1955. 13p. diagrs., tab. (ARC R & M 2861; ARC 14,478. Supersedes RAE Tech. Note Aero 2119)

Calculations were made to find the changes in rotor speed following engine failure in forward flight. Several particular examples were investigated, based on the parameters of the S-51 helicopter. The effect of pilot's control movement was included. A rapid loss of rotational speed occurs with practically no change in forward speed of the helicopter, thus the tip-speed ratio increases rapidly. This may lead to stalling of the retreating blade and/or interference of the blades with the droop stops, either of which are dangerous conditions. The time available to the pilot to reduce the collective pitch after engine failure is very short throughout the speed range and engine failure constitutes a danger to safety on this type of helicopter. Some form of automatic pitch reduction or power failure warning system is necessary.

MISCELLANEOUS

N-41873

RECENT RESEARCH ON THE DETERMINATION OF NATURAL MODES AND FREQUENCIES OF AIRCRAFT WING STRUCTURES. John M. Hedgepeth. (Presented to Structures and Materials Panel of Advisory Group for Aeronautical Research and Development, Washington, D. C., April 1956). 29p. diagrs., photos., tabs.

Results of some recent theoretical and experimental studies of vibrations of aircraft wing structures are summarized and discussed. Assessment is made of the importance of various effects not usually included in the elementary theories of bending and torsion of box beams, such as transverse shear flexibility, shear lag, restraint of warping, longitudinal (rotary) inertia, and cross-sectional deformability. The substitute stringer method of incorporating the effects of shear lag into the analysis of box-beam vibration is outlined. Natural frequencies obtained experimentally from resonance tests of box-beam specimens are presented and compared with the results of theoretical calculations. Two recently developed methods of analysis of low-aspect-ratio wings are described.

N-41875

AERODYNAMIC THEORY AND ITS APPLICATION TO FLUTTER. I. E. Garrick. (Presented to Structures and Materials Panel of Advisory Group for Aeronautical Research and Development, Washington, D. C., April 1956). 38p. diagrs.

A survey is given of the present status of aerodynamic theory in relation to flutter analysis with a discussion of concepts implied in the structural and aerodynamical background. Applications of some recent developments in the theory of oscillating wings, offering promise for the flutter analysis of low-aspect-ratio wings, are indicated. Problems of the subsonic and supersonic speed ranges are included.

N-41948

DIVERGENCE OF DELTA AND SWEPT SURFACES IN THE TRANSONIC AND SUPERSONIC SPEED RANGES. Franklin W. Diederich. (Presented to Structures and Materials Panel of Advisory Group for Aeronautical Research and Development, Washington, D. C., April 1956). 58p. diagrs.

Divergence and other static aeroelastic phenomena of swept and delta surfaces are discussed in a qualitative sense. Conclusions are drawn that swept surfaces cannot normally diverge at transonic and supersonic speeds, but that delta wings may diverge in a predominantly chordwise mode at transonic speeds. A method, which in principle considers the deformation of the surface at all points, is outlined for calculating static aeroelastic phenomena of surfaces of low aspect ratio. Various means of modifying the simple-beam theory commonly used for analyses of static aeroelastic phenomena are discussed with the aim of improving its accuracy for surfaces of low aspect ratio.

N-43019

Advisory Group for Aeronautical Research and Development. PAPERS PRESENTED AT THE JOINT SESSION OF THE FLIGHT TEST TECHNIQUES AND WIND TUNNEL AND MODEL TESTING PANELS, OTTAWA, CANADA, JUNE 1955. 134p. diagrs., photos. (Advisory Group for Aeronautical Research and Development. AG18/P8)

Contents: MODERN TRENDS IN DYNAMIC STABILITY ANALYSIS AND EXPERIMENT. H. Guyford Stever, U.S. Air Force, James T. Van Meter, Elmer E. Larrabee, Joseph Bicknell, and Thomas R. Parsons, Massachusetts Institute of Technology. AN INVESTIGATION OF SOME LONGITUDINAL STABILITY AND CONTROL TROUBLES AT HIGH SUBSONIC SPEEDS. E. Billion, Office National d'Etudes et de Recherches Aeronautiques. INTERPRETATION OF WIND-TUNNEL DATA IN TERMS OF DYNAMIC BEHAVIOR OF AIRCRAFT AT HIGH ANGLES OF ATTACK. Ralph W. Stone, Jr., National Advisory Committee for Aeronautics. ON-LINE AUTOMATIC DATA REDUCTION AT THE

ARNOLD ENGINEERING DEVELOPMENT CENTER. David F. Taylor, ARO, Inc. COMPARAISON DE MESURES EN VOL ET EN SOUFFLERIES PORTANT SUR LES CARACTÉRISTIQUES D'UN AVION DANS LE SUBSONIQUE ÉLEVÉ. F. Vinsonneau, Société Nationale de Constructions Aéronautiques du Sud-Ouest. SOME COMPARISONS BETWEEN WIND TUNNEL MODEL AND FLIGHT TEST RESULTS ON AIRCRAFT AT HIGH ANGLES OF ATTACK. R. R. Duddy, Royal Aircraft Establishment. ICING EXPERIMENTS IN FLIGHT AND COMPARISONS WITH WIND TUNNEL TESTING. D. Fraser, National Aeronautical Establishment.

UNPUBLISHED PAPERS

N-41947*

FUNDAMENTALS OF TURBULENT HEAT TRANSFER. (Die Grundlagen des turbulenten Wärmeüberganges). H. Reichardt. February 1956. 50p. diagrs., tabs. (Trans. from Archiv für die gesamte Wärmetechnik, no. 6/7, 1951, p. 129-142)

The need exists for a representation of the turbulent heat transfer which is not a priori tied to hypothetical presuppositions, and where the facts already recognized are clearly distinguished from those as yet uninvestigated. The present treatise offers such a representation. Results of a study of completely continuous damping of the turbulent exchange in the proximity of the wall are included. Beyond this, general formulas are given which form the basis for a later investigation of the influence on the heat transfer of the dependence of the fluid characteristics on the temperature. In addition, the turbulent heat transfer at extremely low Prandtl numbers is treated.

N-43169*

ON CONVERGING AND DIVERGING FLOWS. (Sebamari oyobi hirogari nagare ni tsuite). Busuke Hudimoto. (1956). 10p. diagrs. (Trans. from Transactions of the Society of Mechanical Engineers of Japan, v. 14, no. 48, sec. 3, 1948, p. 1-4)

An experimental analysis was made of two-dimensional convergent and divergent flow. For the convergent flow, it was found that an increase in favorable pressure drop caused an increase in the laminar sublayer thickness, whereas an increase in adverse pressure gradient caused a decrease in this thickness. In the case of the divergent flow, relations were obtained between the divergence ratio of the stream and the static-pressure recovery.

DECLASSIFIED NACA RESEARCH REPORTS

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1215

IMPINGEMENT OF CLOUD DROPLETS ON A CYLINDER AND PROCEDURE FOR MEASURING LIQUID-WATER CONTENT AND DROPLET SIZES IN SUPERCOOLED CLOUDS BY ROTATING MULTICYLINDER METHOD. R. J. Brun, W. Lewis, P. J. Perkins and J. S. Serafini. Appendix E: ALTERNATE METHOD OF REDUCING ROTATING MULTICYLINDER DATA. Paul T. Hacker. 1955. iv, 43p. diagrs., photos., tabs. (NACA Rept. 1215. Supersedes TN 2903; TN 2904; RM E53D23)

The amount of water impinging in droplet form, the area of impingement, and the rate of impingement per unit area on a cylinder surface are calculated from droplet trajectories and presented in terms of dimensionless parameters to cover a wide range of flight and atmospheric conditions. The rotating multicylinder method for in-flight determination of liquid-water content and droplet size is described, including the theory of operation, the apparatus required, the technique of obtaining data in flight, and detailed methods of calculating the results. Necessary charts and tables are presented.

NACA Rept. 1229

EXACT SOLUTIONS OF LAMINAR-BOUNDARY-LAYER EQUATIONS WITH CONSTANT PROPERTY VALUES FOR POROUS WALL WITH VARIABLE TEMPERATURE. Patrick L. Donoughe and John N. B. Livingood. 1955. ii, 21p. diagrs., tabs. (NACA Rept. 1229. Supersedes TN 3151)

Solutions were computed for a Prandtl number of 0.7 and a range of cooling-air flows, and pressure and wall temperature gradients. For each case, boundary-layer thicknesses and heat-transfer and friction coefficients were also computed and tabulated. Steeper temperature profiles for a given coolant flow were obtained by increased wall temperature gradients. Wall temperature gradients for zero boundary-layer temperature gradients at the wall were increased by increased pressure gradient and decreased by increased coolant flow.

NACA Rept. 1232

A THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE LIFT AND DRAG CHARACTERISTICS OF HYDROFOILS AT SUBCRITICAL AND SUPERCRITICAL SPEEDS. Kenneth L. Wadlin, Charles L. Shuford, Jr., and John R. McGehee. 1955. ii, 22p. diagrs., photos., tab. (NACA Rept. 1232. Supersedes RM L52D23a)

A theoretical and experimental investigation was made of the effect of the free-water surface and rigid boundaries on the lift and drag of an aspect-ratio-10 hydrofoil at both subcritical and supercritical speeds and of an aspect-ratio-4 hydrofoil at supercritical speeds. Approximate theoretical solutions for the effect of the free-water surface and rigid boundaries on lift and drag at supercritical speeds were developed. An approximate theoretical solution for the effect of these boundaries on drag at subcritical speeds was also presented. The agreement between theory and experiment at both supercritical and subcritical speeds is satisfactory for engineering calculations of hydrofoil characteristics from aerodynamic data.

NACA Rept. 1238

INVESTIGATIONS AT SUPERSONIC SPEEDS OF 22 TRIANGULAR WINGS REPRESENTING TWO AIRFOIL SECTIONS FOR EACH OF 11 APEX ANGLES. Eugene S. Love. 1955. ii, 60p. diagrs., photos., tabs. (NACA Rept. 1238. Supersedes RM L9D07)

The results of tests of 22 triangular wings, representing two leading-edge shapes for each of 11 apex angles, at Mach numbers of 1.62, 1.92, and 2.40 are presented and compared with theory. All wings have a common thickness ratio of 8 percent and a common maximum-thickness point at 18 percent chord. Lift, drag, and pitching moment are given for all wings at each Mach number. The relation of transition in the boundary layer, shocks on the wing surfaces, and characteristics of the pressure distributions is discussed for several wings.

*AVAILABLE ON LOAN ONLY.

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NACA Rept. 1239

ERROR IN AIRSPEED MEASUREMENT DUE TO THE STATIC-PRESSURE FIELD AHEAD OF AN AIRPLANE AT TRANSONIC SPEEDS. Thomas C. O'Bryan, Edward C. B. Danforth, and J. Ford Johnston. February 1956. 13p. diagrs., photos. (NACA Rept. 1239. Supersedes RM L9C25; RM L50L28; RM L52A17)

Measurements of static-pressure error ahead of sharp-nose bodies, open-nose air inlets, and ahead of the wing tip of a swept-wing fighter airplane model have been made at transonic speeds by use of the NACA wing-flow method.

NACA Rept. 1249

A UNIFIED TWO-DIMENSIONAL APPROACH TO THE CALCULATION OF THREE-DIMENSIONAL HYPERSONIC FLOWS, WITH APPLICATION TO BODIES OF REVOLUTION. A. J. Eggers, Jr. and Raymond C. Savin. 1955. ii, 27p. diagrs., tab. (NACA Rept. 1249. Supersedes TN 2811)

A procedure for calculating three-dimensional steady and nonsteady supersonic flows with the method of characteristics is developed and discussed. An approximate method is deduced from the characteristics method and shown to be of practical value at high supersonic speeds.

NACA Rept. 1250

THE DYNAMIC-RESPONSE CHARACTERISTICS OF A 35° SWEPT-WING AIRPLANE AS DETERMINED FROM FLIGHT MEASUREMENTS. William C. Triplett, Stuart C. Brown, and G. Allan Smith. 1955. ii, 25p. diagrs., tabs. (NACA Rept. 1250. Supersedes RM A51G27; RM A52I17)

Longitudinal and lateral directional dynamic-response characteristics of a 35° swept-wing fighter airplane are presented. Frequency responses, transfer functions, and stability derivatives are evaluated from flight measurements of airplane responses to abrupt elevator, rudder, and aileron motions through the Mach number range of 0.50 to 1.04. A graphical method for converting frequency-response data into transfer function form is discussed, and test results are compared to predictions based on wind-tunnel tests.

NACA RM L55G26a

A WIND-TUNNEL INVESTIGATION OF A 0.4-SCALE MODEL OF AN ASSAULT-TRANSPORT AIRPLANE WITH BOUNDARY-LAYER CONTROL APPLIED. Marvin P. Fink, Bennie W. Cocke, and Stanley Lipson. May 1956. 63p. diagrs., photos. (NACA RM L55G26a)

The results of an investigation made in the Langley full-scale tunnel to evaluate the lift, drag, and stability and control characteristics of a 0.4-scale model of an assault-transport airplane equipped with a boundary-layer-control system are presented. The boundary-layer-control system of this investigation utilized a single pump to suck air in over the inboard flap and to discharge the same air over the aileron through a blowing slot. Results include the effects of such variables as flap hinge position, suction slot design, quantity of air handled, flap deflection, and propeller operation on the lifting effectiveness of the boundary-layer-control system.

NACA TM 1369

FLAT PLATE CASCADES AT SUPERSONIC SPEED. (Ebene Plattengitter bei Überschallgeschwindigkeit). Rashad M. El Badrawy. May 1956. iii, 130p. diagrs., photos., tabs. (NACA TM 1369. Trans. of Eidgenössische Technische Hochschule Zürich. Institut für Aerodynamik. Mitteilungen 19)

A brief review of exact two-dimensional supersonic flow theory and Ackeret's linearized theory are first presented. The lift and drag coefficients of a cascade of flat plates are calculated exactly and compared to those obtained using the linearized theory. The forces on the cascade are determined for unsteady inlet flow. The flat plate cascade theory is extended to compute the efficiency of a supersonic propeller with friction and finite blade thickness.

NACA TM 1393

FLOW OF GAS THROUGH TURBINE LATTICES. M. E. Deich. May 1956. 136p. diagrs., photos. (NACA TM 1393. Trans. of Russian book: Technical Gasdynamics, ch. 7, 1953, p. 312-420)

This report is concerned with fluid mechanics of two-dimensional cascades, particularly turbine cascades. Methods of solving the incompressible ideal flow in cascades are presented. The causes and the order of magnitude of the two-dimensional losses at subsonic velocities are discussed. Methods are presented for estimating the flow and losses at high subsonic velocities. Transonic and supersonic flows in lattices are then analyzed. Some three-dimensional features of the flow in turbines are noted.

NACA TN 3546

EXPLORATORY INVESTIGATION OF BOUNDARY-LAYER TRANSITION ON A HOLLOW CYLINDER AT A MACH NUMBER OF 6.9. Mitchel H. Bertram. May 1956. 38p. diagrs., photo., tab. (NACA TN 3546)

The Reynolds number for transition on the outside of a hollow cylinder with heat transfer from the boundary layer to the wall has been investigated at a Mach number of 6.9 in the Langley 11-inch hypersonic tunnel. From consideration of only the results obtained in that portion of the nozzle which surveys indicated to have an essentially constant Mach number, the Reynolds number for the start of transition was between 4×10^6 and 6×10^6. From a correlation of results obtained from various sources at lower Mach numbers (in the range 2.0 to 4.5) leading-edge thickness and free-stream Reynolds number per inch appear to be important considerations in flat-plate transition results. At a given Mach number it appears that the Reynolds number based on leading-edge thickness is an important parameter that must be considered in comparisons of flat-plate transition data from various facilities.

NACA TN 3604

LOW-SPEED YAWED-ROLLING CHARACTERISTICS AND OTHER ELASTIC PROPERTIES OF A PAIR OF 26-INCH-DIAMETER, 12-PLY-RATING, TYPE VII AIRCRAFT TIRES. Walter B. Horne, Robert F. Smiley, and Bertrand H. Stephenson. May 1956. 98p. diagrs., photos., tabs. (NACA TN 3604)

The low-speed (up to 2 miles per hour) cornering characteristics of two 26 x 6.6, type VII, 12-ply-rating tires under straight-yawed rolling were determined over a range of inflation pressures and yaw angles for two vertical loads. The cornering characteristics of one tire rolling along circular paths of different radii were investigated for one condition of vertical load and inflation pressure. Static tests were also performed to determine the vertical, lateral, torsional, and fore-and-aft elastic characteristics of the tires. The quantities measured included lateral or cornering force, drag force, torsional moment or self-alining torque, pneumatic caster, vertical tire deflection, lateral tire deflection, wheel torsion or yaw angle, rolling radius, and relaxation length. Some supplementary tests were made which included measurements of tire footprint area and the variation of unloaded tire radius with inflation pressure.

NACA TN 3641

WIND-TUNNEL INVESTIGATION OF A NUMBER OF TOTAL-PRESSURE TUBES AT HIGH ANGLES OF ATTACK. SUBSONIC, TRANSONIC, AND SUPERSONIC SPEEDS. William Gracey. May 1956. 30p. diagrs., tabs. (NACA TN 3641)

The total-pressure errors of 54 total-pressure tubes at angles of attack up to 60° and Mach numbers from 0.26 to 1.62 are presented. The configurations of the various tubes differed as regards external shape, internal shape, and type of total-pressure entry. External shapes tested included cylindrical, conical, and ogival nose sections. Internal shapes and total-pressure entries were varied on the basis of such factors as size of impact openings, internal chamber shape, leading-edge slant profile, and shielding (combined with venting). The effect of these variables on the sensitivities of the tubes to angle of attack is presented.

NACA TN 3643

MEASUREMENT OF AERODYNAMIC FORCES FOR VARIOUS MEAN ANGLES OF ATTACK ON AN AIRFOIL OSCILLATING IN PITCH AND ON TWO FINITE-SPAN WINGS OSCILLATING IN BENDING WITH EMPHASIS ON DAMPING IN THE STALL. A. Gerald Rainey. May 1956. i, 66p. diagrs., photo. (NACA TN 3643)

The oscillating air forces on a two-dimensional wing oscillating in pitch about the midchord have been measured at various angles of attack and at Mach numbers of 0.35 and 0.7. Large regions of unstable damping in pitch were found. Measurements of the aerodynamic damping of a 10-percent-thick and a 3-percent-thick finite-span wing oscillating in, essentially, the first bending mode indicate no regions of unstable damping for this type of motion over the range of variables covered.

NACA TN 3647

INVESTIGATION OF THE COMPRESSIVE STRENGTH AND CREEP LIFETIME OF 2024-T ALUMINUM-ALLOY SKIN-STRINGER PANELS AT ELEVATED TEMPERATURES. Eldon E. Mathauser and William D. Deveikis. May 1956. 29p. diagrs., photos., tabs. (NACA TN 3647)

The experimental results of an investigation to determine compressive strength and creep lifetime of 2024-T (formerly 24S-T) aluminum-alloy skin-stringer panels at room temperature and at 400° F are presented. The results of strength tests at room temperature and 400° F are compared with predicted strength obtained from methods given in the literature for estimating crippling strength of short panels and for predicting column strength of longer panels. Creep lifetime curves are presented for four values of slenderness ratio and creep characteristics of the panels are discussed. A method which makes use of isochronous compressive stress-strain curves for predicting creep lifetime of panels is presented.

NACA TN 3648

INVESTIGATION OF BOUNDARY-LAYER TRANSITION ON 10° CONE IN LANGLEY 4- BY 4-FOOT SUPERSONIC PRESSURE TUNNEL AT MACH NUMBERS OF 1.41, 1.61, AND 2.01. Archibald R. Sinclair and K. R. Czarnecki. May 1956. 17p. diagrs., photos. (NACA TN 3648)

An investigation has been made to determine the transition Reynolds numbers on a 10° cone in the Langley 4- by 4-foot supersonic pressure tunnel at Mach numbers of 1.41, 1.61, and 2.01 and over a Reynolds number range from about 0.8×10^6 to 9.5×10^6 per foot. The results indicated that the transition Reynolds numbers increased with tunnel stagnation pressure and that there was no effect of Mach number on transition Reynolds numbers. A single-element surface roughness caused a larger decrease in transition Reynolds number than was experienced in low-speed or in other supersonic wind-tunnel investigations.

NACA TN 3692

INVESTIGATION AT ZERO FORWARD SPEED OF A LEADING-EDGE SLAT AS A LONGITUDINAL CONTROL DEVICE FOR VERTICALLY RISING AIRPLANES THAT UTILIZE THE REDIRECTED-SLIPSTREAM PRINCIPLE. Richard E. Kuhn. May 1956. 33p. diagrs., photos. (NACA TN 3692)

Results are presented of an investigation of a leading-edge slat as a longitudinal control device for vertically rising airplanes in hovering flight. The model consisted of a semispan wing equipped with a 60-percent-chord and a 30-percent-chord slotted flap operating in the slipstreams of two large-diameter propellers. The tests were conducted at zero speed in a large room. The results indicate that the slat can provide increments of pitching moment of the order of those required for trim and control in hovering flight. Also the leading-edge slat can appreciably reduce the adverse effects of the ground on the effectiveness of the slotted-flap wing in redirecting the slipstreams downward.

NACA TN 3693

PRELIMINARY INVESTIGATION OF THE EFFECTIVENESS OF A SLIDING FLAP IN DEFLECTING A PROPELLER SLIPSTREAM DOWNWARD FOR VERTICAL TAKE-OFF. Richard E. Kuhn and Kenneth P. Spreemann. May 1956. 25p. diagrs., photo. (NACA TN 3693)

Results are presented of an investigation of the effectiveness of a sliding flap in deflecting propeller slipstreams downward for vertical take-off. The model consisted of a semispan wing equipped with a 50-percent-chord sliding flap and a 25-percent-chord plain flap. The tests were conducted at zero forward speed in a large room and included the effects of flap deflection, proximity to the ground, a leading-edge slat, and a chord-extension. The results indicate that the diving moments associated with the sliding flap were appreciably smaller than those of the slotted-flap configuration previously investigated.

NACA TN 3714

A SONIC-FLOW ORIFICE PROBE FOR THE IN-FLIGHT MEASUREMENT OF TEMPERATURE PROFILES OF A JET ENGINE EXHAUST WITH AFTERBURNING. C. Dewey Havill and L. Stewart Rolls. May 1956. 18p. diagrs., photos. (NACA TN 3714)

A temperature-measuring system using two sonic-flow orifices in series is described. This system was adapted to measure the exhaust gas temperature of an afterburning jet engine and was mounted in a swinging pitot-static probe. The sonic-flow orifice system had only a small variation in temperature at the thermocouple and temperature change was measured as a change in pressure. Measurement of exhaust temperature of 3200° R was obtained during afterburner operation in flight.

BRITISH REPORTS

N-41378*

Royal Aircraft Establishment (Gt. Brit.) LOW SPEED TUNNEL TESTS ON THE FLOW STRUCTURE BEHIND A BODY OF REVOLUTION OF FINENESS RATIO $16\frac{2}{3}$:1. A. Spence and W. J. G. Trebble. October 1955. 20p. diagrs. (RAE Tech. Note Aero 2406)

As part of a general program of tests to determine the low speed characteristics of supersonic designs, tests have been made on a body of revolution of fineness ratio $16\frac{2}{3}$:1, the shape being that giving minimum supersonic wave drag for a given fineness ratio and length. Wake traverses have been made at incidences of 10° and 20°, the former having a symmetrical pair of trailing vortices, and the latter an asymmetric flow. Surface pressure measurements have also been made in the symmetrical flow range, and the results analyzed to show the effect of viscosity on the normal force distribution.

N-42459*

Royal Aircraft Establishment (Gt. Brit.) THE ATMOSPHERIC STRESS-CORROSION OF ALUMINIUM-ZINC-MAGNESIUM TYPE ALLOYS. G. Meikle and D. Lewis. October 1955. 41p. diagrs., photos., tabs. (RAE Met. 88)

Variation of structure produced by heat treatment resulted in increased resistance to stress-corrosion. For extruded material containing chromium and stressed in the long transverse direction, improvement was produced by prolonging the aging time at 130° C, raising the aging temperature to 150° C, and by lowering the solution temperature to 435° C. The RR77 forged chromium-free alloy showed improvement by prolonged aging at 130° C and by increasing the aging temperature to 150° C. For both alloys stressed across end-grain the maximum susceptibility was produced after 32 hours aging at 130° C but longer periods indicated that improvement would result. Aging temperatures below 130° C gave poor results.

N-42627*

Royal Aircraft Establishment (Gt. Brit.) AN ABRIDGED LIST OF REPORTS, SPECIFICATIONS, AND INSTRUCTION LEAFLETS, ISSUED BY INSTRUMENTATION DEPARTMENT 1945-1955. N. E. G. Hill. February 1956. 18p. (RAE Tech. Memo. Instn. 273)

The memorandum contains a list of documents, selected from the publications of Instrumentation Department, RAE, during the past 10 years, which are relevant to present technical thought, available, and suitable for general circulation.

N-42628*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) SOME ASPECTS OF NIGHT AND INSTRUMENT FLYING ON SINGLE ROTOR HELICOPTERS. D. A. Wilkinson. January 27, 1956. 29p. diagrs., photos. (AAEE/Res/291)

Several night flying and instrument flying investigations which have been made on Sycamore, Dragonfly, and Whirlwind helicopters are reviewed and related. These include ground lighting equipment and patterns, approach path angles, the entry into restricted sites, the emergency use of parachute flares, cockpit lighting, and instrument flying tests.

N-42629*

Royal Aircraft Establishment (Gt. Brit.)
THE THEORETICAL DETERMINATION OF NORMAL MODES AND FREQUENCIES OF VIBRATION. I. T. Minhinnick. (To be presented to Structures and Materials Panel, Advisory Group for Aeronautical Research and Development, Washington, D. C., April 1956.) January 1956. 47p. diagrs. (RAE Structures 197)

In this paper the various methods that have been devised for the determination of the natural frequencies and normal modes of aircraft are discussed and their accuracy and the amount of work that they entail are compared. An extensive bibliography is given in an appendix. The discussion is mainly from the point of view of the flutter analyst, who commonly bases his analyses on the normal modes, but the description and comparison of the various methods should be of general interest.

N-42630*

Royal Aircraft Establishment (Gt. Brit.)
MODELS FOR AERO-ELASTIC INVESTIGATIONS. H. Templeton. (Presented at a Conference on Model Techniques, Venice, October 1955, by the Accademia Nazionale Dei Lincei of Italy.) November 1955. 20p. diagrs., photos. (RAE Tech. Note Structures 179)

An account is given of several types of aeroelastic models used for flutter investigations. The various purposes for which they are used are outlined, and the scale relationships for prediction models are derived. Different types of model construction are described and their main applications are defined.

N-42632*

Royal Aircraft Establishment (Gt. Brit.)
SUBTABULATION ON A HIGH SPEED COMPUTER. E. R. de Bourcier. January 1956. 32p. diagr. (RAE Tech. Note MS 24)

General formulas are derived for subtabulation at an integral number of subintervals within the original interval, details of an existing program when the number is a power of two are given, and necessary alterations for other cases are indicated. The corresponding formulas for a nonintegral number of subintervals are given; these can be used for conversion of tables from one argument to another. The appendix contains flow diagrams and operational details; detailed coding may be had on request.

N-42634*

Royal Aircraft Establishment (Gt. Brit.)
THE RESPONSE TIME OF TRANSDUCTORS WITH NEGATIVE VOLTAGE FEEDBACK. F. D. Gill. December 1955. 18p. diagrs., tabs. (RAE Tech. Note EL 107)

The use of negative feedback in a transductor circuit reduces both power amplification and response time but not necessarily in the same proportion. Tests were performed to determine to what extent they are affected and to determine the response time when the feedback fraction is sufficient to reduce the voltage amplification to unity.

N-42641*

Royal Aircraft Establishment (Gt. Brit.)
THE HEATING EFFECT OF STEADY AND PULSED CURRENT IN RESISTANCE TRANDUCERS. K. R. Maslen and Mary Coulter. November 1955. 25p. diagrs., photo., tabs. (RAE Tech. Note Instn. 150)

It has been suggested that the output signal of resistance transducers might be increased by energizing them with pulsed input of very much higher voltage than is permissible for steady energization. An attempt is made in this note to determine to what extent such inputs may be increased without increasing the temperature rise in the transducer. Measurements have been made of the heating effect of steady and pulsed input in some unbonded transducers and other specimens, and a theoretical analysis is included. It is shown that, provided the period of energization is short compared with the time constant of heating of an unbonded transducer, the peak voltage may be increased to any extent which does not increase the mean power input to the transducer. The behavior of bonded transducers appears to be more complex, and further work is required to establish the safe conditions for them.

N-42642*

Royal Aircraft Establishment (Gt. Brit.)
STATIC STRENGTH TESTS OF A COMET I PRESSURE CABIN. P. B. Walker. December 1955. 15p. diagrs., photos. (RAE Structures 196)

The Court of Inquiry into the accidents to Comet I aircraft G-ALYP and G-ALYY recommended that a static strength test be made on a complete Comet pressure cabin. Such a test has now been completed at RAE, and is described in this report. The main conclusion is that the static strength of the Comet pressure cabin is satisfactory to the standard laid down at the time of the accidents.

N-42643*

National Gas Turbine Establishment (Gt. Brit.)
THE FOULING OF TURBINE BLADING BY THE PRODUCTS OF COMBUSTION OF PULVERISED FUEL. PART IV. THE EFFECT OF BLADING DESIGN, AND OF INERTIAL DE-DUSTING. R. I. Hodge. December 1955. 39p. diagrs., photos., tabs. (NGTE Memo. M. 253)

This memorandum describes the continuation of the work reported in memorandum No. M. 196. The products of combustion of pulverized coal were passed through a static group of blades and the effects observed with various profiles and operating conditions. The efficacy of an inertial separator of high cleaning efficiency was demonstrated.

N-42644*

Royal Aircraft Establishment (Gt. Brit.)
NON-STOICHIOMETRY AND METAL OXIDES.
I. David. (Two lectures given in Chemistry Department on the 4th and 5th of August, 1955.) September 1955. 20p. diagrs. (RAE Tech. Note Chem. 1264)

The causes of nonstoichiometry in heteropolar compounds are surveyed, emphasis being laid on the relationship between nonstoichiometry and the crystal structure of these substances. The structural characteristics of metal oxides are outlined, and the magnetic and electrical properties of some classes of oxide explained in terms of their crystal structure.

N-42646*

Royal Aircraft Establishment (Gt. Brit.)
POLYURETHANE BASE ENAMELLED WINDING WIRE. T. D. Mason. September 1955. 9p. tabs. (RAE Tech. Note EL 102)

This note compares the properties of polyurethane base enameled winding wires which are commercially available from three different wire manufacturers. The results show that the enamel is hard and reasonably flexible, and has self-fluxing properties which make it possible to tin the wire without previously removing the enamel. Due to the variation in the performance of the wires tested it is considered that this type of covering should not be used in production until a specification is available.

N-42653*

Royal Aircraft Establishment (Gt. Brit.)
SOME EXPERIMENTS ON THE TITANIUM-CARBON SYSTEM. R. L. Bickerdike and G. Hughes. December 1955. 33p. diagrs., photos., tabs. (RAE Met. 89)

A vacuum quenching furnace for use up to 2100° C for short periods and up to at least 1800° C for long periods has been constructed. Using this equipment, the melting point of titanium and part of the titanium-carbon phase diagram have been determined. The melting point of titanium was found to be 1671 ± 8° C and the titanium-carbon system to have a eutectic at 1645 ± 8° C and about 1.14 percent carbon. The liquidus from the eutectic point up to 1763° C has been determined. Experiments were carried out on the rate of carbon pickup by molten titanium, and it is considered that diffusion in the liquid is probably the main rate controlling factor.

MISCELLANEOUS

NACA Rept. 1232

Errata on "A THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE LIFT AND DRAG CHARACTERISTICS OF HYDROFOILS AT SUBCRITICAL AND SUPERCRITICAL SPEEDS." Kenneth L. Wadlin, Charles L. Shuford, Jr., and John R. McGehee. 1955.

UNPUBLISHED PAPERS

N-43503*

ON THE NATURE OF TURBULENT COMBUSTION. (O Prirode Turbulentnogo Goreniya). Y. B. Sviridov. (1956). 30p. diagrs. (Trans. from Akademiia Nauk SSSR, Izvestiia, Otdelenie Tekhnicheskikh Nauk, no. 11, 1953, p. 1577-1597)

The effect of turbulence on flame propagation rates is considered theoretically. Large- and small-scale turbulent combustion is classified as follows: (1) stationary and nonstationary combustion, (2) nonstationary combustion with point ignition and developed initial flame front, and (3) turbulent combustion with developed spectra of both isotropic and anisotropic turbulence. Equations relating the thickening of the combustion zone to the turbulent field characteristics are developed.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification May 14, 1956.

NACA MR L5I13
NACA MR L5K06
NACA MR L6C18
NACA MR L6C21
NACA MR L6G10
NACA MR L6G25

NACA RM A9E24

NACA RM A50E10

THE TRANSONIC CHARACTERISTICS OF A LOW-ASPECT-RATIO TRIANGULAR WING WITH A CONSTANT-CHORD FLAP AS DETERMINED BY WING-FLOW TESTS, INCLUDING CORRELATION WITH LARGE-SCALE TESTS. George A. Rathert, Jr., L. Stewart Rolls, and Carl M. Hanson. July 18, 1950. 39p. diagrs., photo. (NACA RM A50E10)

Wing-flow-method measurements are presented from 0.47 to 1.15 Mach number of the longitudinal stability and control characteristics of a triangular wing of aspect ratio 2 equipped with a constant-chord flap. Because of the low Reynolds number, 920,000 to 1,690,000, correlation with large-scale tests is used to study the effect on the significance of the data. The plan-form characteristics at transonic speeds showed moderate and gradual changes and were relatively unaffected by scale. The flap retained positive effectiveness at all speeds and flap angles.

NACA RM A50F06

LIFT AND PITCHING-MOMENT INTERFERENCE BETWEEN A POINTED CYLINDRICAL BODY AND TRIANGULAR WINGS OF VARIOUS ASPECT RATIOS AT MACH NUMBERS OF 1.50 AND 2.02. Jack N. Nielsen, Elliott D. Katzen, and Kenneth K. Tang. September 12, 1950. 53p. diagrs., photos., tabs. (NACA RM A50F06)

The lift and pitching-moment characteristics of a body alone, six triangular wings of various aspect ratios, and the combinations were measured at Mach numbers of 1.50 and 2.02 at a Reynolds number of 5.5 million (based on the body length). The total lift and pitching-moment interference were determined and compared with theory. The agreement was found to be good.

NACA RM A53E12

THE EFFECTS OF LEADING-EDGE EXTENSIONS, A TRAILING-EDGE EXTENSION, AND A FENCE ON THE STATIC LONGITUDINAL STABILITY OF A WING-FUSELAGE-TAIL COMBINATION HAVING A WING WITH 35° OF SWEEPBACK AND AN ASPECT RATIO OF 4.5. Ralph Selan and Angelo Bandettini. August 1953. 81p. diagrs., photos., tabs. (NACA RM A53E12)

Test results are presented to show the effects of various modifications including several leading-edge chord extensions, a trailing-edge extension, and a fence on the static longitudinal stability of a model having a wing with 35° sweepback, an aspect ratio 4.5, and a taper ratio 0.5. The tests were conducted at various Mach numbers up to 0.92 at a Reynolds number of 2 million, and at a Mach number of 0.20 at a Reynolds number of 11 million.

NACA RM A54E10

EFFECTS OF HIGH-LIFT DEVICES AND HORIZONTAL-TAIL LOCATION ON THE LOW-SPEED CHARACTERISTICS OF A LARGE-SCALE 45° SWEPT-WING AIRPLANE CONFIGURATION. Ralph L. Maki and Ursel R. Embry. August 1954. 46p. diagrs., photo., tabs. (NACA RM A54E10)

An investigation was made of a 45° swept-wing model of aspect ratio 3.5 and taper ratio 0.3 with high-lift devices designed to delay the occurrence of stalled flow to a wing-lift coefficient of 1.4 at 14° angle of attack. Unstable pitching moments after stalled flow began were largely controlled by locating the horizontal tail in the extended wing-chord plane.

NACA RM A54G13

INVESTIGATION OF THE NACA 4-(5)(05)-037 SIX- AND EIGHT-BLADE, DUAL-ROTATION PROPELLERS AT POSITIVE AND NEGATIVE THRUST AT MACH NUMBERS UP TO 0.90, INCLUDING SOME AERODYNAMIC CHARACTERISTICS OF THE NACA 4-(5)(05)-041 TWO- AND FOUR-BLADE, SINGLE-ROTATION PROPELLERS. John H. Walker and Robert M. Reynolds. October 1954. 148p. diagrs., photos., tabs. (NACA RM A54G13)

Presented are the results of tests in the Ames 12-foot pressure tunnel for a wide range of propeller blade angles and forward speeds. Limited comparisons show the effects of total solidity, of spinner shape, and of blade-angle differential between the front and rear units of the dual propeller. Included are the results of tests of the propellers at near static conditions.

#NACA RM E6I23

NACA RM E6L06

PERFORMANCE OF A 20-INCH STEADY-FLOW RAM JET AT HIGH ALTITUDES AND RAM-PRESSURE RATIOS. Eugene Perchonok, William H. Sterbentz, and Fred A. Wilcox. June 25, 1947. 39p. diagrs., photos. (NACA RM E6L06)

The investigation was conducted in the Cleveland altitude wind tunnel at altitudes ranging from 7000 to 41,500 feet and at ram-pressure ratios equivalent to free-stream Mach numbers as great as 1.84 using preheated 62-octane fuel. Supplementary tests to determine any change in performance caused by changing the fuel to preheated 100-octane were also made. An extension of the methods of data reduction and of the generalizing performance parameters applicable at supersonic Mach numbers and over a wide range of operating conditions is presented. The magnitudes of the total-pressure losses across the various phases of the ram-jet cycle are analyzed and discussed.

NACA RM E7I05a

FLIGHT INVESTIGATION OF A 20-INCH-DIAMETER STEADY-FLOW RAM JET. John H. Disher. January 14, 1948. 29p. diagrs., photo. (NACA RM E7I05a)

A flight investigation was conducted on a 20-inch steady-flow ram jet. The ram jet was studied in flight at altitudes from 5,000 to 30,000 feet and free-stream Mach numbers up to 0.51. A range of fuel-air ratios from 0.013 to 0.11 and combustion-chamber-inlet velocities up to 154 feet per second were covered. Data were obtained on flame stability and combustion efficiency for these conditions.

NACA RM E8D22

INVESTIGATION OF EFFECTS OF MOVABLE EXHAUST-NOZZLE PLUG ON OPERATIONAL PERFORMANCE OF 20-INCH RAM JET. William H. Sterbentz and Fred A. Wilcox. July 27, 1948. 32p. diagrs., photos. (NACA RM E8D22)

Effects of a movable exhaust-nozzle plug on the operational performance of a 20-inch ram jet were determined in an investigation conducted in the Cleveland altitude wind tunnel. Incorporation of the nozzle plug into the combustion chamber of the ram jet improved the combustion efficiency of the engine. The negligible effect of the exhaust-nozzle plug on the net thrust per square foot of exhaust-nozzle area indicated that the total-pressure losses over the exhaust-nozzle plug were small.

#NACA RM E8E21
#NACA RM E8F11

NACA RM E8F21

PERFORMANCE OF A RAM-JET-TYPE COMBUSTOR WITH FLAME HOLDERS IMMERSED IN THE COMBUSTION ZONE. Roland Breitwieser. November 1, 1948. 47p. diagrs., photos. (NACA RM E8F21)

A performance comparison was made between a conventional single-row ram-jet burner and burners embodying one, two, and three rows of gutters immersed in the combustion zone. The stepwise addition of rows of wedges immersed in the combustion zone regularly extended the stability limits of combustion. The maximum allowable inlet-air velocity for the four-row configuration was approximately twice the inlet-air velocity of the conventional single-row configuration.

#NACA RM E8I01a
#NACA RM E8L20

NACA RM E9F09

DESIGN FACTORS FOR 4- BY 8-INCH RAM-JET COMBUSTOR. Donald W. Male and Adolph J. Cervenka. August 11, 1949. 47p. diagrs., photos. (NACA RM E9F09)

An investigation was made of a series of flame holders designed with objective of providing high combustion efficiency in a 4- by 8-inch ram-jet combustor 24 inches long at inlet-air velocity of 200 feet per second, inlet-air pressure of 60 inches mercury absolute, inlet-air temperature of 200° F, and near stoichiometric fuel-air ratio. The most efficient and stable combustor designs investigated employed fuel injection directly at upstream end of flame holder that combined surfaces heated to incandescence by immersion in flame with continuous path of low stream velocity for flame propagation between upstream and downstream ends of flame holder. Silicon-coated molybdenum was satisfactorily used as flame-holder material at high temperatures encountered.

NACA RM E9F20

INVESTIGATION OF INTERNAL REGENERATIVE FUEL-HEATING SYSTEM FOR 20-INCH RAM JET. Sol Baker and Eugene Perchonok. September 1, 1949. 22p. diagrs., photos. (NACA RM E9F20)

A test-stand investigation was undertaken to evaluate the effectiveness of a simple internal regenerative fuel preheater for a 20-inch-diameter ram jet. Data obtained at subsonic sea-level conditions indicate that the fuel can be successfully preheated in this manner. The distance the preheater was located downstream of the flame holder is the primary variable affecting the final fuel temperature. The additional pressure loss caused by the introduction of the preheater in the combustion chamber may be considered negligible.

NACA RM E9F22

FREE-FLIGHT PERFORMANCE OF 16-INCH-DIAMETER SUPERSONIC RAM-JET UNITS. I - FOUR UNITS DESIGNED FOR COMBUSTION-CHAMBER-INLET MACH NUMBER OF 0.12 AT FREE-STREAM MACH NUMBER OF 1.6 (UNITS A-2, A-3, A-4, AND A-5). William W. Carlton and Wesley E. Messing. September 22, 1949. 51p. diagrs., photos. (NACA RM E9F22)

Free-flight investigations were conducted on four 16-inch-diameter ram-jet units to determine the performance at high subsonic and supersonic velocities. The effects of free-stream Mach number and gas total-temperature ratio on diffuser total-pressure recovery, thrust coefficient, and external-drag coefficient are correlated. Performance data of individual ram-jet units were obtained over a range of free-stream Mach numbers from 0.38 to 1.73 and for gas total-temperature ratios between 1.0 and 6.6.

NACA RM E9H12

EXPERIMENTAL INVESTIGATION OF PRESSURE FLUCTUATIONS IN 3.6-INCH RAM JET AT MACH NUMBER 1.92. James F. Connors and Albert H. Schroeder. October 13, 1949. 20p. diagrs., photos. (NACA RM E9H12)

From experiments on 3.6-inch ram jet at Mach number 1.92, pressure-fluctuation amplitudes based on single-point instantaneous measurements are presented as function of fuel-air ratio for several outlet-inlet area ratios. With both burner configurations at optimum mean combustion-chamber static pressure, maximum instantaneous pressure coincided with static pressure at optimum cold recovery. With conical flame-holder configuration, minimum instantaneous pressure at optimum mean pressure recovery approximated cold static pressure corresponding to particular outlet area. Fundamental frequency varied from 6 to 35 cycles per second. Improved diffuser performance was realized with regenerative-type burner as compared with perforated conical flame-holder configuration.

NACA RM E9H19

ANALYSIS AND EXPERIMENTAL OBSERVATION OF PRESSURE LOSSES IN RAM-JET COMBUSTION CHAMBERS. William H. Sterbentz. November 4, 1949. 22p. diagrs. (NACA RM E9H19)

Analyses were made to determine the effect of primary variables on pressure losses resulting from flame-holder drag and heat addition in a ram-jet combustion chamber. From a sudden-expansion flow-area theory, an estimate of flame-holder pressure-drop coefficient was made that may be used in the design or performance estimation of ram jets. Experimental data on combustion-chamber pressure losses due to heat addition were obtained from wall-static-pressure measurements and indicated a deviation of pressure-drop coefficient as high as 1.31 times the one-dimensional theoretical value.

NACA RM E9L09

COOLING OF RAM JETS AND TAIL-PIPE BURNERS - ANALYTICAL METHOD FOR DETERMINING TEMPERATURES OF COMBUSTION CHAMBER HAVING ANNULAR COOLING PASSAGE. William K. Koffel, Eugene Stamper, and Newell D. Sanders. March 21, 1950. 51p. diagrs., tab. (NACA RM E9L09)

An analytical method is given for calculating the maximum wall temperature of a tail-pipe burner or a ram-jet combustion chamber cooled by air or gas flowing through a surrounding annular passage. An empirical equation is developed, which expresses the outlet cooling-gas temperature in terms of known conditions of flow and geometry. When the outlet cooling-gas temperature is known, two parameters can be evaluated that make possible the determination of the maximum temperature of the inside wall from a working chart, which solves the heat balance across the inside wall at the outlet.

NACA RM E50I06

FREE-JET PERFORMANCE OF 16-INCH RAM-JET ENGINE WITH SEVERAL FUELS. Fred A. Wilcox. October 31, 1950. 23p. diagrs., photos. (NACA RM E50I06)

Gasoline (AN-F-48b), kerosene (AN-F-32), isopentane, a blend (by volume) of 50-percent gasoline plus 50-percent propylene oxide, and a blend (by volume) of 75-percent kerosene plus 25-percent propylene oxide were used in a 16-inch ram jet during a free-jet investigation of ram-jet performance in the Lewis altitude wind tunnel. Maximum ranges of operation were obtained with the blends of propylene oxide. Gasoline gave minimum values of weight specific fuel consumption, whereas kerosene gave minimum values of volume specific fuel consumption.

NACA RM E51C12

PRELIMINARY EVALUATION OF THE AIR AND FUEL SPECIFIC-IMPULSE CHARACTERISTICS OF SEVERAL POTENTIAL RAM-JET FUELS. I - OCTENE-1, ALUMINUM, AND ALUMINUM - OCTENE-1 SLURRIES. Benson E. Gammon. April 30, 1951. 20p. diagrs. (NACA RM E51C12)

A preliminary analytical evaluation of the air and fuel specific-impulse characteristics of octene-1, aluminum, and aluminum - octene-1 slurries has been made. Adiabatic constant pressure combustion flame temperatures for each fuel at several equivalence ratios were calculated for an initial air temperature of 560° R and a pressure of 2 atmospheres.

NACA RM E51D25

PRELIMINARY EVALUATION OF THE AIR AND FUEL SPECIFIC-IMPULSE CHARACTERISTICS OF SEVERAL POTENTIAL RAM-JET FUELS. III - DIBORANE, PENTABORANE, BORON, AND BORON-OCTENE-1 SLURRIES. Benson E. Gammon. July 1951. 26p. diagrs. (NACA RM E51D25)

A preliminary analytical evaluation of the air and fuel specific-impulse characteristics of diborane, pentaborane, boron, and boron - octene-1 slurries has been made. Adiabatic constant-pressure combustion flame temperatures for each fuel at several equivalence ratios were calculated for an initial air temperature of 560° R and a pressure of 2 atmospheres.

NACA RM E51E01

PERFORMANCE CHARACTERISTICS OF AIRCRAFT COOLING EJECTORS HAVING SHORT CYLINDRICAL SHROUDS. Fred D. Kochendorfer and Morris D. Rousso. May 22, 1951. 39p. diagrs. (NACA RM E51E01)

The factors affecting the performance of ejectors suitable for aircraft cooling are investigated both theoretically and experimentally. The investigation covers a range of shroud-to-nozzle diameter ratios from 1.1 to 1.6, of shroud lengths from 0.2 to 2.28 nozzle diameters, of secondary-to-primary weight-flow ratios from 0 to 0.12, and of ambient-to-nozzle pressure ratios from 0.7 to 0.06. For low values of the ratio of the jet ambient pressure to the primary total pressure, the performance of ejectors can be adequately explained by the methods of nonviscous fluid mechanics. Mixing effects can be neglected.

NACA RM E51F05

PRELIMINARY EVALUATION OF THE AIR AND FUEL SPECIFIC-IMPULSE CHARACTERISTICS OF SEVERAL POTENTIAL RAM-JET FUELS. IV - HYDROGEN, α-METHYLNAPHTHALENE, AND CARBON. Benson E. Gammon. August 1951. 22p. diagrs. (NACA RM E51F05)

A preliminary analytical evaluation of the air and fuel specific-impulse characteristics of hydrogen, α-methylnaphthalene, and graphite carbon has been made. Adiabatic constant-pressure combustion flame temperatures for each fuel at several equivalence ratios were calculated for an initial air temperature of 560° R and a pressure of 2 atmospheres.

NACA RM E51H02

ANALYTICAL INVESTIGATION OF RAM-JET ENGINE PERFORMANCE IN FLIGHT MACH NUMBER RANGE FROM 3 TO 7. Philip J. Evans, Jr. October 1951. 29p. diagrs. (NACA RM E51H02)

An analytical investigation was made of the performance of isolated ram-jet engines in the flight Mach number range from 3 to 7 for two types of diffuser, a high-efficiency diffuser, and a normal-shock diffuser. The fuel was assumed to be a hydrocarbon similar to gasoline. The conclusions reached are: (1) a design altitude of about 100,000 feet is desirable for a high-efficiency high Mach number ram jet on the basis of engine construction and performance; and (2) although greater thrust could be obtained with other fuels, gasoline provides sufficient energy release for maximum engine efficiency in the flight Mach number range investigated. The maximum engine efficiency calculated was 0.47, which occurred at a Mach number of 5. At a Mach number of 7, the maximum propulsive-thrust coefficient was 0.57.

NACA RM E52D08

EFFECT OF FUEL-AIR DISTRIBUTION ON PERFORMANCE OF A 16-INCH RAM-JET ENGINE. A. J. Cervenka and E. E. Dangle. June 1952. 25p. diagrs., photos., tab. (NACA RM E52D08)

The effect of combustion on diffusion in the fuel preparation zone of a 16-inch ram-jet engine was determined. The eddy diffusion coefficients were found to vary from 0.6 square foot per second for no burning in the engine to 1.6 square feet per second with burning. This information was applied in the design of a combustor to operate at lean fuel-air ratios. Operation to a lean fuel-air ratio limit of 0.007 was accomplished with the use of a cylindrical sleeve which limited fuel-air mixing upstream of the flame holder.

NACA RM E52E05

DESIGN AND TEST OF MIXED-FLOW IMPELLERS. I - AERODYNAMIC DESIGN PROCEDURE. Walter M. Osborn and Joseph T. Hamrick. September 1952. 42p. diagrs., photo., tab. (NACA RM E52E05)

A mixed-flow impeller was designed with special emphasis upon the reduction or elimination of velocity decelerations along the wetted surface, especially along the blade suction surface. With the use of a provisional hub-shroud profile, the blade shape at the blade mean height was determined from a prescribed velocity distribution. The blade shape at all other locations was fixed by the introduction of radial blade elements and blade taper which were specified in consideration of stress requirements. The variation in flow conditions from hub to shroud and changes in the hub-shroud profile required to obtain the desired flow rate were investigated by an analysis in the hub-shroud plane in which axially symmetrical flow was assumed. The method was extended to obtain the blade surface-velocity distribution for a finite number of blades. In order to allow for viscous effects and to increase the blade-height-to-passage-width ratio, the blade height was arbitrarily increased and splitter vanes were added. Preliminary experimental results show that an impeller designed by this procedure with allowances for viscous effects had higher than average efficiency and good operating characteristics.

NACA RM E52E21

PRELIMINARY AIR-FLOW AND THRUST CALIBRATIONS OF SEVERAL CONICAL COOLING-AIR EJECTORS WITH A PRIMARY TO SECONDARY TEMPERATURE RATIO OF 1.0. I - DIAMETER RATIOS OF 1.21 AND 1.10. W. K. Greathouse and D. P. Hollister. July 1952. 24p. diagrs. (NACA RM E52E21)

An investigation of the performance of several conical cooling-air ejectors was made at primary jet pressure ratios from 1 to 10, secondary shroud

pressure ratios from 0.60 to 4.00, and a primary to secondary temperature ratio of 1.0. Primary air flow, secondary air flow, primary nozzle thrust, and gross ejector thrust were measured. The data are presented in terms of secondary to primary weight-flow ratio and gross ejector to primary nozzle thrust ratio. This phase of the investigation was limited to ejectors having shroud-exit to primary-nozzle-exit diameter ratios of 1.21 and 1.10 with several spacing ratios for each. The experimental results indicated that for an ejector having a given diameter ratio the spacing ratio for maximum thrust was considerably less than the spacing ratio for maximum pumping. The smaller-diameter-ratio ejector produced less thrust loss at secondary pressure ratios below 1.00 than did the large-diameter-ratio ejector. The data indicated that significant losses in gross thrust will occur if the cooling-air flow is controlled by throttling in the upstream secondary flow passage.

NACA RM E52E22

DESIGN AND TEST OF MIXED-FLOW IMPELLERS. II - EXPERIMENTAL RESULTS, IMPELLER MODEL MFI-1A. Joseph R. Withee, Jr., and William L. Beede. September 1952. 28p. diagrs., photos., tab. (NACA RM E52E22)

An investigation was conducted to determine the performance characteristics of a mixed-flow impeller which was designed with special emphasis on the reduction or elimination of flow decelerations along the wetted surfaces. The performance was investigated over a range of equivalent impeller speeds from 700 to 1600 feet per second and over a range of flow rates from maximum to point of incipient surge. The peak pressure ratio and maximum adiabatic temperature-rise efficiency, measured at 1-1/2 impeller diameters in a vaneless diffuser, at the design speed of 1400 feet per second were 4.00 and 0.83, respectively.

NACA RM E52E27

INFILTRATION OF TITANIUM CARBIDE WITH SEVERAL METALS. Raymond S. Gurnick and Anthony L. Cooper. July 1952. 21p. diagrs., photos. (NACA RM E52E27)

An investigation was made to determine the applicability of infiltration techniques for producing ceramals of titanium carbide with various metals or alloys. Nickel, S-816, Stellite 21 (AMS-5385), Hastelloy B, and Stellite 93 were used as infiltrant materials. Specimens for elevated-temperature modulus-of-rupture and stress-rupture testing, and turbosupercharger blades, were fabricated by infiltrating titanium carbide with S-816 alloy. Turbosupercharger blades were also fabricated by arc-welding or precision-casting of alloy roots to infiltrated ceramal airfoils by means of titanium carbide and S-816 alloy. The ceramal composed of titanium carbide and S-816 had a modulus-of-rupture strength of more than 100,000 pounds per square inch at 1600° F and 54,000 pounds per square inch at 1800° F. The stress-rupture life was 1082 hours at 1500° F and 112 hours at 1600° F at a stress of 15,000 pounds per square inch.

NACA RM E52E28

PRELIMINARY INVESTIGATION OF FLOW FLUCTUATIONS DURING SURGE AND BLADE ROW STALL IN AXIAL-FLOW COMPRESSORS. Merle C. Huppert. August 1952. 52p. diagrs., photos. (NACA RM E52E28)

A preliminary investigation of the flow fluctuations of surge and blade row stall was conducted with three single-stage axial-flow compressors with hub-tip ratios of 0.9, 0.8, and 0.5 and with a multistage axial-flow compressor. Flow fluctuations of large amplitude associated with stall were detected in all compressors investigated. The fluctuations were caused by low flow regions affecting 25 to 40 percent of the annulus area and propagating in the direction of compressor rotation, but at a lower speed. Mild audible surge was obtained with the single-stage compressors with hub-tip ratios of 0.9 and 0.8. No audible surge was detected with the 0.5 hub-tip ratio stage. A severe audible surge was obtained with the multistage axial-flow compressor. The surge point was coincident with the sharp drop in pressure ratio due to stall.

NACA RM E52F26

PRELIMINARY AIR-FLOW AND THRUST CALIBRATIONS OF SEVERAL CONICAL COOLING-AIR EJECTORS WITH A PRIMARY TO SECONDARY TEMPERATURE RATIO OF 1.0. II - DIAMETER RATIOS OF 1.06 AND 1.40. W. K. Greathouse and D. P. Hollister. August 1952. 35p. diagrs. (NACA RM E52F26)

An investigation was made of the performance of nine conical cooling-air ejectors at primary jet pressure ratios from 1 to 10, secondary pressure ratios to 4.0, and a temperature ratio of unity. This phase of the investigation was limited to conical ejectors having shroud-exit to primary-nozzle-exit diameter ratios of 1.06 and 1.40, with several spacing ratios for each. The experimental results indicated that the pumping range and amount of cooling-air flow obtained with a 1.06-diameter-ratio ejector were relatively small for cooling purposes but that the maximum possible thrust loss, which occurred with no secondary flow, was only 7 percent of convergent-nozzle thrust. The 1.40-diameter-ratio ejector produced a large cooling-air flow and showed a possible thrust loss of 29.5 percent with no cooling-air flow. Thrust gains were attained with ejectors of both diameter ratios at secondary pressure ratios greater than 1.0. The limiting primary pressure ratio below which an ejector can operate at a specific secondary pressure ratio (cut-off point) may be estimated for various flight conditions from data contained herein.

NACA RM E52I23

COMBUSTION EFFICIENCY OF HOMOGENEOUS FUEL-AIR MIXTURES IN A 5-INCH RAM-JET-TYPE COMBUSTOR. Thaine W. Reynolds and Robert D. Ingebo. November 1952. 36p. diagrs., tabs. (NACA RM E52I23)

Combustion-efficiency data have been obtained for a 5-inch-diameter ram-jet-type combustor with a straight V-gutter flame holder and a simple cone flame holder with gasoline, isopentane, benzene, and propylene oxide. The data cover a range of inlet static pressures from 2 to 0.5 atmospheres, inlet temperatures from 100° F to 300° F, and inlet velocivelocities from 170 to 300 feet per second. A correlation of the data is presented and is shown to be in agreement with a propagation mechanism based on the concept that the rate of flame propagation through an unburned mixture is a function of the fundamental flame speed.

NACA RM E53C20

EFFECT OF FUELS ON COMBUSTION EFFICIENCY OF 5-INCH RAM-JET-TYPE COMBUSTION. Thaine W. Reynolds. May 1953. 40p. diagrs., tabs. (NACA RM E53C20)

Combustion-efficiency data were obtained for a 5-inch ram-jet-type combustor employing a simple V-gutter flame holder. The data, which are for homogeneous fuel-air mixtures of 14 pure fuels and 2 fuel blends, cover a range of inlet static pressures and velocities. The data are shown to correlate with the following parameter for all of the fuels tested except carbon disulfide:

$$\frac{P^{0.3}T}{V^{0.8}}\left(\frac{U_f}{U_{ref}}\right)^{1.1}$$

where P is the inlet pressure in atmospheres, T is the inlet temperature in °R, V is the inlet velocity in feet per second, U_f is the maximum fundamental flame velocity in feet per second, and U_{ref} is the maximum fundamental flame velocity of the reference fuel in feet per second. This relation was arrived at experimentally and also analytically from an assumption that the combustion proceeded by an increase of the flame-front area through turbulence in the combustor and that the flame propagated at the fundamental flame speed of the fuel-air mixture.

NACA RM L50G17a

TRANSONIC FLIGHT TESTS TO COMPARE THE ZERO-LIFT DRAG OF UNDERSLUNG AND SYMMETRICAL NACELLES VARIED CHORDWISE AT 40 PERCENT SEMISPAN OF A 45° SWEPTBACK, TAPERED WING. William B. Pepper, Jr., and Sherwood Hoffman. October 25, 1950. 36p. diagrs., photos., tabs. (NACA RM L50G17a)

Rocket-powered models were flown at transonic speeds to determine the effect of nacelle location on the zero-lift drag. Solid nacelles were mounted in underslung and symmetrical (midwing) positions and varied chordwise at the 40-percent-semispan station of a 45° sweptback, tapered wing. From these tests it is apparent that the drag increment associated with adding nacelles to a wing-body combination is largely dependent upon the nacelle location.

NACA RM L50H08

A TRANSONIC-WING INVESTIGATION IN THE LANGLEY 8-FOOT HIGH-SPEED TUNNEL AT HIGH SUBSONIC MACH NUMBERS AND AT A MACH NUMBER OF 1.2. WING-FUSELAGE CONFIGURATION WITH A WING OF 45° SWEEPBACK, ASPECT RATIO 4, TAPER RATIO 0.6, AND NACA 65A006 AIRFOIL SECTION. Robert S. Osborne. October 10, 1950. 49p. diagrs., photos. (NACA RM L50H08)

A wing-fuselage combination employing a wing with 45° sweepback of the 0.25-chord line, aspect ratio 4, taper ratio 0.6, and NACA 65A006 airfoil section parallel to the plane of symmetry was tested at high subsonic Mach numbers and at a Mach number of 1.2 to determine its force, moment, wake, and downwash characteristics.

NACA RM L50H10

INITIAL FLIGHT INVESTIGATION OF A TWIN-ENGINE SUPERSONIC RAM JET. Maxime A. Faget and H. Rudolph Dettwyler. September 15, 1950. 28p. diagrs., photos. (NACA RM L50H10)

A flight investigation was made of a supersonic twin-ram-jet test vehicle using short-flame-length burners. The test demonstrated a maximum acceleration of 3.6g and a maximum flight Mach number of 3.02. Data were obtained over a Mach number range from about 1.9 to 3.0, an altitude range from 1,800 to 40,900 feet, and a fuel-air-ratio range from 0.012 to 0.065.

NACA RM L50J09

A TRANSONIC WING INVESTIGATION IN THE LANGLEY 8-FOOT HIGH-SPEED TUNNEL AT HIGH SUBSONIC MACH NUMBERS AND AT A MACH NUMBER OF 1.2. WING-FUSELAGE CONFIGURATION HAVING A WING OF 35° SWEEPBACK, ASPECT RATIO 4, TAPER RATIO 0.6, AND NACA 65A006 AIRFOIL SECTION. Beverly Z. Henry, Jr. November 15, 1950. 40p. diagrs., photo., tab. (NACA RM L50J09)

Lift, drag, and pitching-moment characteristics, wake characteristics, and downwash angles are presented for a wing-fuselage configuration employing a wing with quarter-chord line swept back 35°, an aspect ratio of 4, a taper ratio of 0.6, and an NACA 65A006 airfoil section. Results are presented for various angles of attack at high subsonic Mach numbers and at a Mach number of 1.2.

NACA RM L50L06

FREE-JET TESTS OF A 6.5-INCH-DIAMETER RAM-JET ENGINE AT MACH NUMBERS OF 1.81 AND 2.00. Maxime A. Faget, Raymond S. Watson, and Walter A. Bartlett, Jr. March 7, 1951. 38p. diagrs., photos. (NACA RM L50L06)

Results of free-jet tests of a ram-jet engine at Mach numbers of 1.81 and 2.00, together with a method for evaluation of the performance, are presented. A range of fuel-air ratios from 0.015 to 0.100 was tested. The effects on the engine performance of changes in free-stream temperature are included. The results are compared with flight tests of the engine.

NACA RM L51B23

TABULATED PRESSURE COEFFICIENTS AND AERODYNAMIC CHARACTERISTICS MEASURED ON THE WING OF THE BELL X-1 AIRPLANE IN AN UNACCELERATED STALL AND IN PULL-UPS AT MACH NUMBERS OF 0.74, 0.75, 0.94, AND 0.97. Lawrence A. Smith. June 19, 1951. 49p. diagrs., photo., tabs. (NACA RM L51B23)

Presents tabulated pressure coefficients and aerodynamic characteristics measured on the wing of the Bell X-1 research airplane in an unaccelerated stall and in pull-ups at Mach numbers of approximately 0.74, 0.75, 0.94, and 0.97.

NACA RM L51F13

COMPARISON OF ZERO-LIFT DRAGS DETERMINED BY FLIGHT TESTS AT TRANSONIC SPEEDS OF SYMMETRICALLY MOUNTED NACELLES IN VARIOUS CHORDWISE POSITIONS AT THE WING TIP OF A 45° SWEPTBACK WING AND BODY COMBINATION. William B. Pepper, Jr., and Sherwood Hoffman. September 1951. 16p. diagrs., photos. (NACA RM L51F13)

The effect on drag at transonic speeds of varying the chordwise location of a nacelle at the wing tip of a 45° sweptback wing and body combination has been determined by use of rocket-propelled models at zero lift. The drag of the wing-body-fin configuration was reduced near $M = 1.0$ by adding nacelles at the wing tips.

NACA RM L51K02

TRANSONIC FLIGHT TESTS TO DETERMINE ZERO-LIFT DRAG AND PRESSURE RECOVERY OF NACELLES LOCATED AT THE WING TIPS ON A 45° SWEPTBACK WING AND BODY COMBINATION. Sherwood Hoffman and William B. Pepper, Jr. January 1952. 21p. diagrs., photos., tabs. (NACA RM L51K02)

The zero-lift drag of a high-aspect-ratio 45° sweptback wing and body combination with nacelles having the NACA 1-50-250 nose inlet located at the wing tips was determined by flight tests of rocket-propelled models at transonic speeds. The inlet pressure recovery at transonic speeds was determined from flight tests and at supersonic speeds by preflight jet tests.

NACA RM L51L18

FREE-JET TESTS OF A 1.1-INCH-DIAMETER SUPERSONIC RAM-JET ENGINE. Joseph H. Judd and Otto F. Trout, Jr. March 1952. 24p. diagrs., photos., tabs. (NACA RM L51L18)

Results of free-jet tests of a 1.1-inch-diameter hydrogen-burning ram-jet engine over a Mach number range of 1.42 to 2.28 and a Reynolds number range of 6.01×10^6 to 15.78×10^6 are presented. Tests demonstrated the reliability and wide operating range of the engine and showed its suitability for installation on wind-tunnel models of airplane and missile configurations. A comparison of engine operation with combustion-chamber lengths of 3.33 and 1.51 engine diameters was made at a Mach number of 2.06. A maximum test thrust coefficient of 0.905 was obtained at fuel-air ratio of 0.034 and a Mach number of 2.06 for the engine with the 3.33-diameter combustion chamber.

NACA RM L51L27

TRANSONIC FLIGHT TESTS TO COMPARE THE ZERO-LIFT DRAGS OF 45° SWEPTBACK WINGS OF ASPECT RATIO 3.55 AND 6.0 WITH AND WITHOUT NACELLES AT THE WING TIPS. Sherwood Hoffman and Richard C. Mapp, Jr. March 1952. 17p. diagrs., photos. (NACA RM L51L27)

The zero-lift drags of 45° sweptback wings of aspect ratio 3.55 and 6.0 with and without solid nacelles at the wing tips were determined from flight tests of rocket-propelled models at transonic speeds. The wing-tip nacelle location was found favorable from a drag standpoint.

NACA RM L52D24

FLIGHT MEASUREMENTS AT MACH NUMBERS FROM 1.1 TO 1.9 OF THE ZERO-LIFT DRAG OF A TWIN-ENGINE SUPERSONIC RAM-JET CONFIGURATION. Abraham Leiss. June 1952. 16p. diagrs., photos. (NACA RM L52D24)

A flight investigation was conducted to determine the zero-lift drag of a twin-engine supersonic ram-jet configuration having a fineness ratio of 23.69. Two vehicles were tested - one with nacelles and one without nacelles. The test covered a Mach number range from 0.7 to 1.9 and a Reynolds number range from 20×10^6 to 1.18×10^6. The external drag of the nacelles was 60 percent of the total external drag of the configuration and the fuselage and fins accounted for the other 40 percent.

NACA RM L52E06

EFFECTS OF STABILIZING FINS AND A REAR-SUPPORT STING ON THE BASE PRESSURES OF A BODY OF REVOLUTION IN FREE FLIGHT AT MACH NUMBERS FROM 0.7 TO 1.3. Roger G. Hart. September 1952. 19p. diagrs., photos., tab. (NACA RM L52E06)

Isolated fuselages were flight-tested at Mach numbers from 0.7 to 1.3 in order to determine the contributions of the body and the fin-body interference to the total drag of previously tested combinations. A rear-support sting similar to those used in wind tunnels was tested with one of the fuselages.

#NACA RM L52E07a

NACA RM L52E13

EFFECT OF FUSELAGE INTERFERENCE ON THE DAMPING IN ROLL OF DELTA WINGS OF ASPECT RATIO 4 IN THE MACH NUMBER RANGE BETWEEN 0.6 AND 1.6 AS DETERMINED WITH ROCKET-PROPELLED VEHICLES. William M. Bland, Jr. July 1952. 13p. diagrs., photos. (NACA RM L52E13)

The effect of fuselage-diameter - wing-span ratio on the damping-in-roll characteristics of a delta wing of aspect ratio 4 with 4-percent-thick symmetrical double-wedge airfoil sections was investigated in the Mach number range between 0.6 and 1.6 by a technique which used rocket-propelled vehicles in free flight. It is shown that the damping-in-roll derivative decreased when the fuselage-diameter - wing-span ratio was increased from 0 to 0.4 and then to 0.6; furthermore, it is shown that the experimental results agree with theory.

NACA RM L52E29

A CORRELATION WITH FLIGHT TESTS OF RESULTS OBTAINED FROM THE MEASUREMENT OF WING PRESSURE DISTRIBUTIONS ON A 1/4-SCALE MODEL OF THE X-1 AIRPLANE (10-PERCENT-THICK WING). Jack F. Runckel and James H. Henderson. September 1952. 60p. diagrs., photos., tab. (NACA RM L52E29)

A comparison of wing pressure-distribution measurements obtained on a 1/4-scale model in a slotted wind tunnel with results from flight tests of the X-1 airplane is presented. Results were obtained through a Mach number range from 0.70 to 1.00 at Reynolds numbers up to 4.6 million and at angles of attack up to 15° at lower speeds and up to 5° at $M = 1.00$.

NACA RM L53D23

FLOW DIFFUSION IN A CONSTANT-DIAMETER DUCT DOWNSTREAM OF AN ABRUPTLY TERMINATED CENTER BODY. Charles C. Wood and James T. Higginbotham. July 1953. 27p. diagrs. (NACA RM L53D23)

A preliminary investigation of the flow properties of a constant-outer-wall annular diffuser in combination with a tailpipe has been conducted for the purpose of obtaining qualitative information which might lead to a short efficient configuration applicable to turbojet afterburners. The diffuser has an outer diameter of 21 inches, and area ratio of 1.9:1, and a 180° overall equivalent conical angle of expansion. Tests were conducted with fully developed pipe flow with and without vortex generators, with axial flow and with 20.6° whirling inlet flow, up to a maximum inlet Mach number of 0.33 and a corresponding Reynolds number of 1.06×10^6. With axial flow, a vena contracta region is formed rendering the first 1/2 diameter of tailpipe length ineffective. The introduction of whirl in the inlet flow suppresses the vena contracta resulting in a 170-percent gain in static-pressure rise and a 28-percent reduction in total-pressure loss. The installation of vortex generators has little effect on the vena contracta for axial flow and removes the favorable effect of whirl.

NACA RM L53E06

EFFECTS OF HORIZONTAL-TAIL HEIGHT AND A WING LEADING-EDGE MODIFICATION CONSISTING OF A FULL-SPAN FLAP AND A PARTIAL-SPAN CHORD-EXTENSION ON THE AERODYNAMIC CHARACTERISTICS IN PITCH AT HIGH SUBSONIC SPEEDS OF A MODEL WITH A 45° SWEPTBACK WING. William D. Morrison, Jr. and William J. Alford, Jr. June 1953. 37p. diagrs., photo., tab. (NACA RM L53E06)

The effects of horizontal-tail height (13.9 percent wing semispan below and 13.9 and 25.6 percent semispan above chord plane extended) on the pitch characteristics of a general-research model having full-span wing leading-edge deflection and a partial-span chord-extension have been determined at Mach numbers of 0.40 through 0.93 at Reynolds numbers ranging from about 2,000,000 to 3,000,000. Lift, drag, and pitching moments were determined, for three horizontal tail angles, at all Mach numbers investigated for angles of attack ranging from -2° to 24° except at the higher Mach numbers where tunnel choking restricted this angle range.

NACA RM L53E19

WIND-TUNNEL INVESTIGATION TO DETERMINE THE HORIZONTAL- AND VERTICAL-TAIL CONTRIBUTIONS TO THE STATIC LATERAL STABILITY CHARACTERISTICS OF A COMPLETE-MODEL SWEPT-WING CONFIGURATION AT HIGH SUBSONIC SPEEDS. James W. Wiggins, Richard E. Kuhn, and Paul G. Fournier. July 1953. 34p. diagrs., photo. (NACA RM L53E19)

Results are presented of an investigation made in the Langley high-speed 7- by 10-foot tunnel to determine the horizontal- and vertical-tail contributions to the static lateral stability of a complete-model configuration. The general research model was tested through a Mach number range from 0.40 to 0.95 and an angle-of-attack range from -3° to 25° at angles of sideslip of $\pm 4^{\circ}$.

NACA RM L53E20

WIND-TUNNEL INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS IN PITCH OF WING-FUSELAGE COMBINATIONS AT HIGH SUBSONIC SPEEDS. TAPER-RATIO SERIES. Thomas J. King, Jr. and Thomas B. Pasteur, Jr. June 1953. 37p. diagrs., photos., tab. (NACA RM L53E20)

This paper presents the aerodynamic characteristics of wing-fuselage combinations of aspect ratio 4, sweepback angle of 45°, and taper ratios of 0.3, 0.6, and 1.0. The tests covered a Mach number range from 0.4 to 0.95 at Reynolds numbers of 2,000,000 to 3,000,000 and an angle-of-attack range from -2° to 26°.

NACA RM L53E20a

COMPARISON OF LIFT-CURVE SLOPES FOR A MODEL TESTED IN TWO SLOTTED TUNNELS OF DIFFERENT SIZES AT HIGH SUBSONIC SPEEDS. Robert W. Boswinkle, Jr. June 1953. 13p. diagrs. (NACA RM L53E20a)

The boundary effects on an 18-inch span, 60° triangular wing model tested in the 26-inch Langley transonic blowdown tunnel are shown to cause only small decreases in the lift-curve slopes from those obtained with the same model in the Langley 8-foot transonic tunnel; the decreases amount to less than 0.001 per degree and 0.003 per degree at Mach numbers of 0.80 and 0.975, respectively. The theory of a previously published paper, although not exactly applicable to the present case, gave corrections to the lift-curve slopes obtained in the smaller tunnel which appeared to be of the correct sign and of the proper order of magnitude.

NACA RM L53E26

A COLLECTION OF DATA FOR ZERO-LIFT DAMPING IN ROLL OF WING-BODY COMBINATIONS AS DETERMINED WITH ROCKET-POWERED MODELS EQUIPPED WITH ROLL-TORQUE NOZZLES. David G. Stone. July 1953. 23p. diagrs., tab. (NACA RM L53E26)

Zero-lift damping-in-roll data have been collected from experimentally determined results through high subsonic, transonic, and low supersonic speeds by a torque-nozzle forced-roll technique utilizing rocket-propelled models. These data collections show the effects of wing plan form and airfoil section, and, qualitatively, the effects of wing aeroelasticity and show all wings tested to have damping in roll in this speed range at 0° angle of attack.

NACA RM L53E26a

PRELIMINARY RESULTS OF SUPERSONIC-JET TESTS OF SIMPLIFIED WING STRUCTURES. Richard R. Heldenfels and Richard Rosecrans. July 1953. 19p. diagrs., photos. (NACA RM L53E26a)

Seven small multiweb wing structures were tested under simulated supersonic flight conditions to investigate the structural effects of aerodynamic heating. Three models experienced chordwise flutter and failure; the other four incorporated structural modifications that prevented flutter. The tests are discussed and the conclusion is reached that the models failed as a result of the combined action of aerodynamic heating and loading.

NACA RM L53E27

TEST OF AN AERODYNAMICALLY HEATED MULTIWEB WING STRUCTURE (MW-1) IN A FREE JET AT MACH NUMBER 2. Richard R. Heldenfels, Richard Rosecrans, and George E. Griffith. July 1953. 37p. diagrs., photos. (NACA RM L53E27)

A mulitweb wing structure, representing an airplane or missile wing, was tested under simulated supersonic flight conditions to determine the transient temperature distribution. The aerodynamic loads played an important and unanticipated role, however, in that the model experienced a dynamic failure near the end of the test. The test is discussed and the conclusion reached that the model failed as a result of the combined action of aerodynamic heating and loading. The temperature data collected are analyzed and shown to be in reasonable agreement with calculated values.

NACA RM L53E27a

TRANSIENT TEMPERATURE DISTRIBUTION IN AN AERODYNAMICALLY HEATED MULTIWEB WING. George E. Griffith. July 1953. 10p. diagrs. (NACA RM L53E27a)

Transient skin and interior temperatures are presented for a multiweb wing tested at Mach number 1.99. Four methods involving various degrees of approximation are used to calculate the temperatures; the results are shown to be in good agreement with the experimental temperatures when the significant types of heat conduction are taken into account.

NACA RM L53L24b

PRELIMINARY INVESTIGATION AT SUBSONIC AND TRANSONIC SPEEDS OF THE AERODYNAMIC CHARACTERISTICS OF A BIPLANE COMPOSED OF A SWEPTBACK AND A SWEPTFORWARD WING JOINED AT THE TIPS. Jones F. Cahill and Dexter H. Stead. March 1954. 19p. diagrs., photos. (NACA RM L53L24b)

Results are presented of a preliminary investigation of a swept biplane configuration composed of a sweptback and a sweptforward wing joined at the tips. The aspect ratio is defined on the basis of the total area of both wings. Lift, drag, and pitching moments are presented for Mach numbers of 0.2, 0.76, and 0.90 for a Reynolds number of approximately 2×10^6. Drag data for low lift coefficients are shown for transonic Mach numbers from 0.7 to 1.27 at a Reynolds number of approximately 1.0×10^6. Effective dihedral data are presented for several angles of attack at a Mach number of 0.8.

NACA RM L54E03a

STRESSES AND DEFLECTIONS OF A SWEPT BIPLANE WING. George W. Zender and John E. Duberg. August 1954. 41p. diagrs., photo., tabs. (NACA RM L54E03a)

The results of experimental and theoretical structural studies of a solid swept biplane wing composed of a sweptback front wing and a sweptforward rear wing joined at the tip are compared.

NACA RM L54E13

LONGITUDINAL STABILITY AND DRAG CHARACTERISTICS OF A FIN-STABILIZED BODY OF REVOLUTION WITH A FINENESS RATIO OF 12 AS MEASURED BY THE FREE-FALL METHOD. Max C. Kurbjun. June 1954. 19p. diagrs., photos., tab. (NACA RM L54E13)

Measurements were made of the longitudinal stability and drag characteristics of a fin-stabilized body of revolution with a fineness ratio of 12 at low angles of attack by the free-fall method. The Mach numbers ranged from subsonic to 1.26 and the normal-force coefficients from 0.11 to 0.24. Analysis indicates that the instability of the body decreases more rapidly with increasing normal-force coefficient than the theory of NACA RM A9I26 predicts. The difference in the investigation results and theory is assumed to be attributable to the effect of the increase in Mach number which accompanied the increase in normal-force coefficient. Longitudinal force measurements agreed favorably at subsonic speeds and were 20 percent less at supersonic speeds than the zero-lift drag of NACA RM L9J27.

NACA RM L54E19

SOME INTERNAL-FLOW CHARACTERISTICS AT ZERO FLIGHT SPEED OF AN ANNULAR SUPERSONIC INLET AND AN OPEN-NOSE INLET WITH SHARP AND ROUNDED LIPS. Joseph R. Miliillo. July 1954. 23p. diagrs., photo. (NACA RM L54E19)

A conical-shock inlet and open-nose inlet with three lip shapes were investigated at zero flight speed. Measurements of pressure recovery, surface pressure, total pressure, and mass flow are presented. The pressure recovery and choking mass-flow ratio were greatly improved by replacing the sharp lip by two alternate shapes with lip roundness or internal contraction just behind the leading edge. It was found that inlets with thin sharp lips had similar pressure-recovery characteristics which were adequately defined by theory.

NACA RM L54E19a

SOME INTERNAL-FLOW CHARACTERISTICS OF SEVERAL AXISYMMETRICAL NACA 1-SERIES NOSE AIR INLETS AT ZERO FLIGHT SPEED. Carroll R. Bryan and Frank F. Fleming. July 1954. 30p. diagrs., photos. (NACA RM L54E19a)

Six 8-inch-diameter NACA 1-series nose inlets (one with protruding central body) were tested at zero forward velocity. Presented are total-pressure surveys, pressure-recovery measurements, and flow visualization studies at mass flows from below the normal operating range to choking. Parameters were found which define choking mass flow and choking average total-pressure ratio for inlets whose inner lip geometry is related to those tested.

NACA RM L54E20

INVESTIGATION OF A CANARD MISSILE CONFIGURATION (NACA RM-4) IN THE LANGLEY 9-INCH SUPERSONIC TUNNEL AT MACH NUMBERS OF 1.62 AND 1.93. Carl E. Grigsby. June 1954. 24p. diagrs., photo. (NACA RM L54E20)

An investigation was made in the Langley 9-inch supersonic tunnel of a canard missile configuration designated the NACA RM-4 configuration. Measurements of lift, drag, and pitching moment were made over an angle-of-attack range of -5° to 15° at Mach numbers of 1.62 and 1.93. Breakdown tests were made at a Mach number of 1.62 for several roll angles. For the complete configuration, the deflections of the canard fins and the angle of roll were varied at both Mach numbers. The configuration was tested with the canard fins inline and with the canard fins interdigitated 45° with respect to the wings. The data are presented without analysis.

NACA RM L54J28

VIBRATORY-STRESS INVESTIGATION OF SIX- AND EIGHT-BLADE DUAL-ROTATING PROPELLERS OPERATING AT ZERO ADVANCE. Atwood R. Heath, Jr. and Robert L. O'Neal. February 1955. 26p. diagrs., photo., tabs. (NACA RM L54J28)

An investigation of the vibratory stresses of a dual-rotating propeller of both six- and eight-blade configurations has been made on the NACA 6,000-horsepower propeller dynamometer at the Langley propeller static test stand. The investigation covered a range of blade angle from 4° to 36° and a range of rotational speed from 600 rpm to 2,200 rpm. The propeller-blade vibratory stresses caused by mutual interference of the propeller blades are presented as well as the vibratory stresses resulting from other causes.

NACA RM SE9E03
NACA RM SE9G19
NACA RM SE9J14
NACA RM SE50E22
NACA RM SL55L27

National Advisory Committee for Aeronautics

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1223

THEORETICAL AND EXPERIMENTAL INVESTIGATION OF HEAT TRANSFER BY LAMINAR NATURAL CONVECTION BETWEEN PARALLEL PLATES. A. F. Lietzke. 1955. ii, 7p. diagrs. (NACA Rept. 1223. Supersedes TN 3328)

For the experimental work, parallel walls (one heated uniformly and the other cooled uniformly) were simulated by an annulus with an inner-to-outer diameter ratio near 1. The theoretical results are presented in equations for the velocity and temperature profiles and the ratio of actual temperature drop across the fluid to temperature drop for pure conduction. No experimental measurements were made of the velocity and temperature profiles, but the experimental results are compared with theory on the basis of the ratio of the actual temperature drop to the temperature drop for pure conduction. Good agreement was obtained between theory and experiment for axial temperature gradients above 40^{0} F/ft.

NACA Rept. 1231

NACA TRANSONIC WIND-TUNNEL TEST SECTIONS. Ray H. Wright and Vernon G. Ward. 1955. ii, 38p. diagrs., photos., tabs. (NACA Rept. 1231. Supersedes RM L8J06)

An approximate subsonic theory has been developed for the solid blockage in a circular wind tunnel with walls slotted in the direction of flow. In tests of a tunnel based on this theory, a prediction of the theory regarding the possibility of practical elimination of the interference due to solid blockage has been realized. Choking limitations did not occur in the slotted tunnel, and it could be operated with continuous Mach number variation up to low supersonic Mach numbers merely by varying the power. Pressure distributions over the surface of a nonlifting model in the slotted tunnel were compared with those obtained over the same model in a much larger tunnel where the interference was negligible.

NACA Rept. 1233

SHOCK-TURBULENCE INTERACTION AND THE GENERATION OF NOISE. H. S. Ribner. 1955. iii, 19p. diagrs., tab. (NACA Rept. 1233. Supersedes TN 3255)

Interaction of convected field of turbulence with shock wave is analyzed to yield modified turbulence, entropy spottiness, and noise generated downstream of the shock. Analysis is generalization of single-spectrum-wave treatment of TN 2864. Formulas for spectra and correlations are obtained. Numerical calculations yield curves of rms velocity components, temperature, pressure, and noise in db against Mach number for $M = 1$ to ∞; both isotropic and strongly axisymmetric (lateral/longitudinal = 36/1) initial turbulence are treated. In either case, turbulence of 0.1 percent longitudinal component generates about 120 dbs of noise.

NACA Rept. 1240

AN INVESTIGATION OF THE EFFECTS OF HEAT TRANSFER ON BOUNDARY-LAYER TRANSITION ON A PARABOLIC BODY OF REVOLUTION (NACA RM-10) AT A MACH NUMBER OF 1.61. K. R. Czarnecki and Archibald R. Sinclair. 1955. 11p. diagrs., photos., tab. (NACA Rept. 1240. Supersedes TN 3165 and TN 3166)

This report presents the results of an investigation of the effects of heat transfer on boundary-layer transition on a parabolic body of revolution (NACA RM-10). This report includes also a study of the effectiveness of cooling on boundary-layer transition with the model surface roughened and with tunnel disturbances impinging on the model. The tests were made at a Mach number of 1.6 and over a Reynolds number range from 2.5×10^{6} to 35×10^{6}. A comparison is made between the experimental results and theory.

NACA Rept. 1253

A CORRELATION BY MEANS OF TRANSONIC SIMILARITY RULES OF EXPERIMENTALLY DETERMINED CHARACTERISTICS OF A SERIES OF SYMMETRICAL AND CAMBERED WINGS OF RECTANGULAR PLAN FORM. John B. McDevitt. 1955. ii, 23p. diagrs., tabs. (NACA Rept. 1253. Supersedes RM A51L17b; RM A53G31)

The transonic similarity rules have been used to correlate the experimental lift, drag, and pitching-moment data, obtained by use of the transonic bump

technique, for a series of 40 rectangular wings having NACA 63A0XX, 63A2XX, and 63A4XX sections, aspect ratios from 1/2 to 6, and thicknesses from 2 to 10 percent. The usefulness of certain alternative forms of the transonic similarity parameters was investigated and a range of validity for slender-body theory was demonstrated.

NACA RM 56C20

CORRELATION OF CREEP-BUCKLING TESTS WITH THEORY. Sharad A. Patel, Joseph Kempner, Burton Erickson, and Abol H. Mobassery, Polytechnic Institute of Brooklyn. May 1956. 39p. diagrs., photos., tabs. (NACA RM 56C20)

Results are presented of short-time creep-buckling and creep-bending tests of 2024-T4 aluminum-alloy columns of slenderness ratio 111. The tests were performed at 600° F, and strain measurements were made with high-temperature electric-resistance strain gages. The development of the gages is described in an appendix. The bending results are used together with a previously derived creep-buckling theory to develop a semiempirical formula suitable as a guide for determining the critical time for columns.

NACA RM A55L14

PRELIMINARY REPORT ON A STUDY OF SEPARATED FLOWS IN SUPERSONIC AND SUBSONIC STREAMS. Dean R. Chapman, Donald M. Kuehn, and Howard K. Larson. June 1956. 15p. diagrs., photos. (NACA RM A55L14)

Some results are described of fundamental research conducted on various flow separation phenomena in two-dimensional streams. Experimental and theoretical results are described for the pressure rise across a reattachment region, and for the Reynolds number dependence of the pressure rise to a separation point. Observations are made throughout of the location of transition relative to reattachment and to separation, since this relative location turned out to be the dominant variable investigated.

NACA RM E56C02

PRELIMINARY INVESTIGATION OF SHORT TWO-DIMENSIONAL SUBSONIC DIFFUSERS. Richard R. Woollett. May 1956. 19p. diagrs., photos., tab. (NACA RM E56C02)

The designs which were tested over a range of throat Mach numbers from 0.3 to 0.9, incorporated an effective diffusion angle of approximately 30° and an area ratio of 3. Included were: (1) a 30° faired diffuser with four variations of screens and vanes, (2) a diffuser in which the longitudinal velocity distribution is a step function and which utilizes suction early in the diffusion process, and (3) a vortex-trap design incorporating flow injection and suction. At a throat Mach number of 0.7, the resulting profile distortion of the unmodified 30° diffuser was diminished from about 11 to approximately 4 percent by use of any of the configurations.

NACA TM 1400

BOUNDARY LAYER. (Pogranichnyi sloi). L. G. Loitsianskii. May 1956. 29p. (NACA TM 1400. Trans. from Mechanics in the U.S.S.R. over Thirty Years, 1917-1947, p. 300-320)

The author reviews the scope of papers on boundary layer contained in seventy references for the period from 1917 to 1948.

NACA TN 3274

SOME LINEAR DYNAMICS OF TWO-SPOOL TURBOJET ENGINES. David Novik. June 1956. 35p. diagrs. (NACA TN 3274)

Transfer functions, descriptive of the responses of inner- and outer-spool speed to changes in turbine-inlet temperature and exhaust-nozzle area, were derived analytically and corroborated experimentally. The speed responses of both spools to a change in turbine-inlet temperature appeared as identical first-order lags, specified by the inner-spool time constant. The response to exhaust-nozzle area was characterized by a first-order lag response of the outer-spool, specified by the outer-spool time constant, accompanied by virtually no change in inner-spool speed.

NACA TN 3578

INFLUENCE OF LARGE AMPLITUDES ON FLEXURAL MOTIONS OF ELASTIC PLATES. George Herrmann, Columbia University. May 1956. 45p. diagrs. (NACA TN 3578)

A nonlinear plate theory of motion, valid for large deflections, is developed and discussed in the light of other theories. The influence of large rotations is demonstrated by solution of the resulting equations for the case of straight-crested waves. A study is made of the origin of certain terms appearing in nonlinear plate theories.

NACA TN 3580

STALL PROPAGATION IN AXIAL-FLOW COMPRESSORS. Alan H. Stenning, Anthony R. Kriebel, and Stephen R. Montgomery, Massachusetts Institute of Technology. June 1956. 83p. diagrs., photos., tab. (NACA TN 3580)

A theory for the prediction of the stall propagation velocity in axial-flow compressors has been developed and compared with experiments on a stationary circular cascade and a single-stage compressor. The theory, which is valid for small perturbations in velocity about a mean flow condition with finite pressure rise across the cascade, includes the effects of finite blade chord and boundary-layer response to changes in angle of attack.

NACA TN 3632

CORRELATION, EVALUATION, AND EXTENSION OF LINEARIZED THEORIES FOR TIRE MOTION AND WHEEL SHIMMY. Robert F. Smiley. June 1956. iv, 139p. diagrs., tab. (NACA TN 3632)

An evaluation is made of the existing theories of linearized tire motion and wheel shimmy. It is demonstrated that most of the previously published theories represent varying degrees of approximation to a summary theory developed herein which is a minor modification of the basic theory of Von Schlippe and Dietrich. In most cases where strong differences exist between the previously published theories and the summary theory, it is shown that the previously published theories are of inferior merit. A series of systematic approximations to the summary theory is developed for the treatment of problems too simple to merit the use of the complete summary theory and procedures are discussed for applying the summary theory and its systematic approximations to the shimmy of more complex landing-gear structures than have previously been considered. Comparisons of the existing experimental data with the predictions of the summary and systematic approximation theories provide a fair substantiation of the higher approximate theories.

NACA TN 3639

APPROXIMATE INDICIAL LIFT FUNCTIONS FOR SEVERAL WINGS OF FINITE SPAN IN INCOMPRESSIBLE FLOW AS OBTAINED FROM OSCILLATORY LIFT COEFFICIENTS. Joseph A. Drischler. May 1956. 26p. diagrs., tab. (NACA TN 3639)

The unsteady-lift functions for a wing undergoing a sudden change in sinking speed are presented for delta wings having aspect ratios of 0, 2, and 4 and for rectangular and elliptical wings with aspect ratios of 0, 3, and 6. For the elliptical and rectangular wings the local lift functions are also presented. These functions were calculated from the lift coefficients associated with a wing oscillating harmonically in pure translational motion.

NACA TN 3640

A METHOD FOR DEFLECTION ANALYSIS OF THIN LOW-ASPECT-RATIO WINGS. Manuel Stein and J. Lyell Sanders, Jr. June 1956. 65p. diagrs. (NACA TN 3640)

A method is presented for obtaining influence coefficients for thin low-aspect-ratio wings of built-up construction. Chordwise deflections are assumed to be parabolic (or linear) and the principle of minimum potential energy is used to obtain an appropriate set of equilibrium equations. A simple method is given for taking account of attachment to a flexible fuselage. The computations involved are for the most part organized into matrix form so as to be suitable for high-speed computing machines. The matrices needed at the beginning of the computing process can be set up directly from the data of the wing design.

NACA TN 3649

STATIC LONGITUDINAL AND LATERAL STABILITY CHARACTERISTICS AT LOW SPEED OF UNSWEPT-MIDWING MODELS HAVING WINGS WITH AN ASPECT RATIO OF 2, 4, OR 6. Walter D. Wolhart and David F. Thomas, Jr. May 1956. 41p. diagrs., photos., tabs. (NACA TN 3649)

An experimental investigation was made at low speed in the Langley stability tunnel to determine the static longitudinal and lateral stability characteristics of unswept-midwing models having wings with an aspect ratio of 2, 4, or 6 through an angle-of-attack range from -4° to 32°. The results indicate that the decrease in the tail contribution to longitudinal stability for wing-on configurations at low and moderate angles of attack increases with decreasing wing aspect ratio. There is a decrease in the tail contribution to directional stability at moderate and high angles of attack because of wing-fuselage interference at the tail which is counteracted by a stable shift in the directional stability of all wing-fuselage combinations investigated.

NACA TN 3671

WIND-TUNNEL INVESTIGATION OF THE EFFECT OF CLIPPING THE TIPS OF TRIANGULAR WINGS OF DIFFERENT THICKNESS, CAMBER, AND ASPECT RATIO - TRANSONIC BUMP METHOD. Horace F. Emerson. June 1956. 183p. diagrs., photo., tabs. (NACA TN 3671. Supersedes RM A53L03)

Transonic aerodynamic characteristics are presented for four basic triangular wings having aspect ratios of 2.0, 2.5, 3.0, and 4.0, and for these wings when their tips were progressively clipped to provide taper ratios of 0.1, 0.2, 0.3, 0.4 and in some cases 0.5. The NACA 63A00X profile was used with thickness-to-chord ratios of 0.02, 0.04, and 0.06. In addition, a wing with the NACA 63A(1.5)04 section was tested for each aspect ratio investigated. The Mach number range extended from 0.60 to 1.10, corresponding to a test Reynolds number range from 1.85 million to 2.90 million. Lift, drag, and pitching-moment coefficients are presented for each of the wings.

NACA TN 3673

ON THE RANGE OF APPLICABILITY OF THE TRANSONIC AREA RULE. John R. Spreiter. May 1956. 21p. diagrs. (NACA TN 3673. Supersedes RM A54F28)

Some insight into the range of applicability of the transonic area rule has been gained by comparison with the appropriate similarity rule of transonic flow theory and with experimental data for a large family of rectangular wings having NACA 63AXXX profiles.

NACA TN 3676

INVESTIGATION OF LATERAL CONTROL NEAR THE STALL. FLIGHT TESTS WITH HIGH-WING AND LOW-WING MONOPLANES OF VARIOUS CONFIGURATIONS. Fred E. Weick and H. Norman Abramson, Agricultural and Mechanical College of Texas. June 1956. 34p. diagrs., photos., tabs. (NACA TN 3676)

Flight tests were made with typical light airplanes to investigate possibilities for obtaining reliable lateral control at low flight speeds. The maximum angle of attack below the stall at which control is still available was determined for each airplane, as well as the elevator deflection required to trim at this condition, with power off and on, and to make a three-point landing. One airplane was tested with different horizontal tail configurations in an attempt to provide an arrangement that would give near-optimum conditions with regard to the effect of power change on longitudinal trim near the stall.

NACA TN 3677

INVESTIGATION OF LATERAL CONTROL NEAR THE STALL. ANALYSIS FOR REQUIRED LONGITUDINAL TRIM CHARACTERISTICS AND DISCUSSION OF DESIGN VARIABLES. Fred E. Weick and H. Norman Abramson, Agricultural and Mechanical College of Texas. June 1956. 91p. diagrs., tabs. (NACA TN 3677)

Analytical design procedures for estimating the elevator deflection required to trim in steady longitudinal flight are presented. Pertinent data and formulas for use in evaluating longitudinal trim characteristics are summarized from existing literature and two light airplanes are analyzed quantitatively to illustrate the use of the methods and to provide a comparison with flight-test results. Calculated values of elevator deflection for both airplanes are presented to demonstrate the quantitative effects of changes in some of the more important design parameters.

NACA TN 3681

INVESTIGATION OF PLASTIC BEHAVIOR OF BINARY ALUMINUM ALLOYS BY INTERNAL-FRICTION METHODS. R. E. Maringer, L. L. Marsh, and G. K. Manning, Battelle Memorial Institute. June 1956. 44p. diagrs., tabs. (NACA TN 3681)

The relationship between internal friction and plastic deformation in binary aluminum alloys was investigated, with the percentage of alloying element taken as a variable parameter. The effects of strain rate, amount of strain, heat treatment, temperature, and testing frequency on internal friction during plastic deformation were also studied. The experimental observations are analyzed in light of modern dislocation theory.

NACA TN 3685

FATIGUE CRACK PROPAGATION IN SEVERELY NOTCHED BARS. W. S. Hyler, E. D. Abraham, and H. J. Grover, Battelle Memorial Institute. June 1956. 31p. diagrs., photos., tabs. (NACA TN 3685)

Fatigue tests were made in rotating bending on severely notched bars machined from 2024-T4 aluminum-alloy extruded round rods. Two sizes of specimens were studied, 1/4-inch-diameter and 2-inch-diameter specimens. The smaller specimens were notched with a V-groove and had notch severities K_t of 5.2. The larger specimens also contained V-grooves with notch severities of 5.2 and 13.9.

NACA TN 3687

SOME WIND-TUNNEL EXPERIMENTS ON SINGLE-DEGREE-OF-FREEDOM FLUTTER OF AILERONS IN THE HIGH SUBSONIC SPEED RANGE. Sherman A. Clevenson. June 1956. 32p. diagrs., photo., tabs. (NACA TN 3687. Supersedes RM L9B08)

Results of tests of three wing models with various aileron configurations are presented. Density had little effect on the initial magnitude or initial Mach number of buzz. Buzz frequency decreased with decrease in density. Initial buzz Mach number decreased with increasing angle of attack. Mass balancing and changes of spring stiffness of the ailerons in these tests had little effect on buzz. Increasing the aileron mass moment of inertia lowered the buzz frequency. Placing the aileron at the wing tip delayed the onset of buzz. A comparison of the test results with two empirical analyses is made.

NACA TN 3696

A STUDY OF THE HIGH-SPEED PERFORMANCE CHARACTERISTICS OF 90° BENDS IN CIRCULAR DUCTS. James T. Higginbotham, Charles C. Wood, and E. Floyd Valentine. June 1956. 28p. diagrs. (NACA TN 3696)

Four 90° bends in ducts of constant diameter with ratios of radius of curvature to diameter (r/d) of 0.75, 1.00, 2.50, and 4.00 have been investigated with both a thin and a thick inlet boundary layer to determine the choke Mach number and general performance of each of the elbows. Inlet-boundary-layer thickness had a very small detrimental effect on the choking Mach number and practically no effect on the losses through the elbows. The elbow with $r/d = 2.50$ gave the greatest value of inlet choking Mach number and the least static-pressure loss and total-pressure loss.

NACA TN 3697

FLIGHT TESTS AT SUPERSONIC SPEEDS TO DETERMINE THE EFFECT OF TAPER ON THE ZERO-LIFT DRAG OF SWEPTBACK LOW-ASPECT-RATIO WINGS. Murray Pittel. June 1956. 20p. diagrs., photos. (NACA TN 3697. Supersedes RM L50F30a)

Comparison of experimental flight-test results with theoretical calculations to determine the effect of wing taper and aspect ratio on the zero-lift drag of wings with thin double-wedge sections at supersonic speeds is presented.

NACA TN 3699

SOME EFFECTS OF JOINT CONDUCTIVITY ON THE TEMPERATURES AND THERMAL STRESSES IN AERODYNAMICALLY HEATED SKIN-STIFFENER COMBINATIONS. George E. Griffith and Georgene H. Miltonberger. June 1956. 62p. diagrs. (NACA TN 3699)

Temperatures and thermal stresses in aerodynamically heated skin-stiffener combinations were calculated with the aid of an electronic differential analyzer. Variations were made in an aerodynamic heat-transfer parameter, a joint conductivity parameter, and the ratio of skin width to skin thickness. The results indicate that decreasing the joint conductivity or increasing the heat-transfer coefficient increases the peak thermal stresses in the skin and may appreciably increase the peak stresses in the stiffener, whereas increasing the ratio of skin width to skin thickness produces some increase in the peak stiffener stresses but a corresponding decrease in the peak skin stresses.

NACA TN 3708

INVESTIGATION AT SUPERSONIC SPEEDS OF THE VARIATION WITH REYNOLDS NUMBER AND MACH NUMBER OF THE TOTAL, BASE, AND SKIN-FRICTION DRAG OF SEVEN BOATTAIL BODIES OF REVOLUTION DESIGNED FOR MINIMUM WAVE DRAG. August F. Bromm, Jr. and Julia M. Goodwin. June 1956. 20p. diagrs., photo. (NACA TN 3708. Supersedes RM L53I29b)

Results are presented from an investigation of the variation with Reynolds number and Mach number of the total, base, and skin-friction drag of seven boattail bodies of revolution designed for minimum wave drag according to the theory of NACA TN 2550. The tests covered a Reynolds number range from approximately 1.0×10^6 to 10.0×10^6 at Mach numbers of 1.62, 1.93, and 2.41, respectively.

NACA TN 3712

BOUNDARY LAYER BEHIND SHOCK OR THIN EXPANSION WAVE MOVING INTO STATIONARY FLUID. Harold Mirels. May 1956. i, 53p. diagrs., tabs. (NACA TN 3712)

The boundary layer behind a shock or thin expansion wave moving into a stationary fluid has been studied. Both laminar and turbulent boundary layers were considered. The wall surface temperature behind the waves was also investigated. Numerical and analytical results are presented for the various boundary-layer parameters of interest. It was found that the wall surface temperature was uniform (as a function of distance behind the wave) for the laminar-boundary-layer case but varies with distance for the turbulent-boundary-layer case.

NACA TN 3713

SELECTION OF OPTIMUM CONFIGURATIONS FOR HEAT EXCHANGER WITH ONE DOMINATING FILM RESISTANCE. E. R. G. Eckert and T. F. Irvine, Jr. June 1956. 48p. diagrs. (NACA TN 3713)

A study is presented for selecting an optimum configuration for a heat exchanger. Compact heat-exchanger configurations with one dominating film resistance are considered. Any one of the parameters (power, weight, volume, or frontal area) can be optimized against any one of the remaining three when the heat exchanger is arranged normal to the approaching primary fluid. When the heat exchanger is inclined at an angle to the upstream direction, any one of the parameters (power, weight, or volume) can be optimized against any one of the remaining two. The projected frontal area of the inclined heat exchanger will equal the frontal area of the exchanger requiring the minimum duct cross-sectional area when arranged normal to the flow.

NACA TN 3715

COMPARISON OF THE EXPERIMENTAL AND THEORETICAL DISTRIBUTIONS OF LIFT ON A SLENDER INCLINED BODY OF REVOLUTION AT $M = 2^1$. Edward W. Perkins and Donald M. Kuehn. May 1956. 39p. diagrs., photos., tabs. (NACA TN 3715. Supersedes RM A53E01)

An investigation of the pressure distribution for a body of revolution, consisting of a 33-1/3 caliber (5.75 fineness ratio) tangent ogival nose and a cylindrical afterbody, has been made for an angle-of-attack range of 0° to 35.5° at a Mach number of 1.98 and a Reynolds number of approximately 0.5×10^6, based on body diameter. Comparisons of the theoretical and experimental pressure distributions are made to show the nature of the effects of both viscosity and cross-flow compressibility. The experimental load distributions are compared with those predicted by the method suggested in NACA RM A9I26 which includes an approximate method for taking into account the effects of viscosity on the lift distribution.

NACA TN 3716

COMPARISON OF EXPERIMENTAL AND THEORETICAL NORMAL-FORCE DISTRIBUTIONS (INCLUDING REYNOLDS NUMBER EFFECTS) ON AN OGIVE-CYLINDER BODY AT MACH NUMBER 1.98. Edward W. Perkins and Leland H. Jorgensen. May 1956. 50p. diagrs., tab. (NACA TN 3716. Supersedes RM A54H23)

Effects of Reynolds number and angle of attack on the pressure distribution and normal-force characteristics of a body of revolution consisting of a fineness ratio 3 ogival nose tangent to a cylindrical afterbody 7 diameters long have been determined. The test Mach number was 1.98 and the angle-of-attack range from 0° to 20°. The Reynolds numbers, based on body diameter, were 0.15×10^{6} and 0.45×10^{6}. The experimental results are compared with theory.

NACA TN 3720

COMPARISON BETWEEN EXPERIMENTAL AND PREDICTED DOWNWASH AT A MACH NUMBER OF 0.25 BEHIND A WING-BODY COMBINATION HAVING A TRIANGULAR WING OF ASPECT RATIO 2.0. Norman E. Sorensen and Edward J. Hopkins. May 1956. 29p. diagrs., photos. (NACA TN 3720)

A comparison is made between experimental and predicted downwash angles and span load distributions for a wing-body combination (maximum diameter to wing span ratio = 0.259) through an angle-of-attack range from 0° to 20°. Positions of the vortex cores indicated by the tuft-grid, the water-tank technique, and a numerical method are compared.

BRITISH REPORTS

N-42559*

Royal Aircraft Establishment (Gt. Brit.)
STRAIN GAUGE BALANCES FOR WIND TUNNELS: AN OUTLINE OF PRACTICE IN THE UNITED KINGDOM. J. R. Anderson. (Prepared for AGARD Wind Tunnel and Model Testing Panel, February 1956, Rome, Italy). January 1956. 68p. diagrs., photos., tab. (RAE Tech.Note Aero 2434)

A brief survey of developments in strain-gage balance practice is made, with notes on the various types of balance employed, their design and fabrication. Descriptions of 12 particular strain-gage balances are included.

N-42782*

Royal Aircraft Establishment (Gt. Brit.)
THE STRENGTH OF TUBES UNDER UNIFORM EXTERNAL PRESSURE. P. C. Cleaver. November 1955. 191p. diagrs., photos., tabs. (RAE Structures 193)

This report traces the development of theoretical solutions to the problem of determining the strength of tubes subjected to uniform external pressure, and describes an extensive series of tests to check the accuracy of the Sturm solution to this problem and the effects of material properties on collapse pressure. A total of 530 tests were made covering ranges of length:diameter from 14.0 to 0.51 and nominal thickness:diameter from 0.0098 to 0.056. The mean collapse pressure of the tests designed to check the accuracy of the Sturm solution corrected for eccentricity effects exceeded the mean theoretical collapse pressure by 2.2 percent, the standard deviation was 7.0 percent, and the distribution approximately Gaussian. It is concluded that this theory may confidently be used to predict the strength of tubes under uniform external pressure applied to the sides only.

N-42783*

Royal Aircraft Establishment (Gt. Brit.)
THE TEMPERATURE OF MATERIALS AT HIGH FLIGHT SPEEDS AND THE PROBLEMS INVOLVED. A. S. Hartshorn. September 1955. 30p. diagrs., tabs. (RAE Tech. Note Aero 2397)

Much has been written on the subject of kinetic heating, considered from many angles. This note is addressed primarily to those engaged in research on new materials suitable for aircraft designed for very high speeds. It gives in broad outline the temperature to which they will be exposed and the effect that these temperatures will have on the structural design.

N-42784*

Royal Aircraft Establishment (Gt. Brit.)
MECHANICAL PROPERTIES OF Ti 75A SHEET TITANIUM AT ROOM AND ELEVATED TEMPERATURES. D. C. Hayward. November 1955. 19p. diagrs., tabs. (RAE Tech. Note Met. 210)

The mechanical properties in tension and compression were determined on 16 S.W.G. (0.064 inch) sheet at room temperature, 200° C, and 400° C in directions along and transverse to rolling. It was found that at each temperature level, Young's modulus was of a similar order for tension and compression in the same direction but transverse values exceeded longitudinal values. While longitudinal proof-stress values for tension and compression were in most cases exceeded by values in the transverse direction, ultimate tensile stresses were of similar magnitude in both directions. Elongation was greater at 200° C than at either room temperature or 400° C. Stress-strain, tangent-moduli, and secant-moduli curves are given.

N-42785*

Royal Aircraft Establishment (Gt. Brit.)
EFFECT OF TWO TYPES OF ETCHING PENCIL MARKING ON THE FATIGUE STRENGTH OF ALUMINUM ALLOY DTD. 683. J. T. Ballett. November 1955. 7p. diagrs., tabs. (RAE Tech. Note Met. 232)

Wohler type fatigue tests have been made on specimens of high strength aluminum alloy DTD 683 after treatment by two types of marking pencils, that is, electric etching and pneumatic etching. When compared with plain longitudinally polished specimens, the former type of marking resulted in a drop of fatigue strength at 10^7 cycles of about 70 percent while the latter type resulted in a drop of about 30 percent.

N-42786*

Royal Aircraft Establishment (Gt. Brit.)
MECHANICAL PROPERTIES OF R. C. 130A SHEET TITANIUM AT ROOM AND ELEVATED TEMPERATURES. D. C. Hayward. November 1955. 20p. diagrs., tabs. (RAE Tech. Note Met. 214)

The mechanical properties in tension and compression were determined on 16 S.W.G. R.C. 130A titanium alloy sheet now designated C. 110M, at room temperature, 200° C, and 400° C in directions along and transverse to rolling. It was found that at each temperature level Young's modulus was about the same for tension and compression in the same direction but transverse values exceeded longitudinal values. Marked differences, up to 25 percent of the maximum stress, between longitudinal and transverse proof stress values were found for both tension and compression; however, at maximum stress these differences were reduced to about 5 percent. Elongation values decreased with increase in temperature over the range considered. Stress-strain, tangent-moduli, and secant-moduli curves are given.

N-42787*

National Gas Turbine Establishment (Gt. Brit.)
THERMAL SHOCK STRESSES IN A CYLINDER OF RECTANGULAR CROSS SECTION. P. W. H. Howe. February 1956. 27p. diagrs., tabs. (NGTE Memo. M. 263)

The stresses arising when a hot cylinder of rectangular cross section is quenched are calculated. On account of the computing work involved the calculation is made for one set of values only of the length/width ratio of the rectangular cross section, heat-transfer coefficient, and time after quenching starts. For this case the maximum tensile stresses at the corners, at the midpoint of the short side, and at the midpoint of the long side are in the approximate ratio of 3:2:1. The stresses are of the same order as those in a quenched circular cylinder. If the method can be programed for an automatic computing machine, it will be a practical proposition to calculate thermal shock stresses in a turbine blade.

N-42788*

Royal Aircraft Establishment (Gt. Brit.)
CORROSION AND STRESS CORROSION PROPERTIES OF ALUMINUM-COPPER AND ALUMINUM-COPPER-CADMIUM ALLOYS. C. Braithwaite. November 1955. 9p. tabs. (RAE Tech. Note Met. 219)

Fulmer Research Institute have carried out some work for the Ministry of Supply on the aging characteristics. etc., of aluminium-copper alloys. It was required to investigate the corrosion resistance with and without stress on the most promising of these alloys after heat treatment to obtain the maximum tensile strength. The alloys supplied by the Institute were aluminium/$4\frac{1}{4}$ percent copper and aluminium/$4\frac{1}{4}$ percent copper/0.097 percent cadmium. Both alloys showed remarkable high corrosion resistance under intermittent sea-water spray conditions with and without stress. A safe stress of over the 0.1-percent proof stress was maintained for 18 months. When exposed without load for 18 months neither of the alloys lost any tensile strength.

N-42789*

Royal Aircraft Establishment (Gt. Brit.)
THE ASSESSMENT OF INTERLAMINAR STRENGTH IN SHEAR OF POLYESTER-GLASS LAMINATES. R. B. King. August 1955. 9p. diagrs., tabs. (RAE Tech. Note Chem. 1258)

A method of estimating the interlaminar strength in shear of polyester-glass laminates is discussed, and used to differentiate between the effects of degree of cure, surface treatment, and humidity. Results showed that the method was of use in determining the effects of variation of cure and humidity, but comparing the surface finishes used, a significant difference was found only for the vinyl trichlorosilane treatment.

N-42791*

Royal Aircraft Establishment (Gt. Brit.)
THE FATIGUE STRENGTH OF TWO MATERIALS UNDER DIFFERENT TYPES OF STRESSING. N. J. F. Gunn. November 1955. 17p. diagrs., tabs. (RAE Tech. Note Met. 231)

Fatigue tests have been conducted on an aluminum alloy DTD 683 and a normalized carbon steel BSS S6B under three types of stressing, namely, axial, uniform bend, and rotating cantilever. It was found that the materials withstood for a given endurance a smaller fatigue stress when subjected to axial type stressing than when subjected to either rotating cantilever or uniform bend types of stressing.

N-42792*

Royal Aircraft Establishment (Gt. Brit.)
FATIGUE LOADINGS IN FLIGHT: LOADS IN THE TAILPLANE AND FIN OF A VARSITY. Anne Burns. January 1956. 20p. diagrs., photo., tabs. (RAE Tech. Note Structures 183)

Data are presented on the number of load cycles of various sizes occurring in the tailplane and fin of a Varsity in normal ground and flight conditions. The conditions include flight in turbulence, take-off, landing, taxiing, and ground running of the engines. The relative importance of the loads in the different conditions is illustrated by reference to the loads in a typical flight.

N-42793*

Royal Aircraft Establishment (Gt. Brit.)
AN INVESTIGATION INTO THE TRANSMISSION OF DATA OVER A TELEPRINTER LINK. A. Cohen. January 1956. 10p. (RAE Tech. Note TD 2)

The necessity for sending G. W. Trials Data from G. W. T. W., Aberporth to R. A. E. Farnborough for computations on the R. A. E. Digital Computer "DEUCE" has led to an investigation of a system for transmitting the data over a teleprinter link. This method appears to be promising but it is considered necessary to carry out a series of tests on such a teleprinter link. Some 3 months' experience with this test link indicates that, to cope with most eventualities, a system of automatic detection and correction of errors would be necessary. A system is proposed using direct transmission between Hollerith cards. It is shown that the efficiency of this system would be of the order of 90 percent.

N-42800*

Marine Aircraft Experimental Establishment (Gt. Brit.) TOWING TANK TESTS TO DETERMINE THE WATER DRAG TO THE HULL OF A JET PROPELLED FLYING BOAT FIGHTER (SPEC. E. 6/44) AND COMPARISON WITH FULL SCALE MEASUREMENTS. R. V. Gigg, A. G. Kurn, and J. K. Friswell. May 1955; February 1956 (rev.). 41p. diagrs., tab. (MAEE F/Res/263)

The water drag, draught, wetted areas, and mean wetted lengths of a 1/9-scale E. 6/44 flying boat model hull have been measured for all anticipated take-off loads and attitudes over the take-off run. A method of scaling up model drag to make allowances for the differences in skin friction, model and full scale, has been used and the results compared with actual full-scale tests. There is not satisfactory agreement between estimated and measured full-scale results, and the tests do not provide sufficient evidence to determine whether the accurate estimation of full-scale water resistance by the methods used is possible.

N-42801*

Marine Aircraft Experimental Establishment (Gt. Brit.) INVESTIGATION OF HIGH LENGTH/BEAM RATIO SEAPLANE HULLS WITH HIGH BEAM LOADINGS. HYDRODYNAMIC STABILITY. PART 19. THE INTERACTION OF THE EFFECTS OF FOREBODY WARP, AFTERBODY LENGTH AND AFTERBODY ANGLE ON LONGITUDINAL STABILITY CHARACTERISTICS. J. K. Friswell. September 1955. 45p. diagrs., tab. (MAEE F/Res/255)

In this report the interaction of the effects of the different parameters concerned in the investigation is considered. It is found that by a redefinition of stability it is possible to predict these interactions as far as the undisturbed lower limit is concerned, but that otherwise there seems to be no simple law governing them. Some broad generalizations are, however, possible.

N-42802*

Marine Aircraft Experimental Establishment (Gt. Brit.) INVESTIGATION OF HIGH LENGTH/BEAM RATIO SEAPLANE HULLS WITH HIGH BEAM LOADINGS. HYDRODYNAMIC STABILITY. PART 22. TABULATED TEST DATA. D. M. Ridland, J. K. Friswell and A. G. Kurn. September 1955. 106p. tabs. (MAEE F/Res/262)

This report contains tabulated test data obtained during the investigation made by MAEE into the hydrodynamic stability characteristics of high length/beam ratio seaplane hulls. The data cover tests on all models, A to N, in all configurations, both aerodynamic and hydrodynamic.

N-42803*

Royal Aircraft Establishment (Gt. Brit.)
THE CORROSION RESISTANCE OF BINARY MAGNESIUM-LITHIUM ALLOYS IN SHEET FORM. H. G. Cole. February 1956. 7p. diagr., tab. (RAE Tech. Note Met. 235)

Corrosion tests by total immersion in 3 percent sodium chloride solution and by intermittent sea-water spray have been made on sheets rolled from a series of binary magnesium-lithium alloys low in sodium. Alloys containing up to 10 percent lithium by weight had a corrosion resistance approximately equal to that of magnesium -1. 5 percent manganese alloy sheet and were equally well protected by conventional protective treatments. At lithium contents of 12 percent and over, corrosion resistance fell rapidly.

N-42804*

Royal Aircraft Establishment (Gt. Brit.) RELATIVE ACCURACY OF DEFLECTIONS AND BENDING MOMENTS (OR STRESSES) DERIVED BY THE METHOD OF R. A. E. REPORT NO. STRUCTURES 168. D. Williams. March 1956. 12p. diagrs., tabs. (RAE Tech. Note Structures 188)

The relative accuracies of moments and deflections, as derived by the method of reference 1, are discussed, and it is shown that moments are not expected in general to be less accurate than the deflections.

N-42805*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) AN AIRBORNE RECORDING TACHOMETER USING THYRATRONS. F. Walder. February 6, 1956. 9p. diagrs. (AAEE/Res/292)

A flight instrument is described which will record the frequency of the normal type of airborne tachometer generator to an accuracy better than ±1 percent with a full-scale deflection covering any predetermined range. The output is in a suitable form for pilot indication or for galvanometer camera recording.

N-42806*

Royal Aircraft Establishment (Gt. Brit.) THE POLYMERISATION OF PHOSPHONITRILIC CHLORIDES. PART 1. THE NATURE OF THE PROBLEM. F. G. R. Gimblett. February 1956. 8p. tab. (RAE Tech. Note Chem. 1274)

A review of the methods of preparation of the phosphonitrilic chloride polymers is given, together with an account of their mechanical and physical properties. Possible methods of developing these polymers to give materials capable of withstanding high temperatures up to 500° C are mentioned.

N-42807*

Royal Aircraft Establishment (Gt. Brit.) MEASUREMENT OF THE RESPONSE FUNCTION OF AN OPTICAL SYSTEM. J. M. Naish and A. C. Marchant. January 1956. 25p. diagrs., photos. (RAE Tech. Note PH. 493)

The need for new methods of optical assessment is discussed with particular reference to the vagaries of existing tests. Reasons favoring the choice of the response function are given and the theory of image formation by Fourier methods is summarized. The considerations leading to the choice of the present experimental method are given and after discussing the results some indications are made concerning applications possible in the case of air camera lenses.

N-42808*

Royal Aircraft Establishment (Gt. Brit.) FLUTTER PREDICTION IN PRACTICE. E. G. Boradbent. (To be presented at Structures and Materials Panel, Advisory Group for Aeronautical Research and Development, Washington, D. C., April 1956). February 1956. 32p. diagrs., tabs. (RAE Tech. Note Structures 185)

A brief summary is given of the resources available for flutter prediction, both experimental and theoretical. Specific flutter investigations are described for four separate flutter incidents which have occurred in Great Britain during the past few years. In all four examples good agreement is eventually obtained between the calculations and full-scale experience and it is thought that useful lessons can be learned from the steps which proved necessary to get this agreement. Two of the examples relate to classical flutter, in which compressibility is unimportant, but in the other two examples, although compressibility is important, it would have been wrong to conclude that the incidents were only due to negative aerodynamic damping in one degree of freedom. Conclusions for future guidance are drawn from all the examples, with particular reference to the aerodynamic treatment. The paper concludes with a few points from a more general statistical survey of recent incidents.

N-42912*

Royal Aircraft Establishment (Gt. Brit.) FATIGUE TESTS ON SPECIMENS FROM ALUMINUM ALLOY D.T.D. 683 AND B.S. L.40 EXTRUDED ANGLE SHOWING 'ORANGE PEEL' EFFECTS. M. S. Binning. September 1955. 12p. diagrs., photos., tab. (RAE Tech.Note Met.228)

Angle section aluminium alloy extrusions in D.T.D. 683 and B.S. L.40, after solution heat treatment, stretch forming, and aging, exhibited an "orange peel" effect on the surface. Fatigue tests made in fluctuating tension in Haigh fatigue machines showed that this surface resulted in no marked change in the fatigue properties of either alloy.

N-42913*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) AN ANALYSIS OF THE METEOROLOGICAL CONDITIONS WHICH MAY CAUSE THE MISTING OF AIRCRAFT TRANSPARENCIES. G. C. Abel and K. W. Taylor. March 21, 1956. 9p. diagrs., tabs. (AAEE/Tech/123)

Analysis of meteorological data shows that the atmospheric conditions in U.K. give little direct indication of the chances of aircraft transparencies misting in the tropics. The tropical high altitude temperatures are lower and the low altitude dewpoints higher, especially over the sea, so that even the worst conditions obtainable in U.K. are less likely to cause misting than those that can be experienced almost any day in the tropics by high flying aircraft descending rapidly for a strike or for combat or to land.

MISCELLANEOUS

N-43270*

Advisory Group for Aeronautical Research and Development. THEORY OF COMBUSTION INSTABILITY IN LIQUID PROPELLANT ROCKET MOTORS. Luigi Crocco and Sin-I Cheng. 1956. viii, 200p. diagrs., photos. (AGARDograph 8)

Use is made of present knowledge of combustion processes with the following objectives: to establish a rational explanation for the existence of a detrimental and of a nondetrimental type of rough combustion, to distinguish a number of mechanisms which may be responsible for the appearance of the detrimental type, to give for some of these mechanisms plausible quantitative formulations, and to analyze in detail the results of the theoretical developments.

(May be purchased from Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, New York, at $5.25.)

UNPUBLISHED PAPERS

N-9275*

Polytechnic Institute of Brooklyn. CALCULATION OF STABILITY OF CONSTANT-PRESSURE BOUNDARY LAYERS ON ISOTHERMAL SURFACES WITH AN INTEGRAL-METHOD MEAN-FLOW SOLUTION. Martin Bloom. September 25, 1953. 68p. diagrs., tabs. (Polytechnic Institute of Brooklyn. PIBAL Rept.179)

The laminar boundary layer with constant pressure, heat transfer through an isothermal surface, unit Prandtl number, a linear temperature-viscosity relation, and constant heat capacity is considered. Velocity profile derivatives obtained by assuming a sixth-degree polynomial profile in the Kármán-Pohlhausen integral method are shown to agree well with those of a mathematically exact solution. Comparative calculations of minimum critical Reynolds numbers for laminar boundary-layer stability, made with both integral-method and more exact mean-flow values, for $M < 2$, are shown to agree reasonably well with each other. The stability theory of Lees and Lin is used for this purpose.

N-43627*

HARMONIC ANALYSIS APPLIED TO VIBRATION TESTS OF NONLINEAR STRUCTURES. (L'analyse harmonique appliquee aux essais de vibration des structures non-lineaires). G. deVries. April 1956. 15p. diagrs. (Trans. from Recherche Aéronautique, no.44, March-April 1955)

The application of harmonic analysis to the measurement of vibration offers unquestionable advantages from both the theoretical and practical viewpoint. It gives an effective means of measuring with precision the natural values of nonlinear systems, but it facilitates equally measurements on practically linear systems. In view of the fact that the mobile elements of the pickups may be very light, the structure is little affected by the measuring apparatus. The absence of electronic means makes the measurement simple, avoids elements variable with time, thus repeated calibrations, and facilitates employment of a great number of pickups.

N-43645*

INVESTIGATIONS OF CASCADE FLOWS IN TURBOMACHINES. (Untersuchungen an Schaufelgittern von Strömungsmaschinen). Norbert Scholz. April 1956. 14p. diagrs., photo. (Trans. from Zeitschrift für Flugwissenshaften, v.3, no.3/4, 1955, p.99-104)

Recently, theoretical and experimental investigations of cascade flows have been carried out to an ever growing extent in order to improve the aerodynamical effectiveness of turbomachines. The problems of cascade flows are treated and, in particular, the present state of experimental research techniques is discussed. Some examples of test arrangements and results of measurements are given.

N-43674*

THE SOLUTIONS OF THE INTEGRAL EQUATION $g(x) = \frac{1}{2\pi} \oint_{-a}^{a} \frac{f(\xi)}{x - \xi} d\xi$ AND THEIR APPLICATION IN WING THEORY. (Die Lösungen der Integralgleichung $g(x) = \frac{1}{2\pi} \oint_{-a}^{a} \frac{f(\xi)}{x - \xi} d\xi$ und deren Anwendung in der Tragflügeltheorie). Heinz Söhngen. May 1956. 23p. (Trans. from Mathematische Zeitschrift, v.45, 1939, p.245-264)

N-43717*

National Bureau of Standards. STRENGTH AND STRESS DISTRIBUTION TEST OF A SIMPLIFIED LOW ASPECT RATIO SWEPT WING SUBJECTED TO LATERAL POINT LOADS. Stanley Goodman and Stanton B. Russell. July 30, 1954. 30p. diagrs., photos., tabs. (National Bureau of Standards. Rept.3486)

Stress distribution, deformation, and rotation at the root were measured for a tapered, swept, low-aspect-ratio two-cell simplified wing subjected to a sequence of elastic lateral loads at various points. The wing was tested to failure by a lateral point load applied to the main spar. For purposes of comparison, influence coefficients were computed by conventional methods for a nonswept wing having the same bending and torsional stiffness as the swept wing clear of the root and tip sections. In addition comparison was made between the measured influence coefficients and available influence coefficients computed for the wing by a method developed for delta wings.

N-43718*

Rocket Laboratory, Purdue University. EXPERIMENTAL INVESTIGATION OF THE HEAT TRANSFER AND FLUID FRICTION CHARACTERISTICS FOR WHITE FUMING AND RED FUMING NITRIC ACID AT HIGH HEAT FLUX DENSITIES. Helmut Wolf and Foster L. Gray. March 1955. x, 114p. diagrs., photos., tabs. (Rocket Laboratory, Purdue University. Rept.F-55-1)

The investigation with which this report is concerned covered a heat flux range for WFNA varying from 0.11 to 5.13 B/sec sq in. Two different systems were employed for supplying the WFNA to the test section, the recirculatory system and the single-pass system. The variables investigated for RFNA and WFNA in these two systems were Reynolds number, heat flux density, inlet bulk temperature, and inlet pressure.

N-43719*

Harvard University. RESEARCH REPORT, OCTOBER 1952 - MARCH 1953. J. A. Cole. (NACA Lubrication Project). March 1953. 20p. diagrs. (Harvard University)

The construction and limitations of the Harvard rotating cylinder viscometer are examined in the light of experience gained since the resumption of work on the project, and relative to high shear viscometry generally. Results of a series of tests using a mineral oil and of preliminary tests using a polymer-containing oil in the shear rate range 0.001-0.25 million reciprocal sec. are presented in terms of the Hagg thermal effects analysis. The temperature measurements are shown to be in good agreement, but the torque measurements confirm that the present torque-meter is unsatisfactory. An extension of the analysis of thermal conditions to the case of non-Newtonian lubricants is proposed.

N-43720*

Guggenheim Aeronautical Laboratory, California Institute of Technology. A DESCRIPTION OF THE DESIGN OF A HIGH SPEED, LOW NOISE AND TURBULENCE LEVEL AIR SUPPLY. William W. Willmarth. January 1955. 16p. diagrs., photo. (Guggenheim Aeronautical Laboratory, California Institute of Technology)

The report is concerned with the design problems encountered in obtaining a low noise and turbulence level air supply using a closed return system powered by centrifugal compressors. The present performance of the equipment indicates that a satisfactory, economical solution to these problems has been obtained.

N-43721*

Columbia University. ADIABATIC HEATING AND TEMPERATURE-RECOVERY FACTOR OF THE WALLS OF TUBES CARRYING LIQUIDS OF HIGH PRANDTL NUMBER. Charles F. Bonilla, James P. Collins, and Susanta K. Aditya. (Final report). March 15, 1955. 51p. diagrs., tabs. (Columbia University. CU-4-55-NAw-6160-Ch.E)

Oil of Prandtl number ranging from 80 to 600 was pumped at velocities of 20 to 70 ft/sec through a tube of 0.4 in. internal diameter and 100 diameters long, with a rounded inlet nozzle. The adiabatic wall temperature rise was measured, ranging up to 3.8° F. Low or negative recovery factors were obtained at both ends. Streamline flow was obtained at diameter RN up to 12,000. The temperature-recovery factor based on mean stream temperature and velocity increased downstream fairly linearly towards a highest value of 17 to 37, giving indication that it would keep on increasing in a longer tube, possibly towards the theoretical value of twice the Prandtl number. Turbulent flow was achieved in the stream by inserting a rod across the stream and fairly uniform values of the recovery factor, roughly equal to the square root of the Prandtl number, were obtained over at least half of the length of the tube. No clear-cut transition from a laminar to a turbulent boundary layer was noted.

N-43722*

Applied Science Research Laboratory, University of Cincinnati. OXIDATIVE DEGRADATION OF METHYLCYCLOHEXANE AND n-HEPTANE. Donald Swarts. (Final report, September 1, 1954 - August 31, 1955). August 10, 1955. 32p. diagrs., tabs. (Applied Science Research Laboratory, University of Cincinnati)

The present study shows the tendency of methylcyclohexane and n-heptane to form carbonaceous deposits and their relative rates of vapor phase oxidation at various temperatures and hydrocarbon-oxygen compositions. The formation of cokes and resins from these two compounds at both high and low temperatures was observed and the relation between temperature, contact time, hydrocarbon-oxygen composition and residue formation was studied. The rate of hydrocarbon disappearance in excess oxygen was also studied and the quantitative difference in susceptibility to oxidation of methylcyclohexane and n-heptane was measured. The effect of temperature on reaction rate led to the determination of an approximate over-all energy of activation for the oxidations.

N-43723*

Cornell University, Graduate School of Aeronautical Engineering. HOT-WIRE MEASUREMENTS WITH X-METERS. Harry Ashkenas. May 1955. 64p. diagrs., photo. (Cornell University, Graduate School of Aeronautical Engineering)

A method is devised for the measurement of turbulent shearing stress, using a biplanar X-meter, which at the same time produces consistent turbulence intensity measurements. The measurements reported were all made in a fully developed pipe flow. The pipe was chosen since the shear distribution can be determined by means other than hot-wire anemometry and thus an overall check on the accuracy of the measurements can be obtained.

N-43724*

Polytechnic Institute of Brooklyn. SOLUTIONS OF THE EXACT EQUILIBRIUM EQUATIONS OF A ONE-DIMENSIONAL MEMBRANE. Frederick V. Pohle. 16p. diagrs. (Polytechnic Institute of Brooklyn. PIBAL Rept.229)

The equations of equilibrium of a one-dimensional membrane are derived under the assumption of a linear stress-strain law, but without approximation in the strain-displacement relations. The equations are solved explicitly for two loading cases, a constant normal loading exerted on the final deflected shape and a constant vertical loading. Comparison is made with the conventional nonlinear theory, the classical catenary problem, and the problem of the elastic catenary.

N-43725*

Harvard University, Division of Applied Science. REPORT ON DEVELOPMENT AND PRELIMINARY TESTS OF A ROTATING VISCOSIMETER. Howard W. Emmons and Shao-Lee Soo. (NACA Lubrication Project). May 1952. 42p. diagrs. (Harvard University, Division of Applied Science)

This investigation undertakes to measure viscosities at a range of rates of shear up to values approaching 10^6 in an apparatus in which an accurate knowledge of the lubricant temperature is available. The progress of molecular orientation will also be followed by the measurement of the lubricant dielectric constant. The fluids used were n-butyl sebacate, silicone 200, and Etna Oil light.

N-43726*

Polytechnic Institute of Brooklyn. A NUMERICAL SOLUTION FOR A CIRCULAR CYLINDRICAL SHELL WITH A SINUSOIDAL LOAD ALONG ONE GENERATOR. Nicholas Perrone and F. S. Shaw. April 1954. 30p. diagrs. (Polytechnic Institute of Brooklyn. PIBAL Rept. 250)

A numerical solution is presented for a circular cylinder of uniform thickness and finite length which is stressed by the application of a normal sinusoidal load acting along one generator. The three simultaneous linear displacement equations derived by Donnell are solved. For boundary conditions it is assumed that both ends of the cylinder are clamped. Finite-difference approximations to derivatives are used, and the resulting simultaneous algebraic equations are solved by a relaxation-iteration technique. For the finite-difference representations a rectangular mesh is used, rather than the usual square one. Values and contours of stress components are presented, as well as displacement components, both for membrane and bending.

N-43727*

Gordon McKay Laboratory, Harvard University. REPORT ON PRELIMINARY TESTS OF A ROTATING VISCOSIMETER. Howard W. Emmons and Vernon H. Head. (NACA Lubrication Project). November 1950. 35p. diagrs. (Gordon McKay Laboratory, Harvard University)

A rotating viscosimeter has been developed to give accurate information on the viscosity of liquid lubricants at rates of shear approaching 10^6 sec^{-1}. Further, it is suggested that the instrumentation is capable of giving information on lubricant temperature distribution and on the change, if any, of electrical properties (resistivity and dielectric constant) of the lubricant under high rates of shear.

N-43728*

Guggenheim Aeronautical Laboratory, California Institute of Technology. ON THE ACOUSTIC RADIATION FROM BOUNDARY LAYERS AND JETS. H. W. Liepmann. August 1954. 24p. diagrs. (Guggenheim Aeronautical Laboratory, California Institute of Technology)

A general discussion of aerodynamically created sound is given which is essentially theoretical but arrives at a description of the physical phenomena in such a way as to yield an immediate access to experiments. The problem of aerodynamic noise is defined and two simple mechanical analogues discussed. The general equations of motion of a viscous, compressible fluid are rearranged in a form suitable for a comparison with Lighthill's approach, but instead the concept of induced velocities due to displacement effects is put forward and carried through for noise produced by boundary-layer flow. The same concept is then extended to describe the sound field created by a jet.

N-43729*

National Opinion Research Center, University of Chicago. COMMUNITY ASPECTS OF AIRCRAFT ANNOYANCE. Paul N. Borsky. December 15, 1954. xi, 202p. diagrs., tabs. (National Opinion Research Center, University of Chicago)

The three primary objectives of this study are: (1) to determine the relationships of human annoyance and overt expressions of annoyance with varying airplane noise levels and airplane flight conditions, (2) to determine the socio-psychological factors contributing to the adaptation of intensification of annoyance reactions, and (3) to determine whether the personal interview technique can be utilized in establishing specific criteria for acceptable airplane noise levels.

N-43730,pt.1*

Guggenheim Aeronautical Laboratory, California Institute of Technology. TIME CORRELATOR. George T. Skinner. April 1954. 21p. diagrs. (Guggenheim Aeronautical Laboratory, California Institute of Technology)

The design of a fairly simple instrument for measuring time correlation is discussed. The instrument has been partly constructed and is expected to be completed in the near future. Its operation is one of taking a sample of one random function, storing it in a digital counter, and at a later time performing the multiplication of the stored value by the instantaneous value of a second random function. This cycle is repeated at regular intervals and the results are to be integrated and averaged. It is shown how reasonable accuracy can be attained, with stationary random functions, despite a considerable lack of precision in each individual cycle of operations.

N-43730,pt.2*

Guggenheim Aeronautical Laboratory, California Institute of Technology. TIME CORRELATOR, PART II. George T. Skinner. December 1954. ii, 9p. diagrs. (Guggenheim Aeronautical Laboratory, California Institute of Technology)

The time correlator described in part I has now been essentially completed and is in the process of being checked for satisfactory operation over the range of frequencies and time delays which will be required in turbulence work. The correlator has demonstrated its ability to carry out its function satisfactorily within the range of averaging times permitted by the long-period ballistic galvanometer used as integrator.

DECLASSIFIED
NACA RESEARCH REPORTS

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NACA RM E51C23

PRELIMINARY EVALUATION OF THE AIR AND FUEL SPECIFIC-IMPULSE CHARACTERISTICS OF SEVERAL POTENTIAL RAM-JET FUELS. II - MAGNESIUM AND MAGNESIUM - OCTENE-1 SLURRIES. Benson E. Gammon. May 2, 1951. 15p. diagrs. (NACA RM E51C23)

A preliminary analytical evaluation of the air and fuel specific-impulse characteristics of magnesium and magnesium - octene-1 slurries has been made. Adiabatic constant-pressure combustion temperatures for each fuel at several equivalence ratios were calculated for an initial air temperature of 560° R and a pressure of 2 atmospheres.

NACA RM E52L08

SUMMARY REPORT ON ANALYTICAL EVALUATION OF AIR AND FUEL SPECIFIC-IMPULSE CHARACTERISTICS OF SEVERAL NONHYDROCARBON JET-ENGINE FUELS. Roland Breitwieser, Sanford Gordon and Benson Gammon. February 1953. 58p. diagrs., tab. (NACA RM E52L08)

An analytical evaluation of the air and fuel specific-impulse characteristics of magnesium, magnesium - octene-1 slurries, aluminum, aluminum - octene-1 slurries, boron, boron - octene-1 slurries, carbon, hydrogen, α-methylnaphthalene, diborane, and pentaborane, is presented herein. Adiabatic constant pressure combustion temperature, air specific impulse, fuel specific impulse, and equilibrium composition data are given for each fuel over a range of equivalence ratios. Data for octene-1, considered representative of aviation gasoline performance, are presented for comparison. Magnesium, magnesium - octene-1 slurries, aluminum, aluminum - octene-1 slurries, boron - octene-1 slurries, pentaborane, diborane, and hydrogen, permit the attainment of air-specific-impulse values beyond the octene-1 limit. At any fixed air specific impulse below 135 seconds, the fuel-weight specific impulses of hydrogen, diborane, pentaborane, boron, boron - octene-1 slurries, are superior to octene-1. The fuel-volume specific impulses of boron, aluminum, carbon, boron - octene-1 slurries, magnesium, pentaborane, α-methylnaphthalene, and magnesium - octene-1 slurries, are superior to octene-1.

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NACA MR dated November 9, 1938
NACA MR dated March 6, 1939
NACA MR dated April 22, 1941
NACA MR dated December 6, 1941
NACA MR L4J06
NACA MR L5D27
NACA MR L5F23b
NACA MR L5H01
NACA MR L5H07a
NACA MR L5J05a
NACA MR L6H22

NACA RM A9F14

AERODYNAMIC STUDY OF A WING-FUSELAGE COMBINATION EMPLOYING A WING SWEPT BACK 63°. - AERODYNAMIC CHARACTERISTICS IN SIDESLIP OF A LARGE-SCALE MODEL HAVING A 63° SWEPT-BACK VERTICAL TAIL. Gerald M. McCormack. October 7, 1949. 26p. diagrs., photos. (NACA RM A9F14)

Aerodynamic characteristics in sideslip are presented for a wing-fuselage combination employing a wing with the leading edge swept back 63° with and without a vertical tail having the leading edge swept back 63°. Included also are the rudder effectiveness and the rudder hinge-moment characteristics. The experimental results are compared with values predicted theoretically in order to provide a basis for estimating the effects of geometric changes of the vertical tail.

NACA RM A51F15

SOME LOW-SPEED CHARACTERISTICS OF AN AIR-INDUCTION SYSTEM HAVING SCOOP-TYPE INLETS WITH PROVISIONS FOR BOUNDARY-LAYER CONTROL. Earl C. Watson. August 1951. 42p. diagrs., photos., tab. (NACA RM A51F15)

Results are presented of an experimental investigation at subsonic speeds of the main and boundary-layer control air-induction systems designed for a supersonic airplane. A lip profile for the main scoop was developed which provided unseparated external flow for mass-flow ratios down to 0.75 for a wide range of angle of attack, and which improved the pressure recovery in the main duct. The effects of angle of attack, angle of sideslip, and of boundary-layer removal on the pressure recovery in the main and boundary-layer-control ducts are shown for a wide range of mass-flow ratios.

NACA RM A52F16

EFFECT OF CAMBER AND TWIST ON THE STABILITY CHARACTERISTICS OF MODELS HAVING A 45° SWEPT WING AS DETERMINED BY THE FREE-FALL METHOD AT TRANSONIC SPEEDS. Maurice D. White. August 1952. 35p. diagrs., photos., tab. (NACA RM A52F16)

Measurements were made in free fall at transonic speeds of the dynamic stability characteristics of three models. Two of the models had 45° swept wings of aspect ratio 6 and 45° swept tail surfaces, and differed from each other only in that the wing of one of the models was plane and the wing of the other was cambered and twisted. The third model had the same fuselage-tail arrangement as the others, but had no wing. Static and dynamic longitudinal stability characteristics are presented for Mach numbers ranging from 0.84 to 1.16, and static directional-stability characteristics for Mach numbers from 0.60 to 1.13.

NACA RM A53F03

THE LATERAL CONTROL CHARACTERISTICS OF CONSTANT-PERCENT-CHORD TRAILING-EDGE ELEVONS ON A POINTED WING OF ASPECT RATIO 2 AT MACH NUMBERS UP TO 0.95. Verlin D. Reed and Donald W. Smith. August 1953. 105p. diagrs., photo., tabs. (NACA RM A53F03)

Results of tests made of a wing-body combination to determine the lateral control characteristics of constant-percent-chord trailing-edge elevons on a pointed wing with an aspect ratio of 2 and the effectiveness of tabs in reducing elevon hinge moments are presented. The data were obtained for a range of Mach numbers from 0.24 to 0.95 at a constant Reynolds number of 3.0 million and for Reynolds numbers up to 15.0 million at a constant Mach number of 0.24.

NACA RM A53F23

THE EFFECTS OF FENCES ON THE HIGH-SPEED LONGITUDINAL STABILITY OF A SWEPT-WING AIRPLANE. Richard S. Bray. August 1953. 37p. diagrs., photos., tabs. (NACA RM A53F23)

A swept-wing airplane was tested with a series of fence configurations to determine their effects on the longitudinal instability, or pitch-up, noted at Mach numbers between 0.80 and 0.95. Several fence installations significantly delayed the pitch-up to higher lift coefficients at Mach numbers near 0.9.

NACA RM E8F15

PRELIMINARY INVESTIGATION OF EFFECTS OF COMBUSTION IN RAM JET ON PERFORMANCE OF SUPERSONIC DIFFUSERS. I - SHOCK DIFFUSER WITH TRIPLE-SHOCK PROJECTING CONE. J. F. Connors and A. H. Schroeder. September 15, 1948. 18p. diagrs. (NACA RM E8F15)

The effect of combustion on the total-pressure recovery and the Mach number distribution at the diffuser outlet has been determined with a 3.6-inch-diameter ram jet at a Mach number of 1.92. Normal-shock oscillation, initiated by pressure pulsations from the combustion process, causes a rapid decrease in peak total-pressure recovery with increasing outlet area and increasing fuel flows. The cold steady-flow peak total-pressure recovery was not attainable with combustion.

NACA RM E8F28

PERFORMANCE INVESTIGATION OF CAN-TYPE COMBUSTOR. II - WATER INJECTION AT VARIOUS STATIONS IN COMBUSTOR. William P. Cook and Eugene V. Zettle. September 30, 1948. 27p. diagrs. (NACA RM E8F28)

For water introduced at one station ahead of combustor and three stations in can-type combustor of 4000-pound-thrust axial-flow turbojet engine operating at various simulated altitudes from 15,000 to 45,000 feet, the effect on exhaust-gas temperature distribution, the location in the combustor at which the maximum quantity of water can be injected, and the maximum quantities of water that can be injected are determined. The maximum quantity of water was injected in approximately the center of the combustion chamber and the total liquid-air ratio was approximately 0.07.

NACA RM E8G16

PRELIMINARY INVESTIGATION OF EFFECTS OF COMBUSTION IN RAM JET ON PERFORMANCE OF SUPERSONIC DIFFUSERS. II - PERFORATED SUPERSONIC INLET. Albert H. Schroeder and James F. Connors. October 4, 1948. 14p. diagrs. (NACA RM E8G16)

An investigation was conducted on a 3.6-inch-diameter ram jet with a variable-outlet nozzle at a Mach number of 1.92 to determine the effect of an actual combustion process on the performance of a perforated diffuser. Peak total-pressure recovery decreased with increased outlet area and fuel flow. The theory of normal-shock oscillation initiated by pressure pulsations from the combustion process is believed to be an explanation for this decrease. The combustion process did not alter the Mach number distribution at the combustion-chamber inlet as compared with the distribution without combustion on the basis of equal pressure recovery.

NACA RM E8J18

PRELIMINARY INVESTIGATION OF EFFECTS OF COMBUSTION IN RAM JET ON PERFORMANCE OF SUPERSONIC DIFFUSERS. III - NORMAL-SHOCK DIFFUSER. Albert H. Schroeder and James F. Connors. December 22, 1948. 15p. diagrs. (NACA RM E8J18)

Effects of combustion on performance of a basic normal-shock diffuser were experimentally determined at a Mach number of 1.92 on a 3.60-inch-diameter ram jet. Total-pressure recovery was evaluated as a function of outlet-inlet area ratio and fuel flow. As a result of unsteady flow conditions associated with normal-shock oscillations, a rapid decrease in peak total-pressure recovery was obtained with increasing outlet-inlet area ratio. Modifications to the combustion chamber produced no noticeable change in this phenomenon. A marked improvement in total-pressure recovery was obtained, however, when a powdered magnesium flare was used as source of smooth combustion.

NACA RM E50D20

STARTING OF ROCKET ENGINE AT CONDITIONS OF SIMULATED ALTITUDE USING CRUDE MONOETHYLANILINE AND OTHER FUELS WITH MIXED ACID. Dezso J. Ladanyi, John L. Sloop, Jack C. Humphrey, and Gerald Morrell. July 19, 1950. 64p. diagrs., photos., tabs. (NACA RM E50D20)

Experiments were conducted at sea level and pressure altitude of about 55,000 feet at various temperatures to determine starting characteristics of a commercial rocket engine using crude monoethylaniline and other fuels with mixed acid. With crude monoethylaniline, ignition difficulties were encountered at temperatures below about 20° F. With mixed butyl mercaptans, water-white turpentine, and α-pinene, no starting difficulties were experienced at temperatures as low as -74° F. Turpentine and α-pinene, however, sometimes left deposits on the injector face. With blends containing furfuryl alcohol and with other blends, difficulties were experienced either from appreciable deposits or from starting.

NACA RM E50H16

LOW-TEMPERATURE IGNITION-DELAY CHARACTERISTICS OF SEVERAL ROCKET FUELS WITH MIXED ACID IN MODIFIED OPEN-CUP-TYPE APPARATUS. Riley O. Miller. October 17, 1950. 23p. diagrs., photos., tabs. (NACA RM E50H16)

Summaries of low-temperature self-ignition data of various rocket fuels with mixed acid (nitric plus sulfuric) are presented. Several fuels are shown to have shorter ignition-delay intervals and less variation in delay intervals at moderate and subzero temperatures than crude N-ethylaniline (monoethylaniline), a rocket fuel in current use.

NACA RM E51F12

TWO-DIMENSIONAL CASCADE INVESTIGATION OF THE MAXIMUM EXIT TANGENTIAL VELOCITY COMPONENT AND OTHER FLOW CONDITIONS AT THE EXIT OF SEVERAL TURBINE BLADE DESIGNS AT SUPERCRITICAL PRESSURE RATIOS. Cavour H. Hauser and Henry W. Plohr. August 1951. 34p. diagrs., photos. (NACA RM E51F12)

The nature of the flow at the exit of a row of turbine blades for the range of conditions represented by four different blade configurations was evaluated by the conservation-of-momentum principle using static-pressure surveys and by analysis of schlieren photographs of the flow. It was found that for blades of the type investigated, the maximum exit tangential-velocity component is a function of the blade geometry only and can be accurately predicted by the method of characteristics. A maximum value of exit velocity coefficient is obtained at a pressure ratio immediately below that required for maximum blade loading followed by a sharp drop after maximum blade loading occurs.

NACA RM E51J01

IGNITION DELAY EXPERIMENTS WITH SMALL-SCALE ROCKET ENGINE AT SIMULATED ALTITUDE CONDITIONS USING VARIOUS FUELS WITH NITRIC ACID OXIDANTS. Dezso J. Ladanyi. January 1952. 44p. diagrs., photos., tabs. (NACA RM E51J01)

Ignition delay determinations of several fuels with nitric acid oxidants were made at simulated altitude conditions utilizing a small-scale rocket engine of approximately 50 pounds thrust. Included in the fuels were aniline, hydrazine hydrate, furfuryl alcohol, furfuryl mercaptan, turpentine, and mixtures of triethylamine with mixed xylidines and diallylaniline. Red fuming, white fuming, and anhydrous nitric acids were used with and without additives. A diallylaniline - triethylamine mixture and a red fuming nitric acid analyzing 3.5 percent water and 16 percent NO_2 by weight was found to have a wide temperature-pressure ignition range, yielding average delays from 13 milliseconds at 110° F to 55 milliseconds at -95° F regardless of the initial ambient pressure that ranged from sea-level pressure to a pressure altitude of 94,000 feet.

NACA RM E52C21

EXPERIMENTAL INVESTIGATION OF AIR-COOLED TURBINE BLADES IN TURBOJET ENGINE. XI - INTERNAL-STRUT-SUPPORTED ROTOR BLADE. Reeves P. Cochran, Francis S. Stepka, and Morton H. Krasner. June 1952. 45p. diagrs., photos., tabs. (NACA RM E52C21)

The cooling effectiveness and cooling-air pressure losses of an air-cooled internal-strut-supported blade were investigated in a modified production turbojet engine over a range of engine speeds and coolant-to-gas weight-flow ratios per blade. Comparisons of the results of this investigation with similar investigations of shell-supported blades showed that the cooling effectiveness and stress-ratio factor are higher for the strut-supported blade than for the shell-supported blades, and that the cooling-air pressure losses for the strut-supported blade are within the range of pressure losses for the shell-supported blades. On the basis of these comparisons, the strut-supported blade indicated promise of operating at higher turbine-inlet temperatures or at lower coolant-to-gas weight-flow ratios per blade than shell-supported blades. Comparison of experimental results with analytically predicted results indicated that the analytical method of predicting temperatures in a strut-supported blade was sufficiently accurate for design purposes.

NACA RM E52F24

EXPERIMENTAL INVESTIGATION OF AIR-COOLED TURBINE BLADES IN TURBOJET ENGINE. XII - COOLING EFFECTIVENESS OF A BLADE WITH AN INSERT AND WITH FINS MADE OF A CONTINUOUS CORRUGATED SHEET. Edward R. Bartoo and John L. Clure. August 1952. 33p. diagrs., photos. (NACA RM E52F24)

An investigation was conducted in a modified turbojet engine to determine the cooling effectiveness of an air-cooled corrugated-fin blade. The results of this investigation are shown and comparisons are made with two of the most promising shell-supported blade types previously investigated at NACA and also with an air-cooled blade in which the shell was supported by an internal strut. Calculations indicate that a corrugated fin blade made of Timken 17-22A(S) nonstrategic steel can operate safely at rated engine conditions at cooling-air-to-combustion-gas flow ratios of 0.01 or less with cooling-air inlet temperatures up to 450° F.

NACA RM E52J01

SOME FUNDAMENTAL ASPECTS OF NITRIC ACID OXIDANTS FOR ROCKET APPLICATIONS. Dezso J. Ladanyi, Riley O. Miller, Wolf Karo, and Charles E. Feiler. January 1953. ii, 95p. diagrs., tabs. (NACA RM E52J01)

The literature pertaining to the preparation, physical properties, corrosiveness, thermal stability, constitution, and analysis of various nitric acids is reviewed primarily with respect to their use as rocket oxidants. Conflicting data are evaluated and recommendations for additional experimental work are indicated. Reactions of nitric acid which could occur during the starting and steady-stage phases of rocket operation are discussed and probable mechanisms are selected on the basis of reported thermal and kinetic data.

NACA RM E52J15

PRELIMINARY INVESTIGATION OF COMPRESSOR BLADE VIBRATION EXCITED BY ROTATING STALL. Merle C. Huppert, Donald F. Johnsen, and Eleanor L. Costilow. December 1952. 27p. diagrs., photos. (NACA RM E52J15)

A preliminary investigation of compressor blade vibration excited by rotating stall was conducted on a single-stage axial-flow compressor with a hub-tip ratio of 0.5. Resonant bending vibrations were excited in the aluminum stator blades by rotating stall.

NACA RM E52K19

ORTHOTOLUIDINE AND TRIETHYLAMINE IN ROCKET ENGINE APPLICATIONS. Dezso J. Ladanyi. January 1953. 24p. diagrs., tabs. (NACA RM E52K19)

The literature pertaining to the use of orthotoluidine and triethylamine in rocket propellant combinations was surveyed and summarized with particular emphasis on ignition delay investigations and fuel mixture applications. In addition, experimental ignition delay determinations of two orthotoluidine-triethylamine mixtures (1:1 and 3:7 by volume) and a low-freezing-point red fuming nitric acid were conducted at simulated altitude conditions utilizing a small-scale rocket engine of approximately 50 pounds thrust. The delays varied almost linearly from about 12 milliseconds at 120° F to about 28 milliseconds at -70° F for both propellant combinations. At -95° F, the ignition delays for the 1:1 and 3:7 fuel blends were about 101 and 29 milliseconds, respectively. Experiments at pressure altitudes of about 90,000 feet at the two temperature extremes indicated no significant effect of low initial ambient pressure on ignition delay.

NACA RM E53D03

COMPARISON OF IGNITION DELAYS OF SEVERAL PROPELLANT COMBINATIONS OBTAINED WITH MODIFIED OPEN-CUP AND SMALL-SCALE ROCKET ENGINE APPARATUS. Dezso J. Ladanyi and Riley O. Miller. June 1953. 20p. diagrs., photos., tabs. (NACA RM E53D03)

Ignition delays of several propellant combinations obtained with a modified open-cup apparatus and with a small-scale rocket engine of approximately 50-pounds thrust were compared to study any correlations that might exist between the two methods of ignition-delay determination. The comparison showed that the results were generally similar for the same propellant combinations at the same operating conditions as long as the propellant viscosities were low enough to produce no significant effect on ignition delay.

NACA RM E53G14

ANALYTICAL EVALUATION OF EFFECT OF EQUIVALENCE RATIO, INLET-AIR TEMPERATURE, AND COMBUSTION PRESSURE ON PERFORMANCE OF SEVERAL POSSIBLE RAM-JET FUELS. Leonard K. Tower and Benson E. Gammon. September 1953. 59p. diagrs., tabs. (NACA RM E53G14)

The results of an analytical investigation of the theoretical air specific impulse performance and adiabatic combustion temperatures of several possible ram-jet fuels over a range of equivalence ratios, inlet-air temperatures, and combustion pressures, are presented herein. The fuels include octene-1, 50-percent-magnesium slurry, boron, pentaborane, diborane, hydrogen, carbon, and aluminum. Thermal effects from high combustion temperatures were found to affect considerably the combustion performance of all the fuels. An increase in combustion pressure was beneficial to air specific impulse at high combustion temperatures. The use of these theoretical data in engine operation and in the evaluation of experimental data is described.

NACA RM E53G31

EFFECTS OF NITROGEN TETROXIDE AND WATER CONCENTRATION ON FREEZING POINT AND IGNITION DELAY OF FUMING NITRIC ACID. Riley O. Miller. September 1953. 32p. diagrs., tabs. (NACA RM E53G31)

The interrelated effects of water from 0 to 10 percent and nitrogen tetroxide from 0 to 25 percent by weight in fuming nitric acid were investigated with respect to the freezing points of the acids and the ignition delays of the acids with several fuels. An equilibrium freezing-point surface for the acids in the composition range studied is presented. A minimum freezing point of -88.5° F occurs in the region of approximately 5 percent water and 17 percent nitrogen tetroxide and a binary eutectic line extends from this region to nearly anhydrous acids containing 25 to 26 percent nitrogen tetroxide (-82.5° F). The ignition delays of fuel blends of 30 percent o-toluidine, 50 percent allylamine, and 50 percent ethylenimine, respectively, in triethylamine were determined at 70° and -40° F. In general, acids containing small amounts of water and large amounts of nitrogen tetroxide give shorter delays than acids containing large amounts of water and small amounts of nitrogen tetroxide; this effect is more pronounced at low temperature. An acid composition region giving low freezing points falls within the region of short ignition delay.

NACA RM E53I09

EXPERIMENTAL AND THEORETICAL INVESTIGATION OF ROTATING-STALL CHARACTERISTICS OF SINGLE-STAGE AXIAL-FLOW COMPRESSOR WITH HUB-TIP RATIO OF 0.76. Robert W. Graham and Vasily D. Prian. November 1953. 34p. diagrs., photos., tab. (NACA RM E53I09)

The rotating-stall characteristics of a single-stage compressor with a hub-tip ratio of 0.76 and a symmetrical velocity diagram were investigated over a wide range of weight flow and speed. The number and speed of total- and partial-span rotating stalls were experimentally determined. The compressor performance map reveals no effect of compressor speed on the magnitude of the flow coefficients marking the boundaries of the rotating-stall regions; however, hysteresis effects were apparent in shifting the rotating-stall regions during increasing and decreasing weight-flow operations. A theory on rotating stall was applied to the data obtained from this and other similar compressors in an attempt to evaluate some of the factors that affect the mechanism of rotating stall. A correlation was obtained between a stall-propagation-rate parameter and the aerodynamic phase angle of the rotor blades.

NACA RM E54F23a

EXPERIMENTAL INVESTIGATION OF AIR-COOLED TURBINE BLADES IN TURBOJET ENGINE. XIV - ENDURANCE EVALUATION OF SHELL-SUPPORTED TURBINE ROTOR BLADES MADE OF TIMKEN 17-22A(S) STEEL. Francis S. Stepka, H. Robert Bear, and John L. Clure. September 1954. 29p. diagrs., photos., tabs. (NACA RM E54F23a)

These blades with mild-steel tube inserts were investigated over a range of cooling-air to combustion-gas flow ratios in a modified turbojet engine. Modifications of the original construction and various heat treatments effected a satisfactory durability. At a coolant-flow ratio of 0.027, for example, two blades were in good condition after 350-hour operation. A design criterion for the blades, the stress-ratio factor (av. allowable stress-rupture strength to av. centrifugal stress), is presented, the mean value of which was about 2.3 over the range of coolant-flow ratio from 0.015 to 0.027.

NACA RM L50F06

PRESSURE MEASUREMENTS ON A SHARPLY CONVERGING FUSELAGE AFTERBODY WITH JET ON AND OFF AT MACH NUMBERS FROM 0.8 TO 1.6. William E. Stoney, Jr., and Ellis Katz. August 10, 1950. 18p. diagrs., photos. (NACA RM L50F06)

Pressure measurements were made in free flight on a sharply converging fuselage afterbody with jet on and off at Mach numbers from 0.8 to 1.6. The negative pressures over the afterbody were indicated to be very high although less than predicted by linearized theory. This difference may account for the discrepancy in experimental and theoretical drag shown by previous flight tests of this type of body.

NACA RM L50F08

EFFECTS OF VARYING THE SIZE AND LOCATION OF TRAILING-EDGE FLAP-TYPE CONTROLS ON THE AERODYNAMIC CHARACTERISTICS OF AN UNSWEPT WING AT A MACH NUMBER OF 1.9. Meade H. Mitchell, Jr. August 16, 1950. 33p. diagrs., photo., tab. (NACA RM L50F08)

Plain flaps covering a range of flap chords, spans, and spanwise locations were tested on an unswept, semispan wing that had an aspect ratio of 2.5, a taper ratio of 0.625, and 6-percent-thick modified double-wedge airfoil sections. The tests were made with the wing in the presence of a half-fuselage in the Langley 9- by 12-inch supersonic blowdown tunnel at a Mach number of 1.9 and a Reynolds number of 2.3×10^6 and covered a small angle-of-attack range. Experimental flap characteristics are compared with the characteristics calculated by linearized theory.

NACA RM L50H21

FLIGHT INVESTIGATION OF A ROLL-STABILIZED MISSILE CONFIGURATION AT VARYING ANGLES OF ATTACK AT MACH NUMBERS BETWEEN 0.8 AND 1.79. Jacob Zarovsky and Robert A. Gardiner. March 6, 1951. 38p. diagrs., photos., tab. (NACA RM L50H21)

A missile research model was flown at supersonic speed to determine the quality of automatic roll stabilization at varying angles of attack. Aerodynamic rolling and pitching derivatives were determined from the flight record. It was concluded that the combination of the gyro-actuated automatic pilot with wing-tip ailerons provided adequate roll stabilization under conditions encountered in flight.

NACA RM L51F07

TRANSONIC-WING INVESTIGATION IN THE LANGLEY 8-FOOT HIGH-SPEED TUNNEL AT HIGH SUBSONIC MACH NUMBERS AND AT A MACH NUMBER OF 1.2. ANALYSIS OF PRESSURE DISTRIBUTION OF WING-FUSELAGE CONFIGURATION HAVING A WING OF 45° SWEEPBACK, ASPECT RATIO 4, TAPER RATIO 0.6, AND NACA 65A006 AIRFOIL SECTION. Donald L. Loving and Bruce B. Estabrooks. September 1951. 132p. diagrs., photos. (NACA RM L51F07)

An analysis is presented of the detailed pressure distributions measured in the Langley 8-foot high-speed tunnel on a fuselage and wing-fuselage combination employing a wing with 45° sweepback of the 0.25-chord line, aspect ratio 4, taper ratio 0.6, and NACA 65A006 airfoil section. Pressure measurements were obtained on the wing-fuselage combination at angles of attack from -2° to 14° at Mach numbers from 0.60 to 0.96 and at angles of attack from -2° to 6° at a Mach number of 1.2. Fuselage pressure measurements were obtained at angles of attack from 0° to 14° for all Mach numbers investigated. Flow phenomena are discussed and the problems of wing-fuselage interference are explored.

NACA RM L52F02a

TRANSONIC FLIGHT TESTS TO DETERMINE THE EFFECT OF THICKNESS RATIO AND PLAN-FORM MODIFICATION ON THE ZERO-LIFT DRAG OF A 45° SWEPTBACK WING. William B. Pepper, Jr., and Sherwood Hoffman. August 1952. 24p. diagrs., photos., tabs. (NACA RM L52F02a)

Rocket-powered models were flown at transonic speeds to determine the effect of wing-thickness-ratio variation on the zero-lift drag coefficient of a 45° sweptback wing of aspect ratio 6 and taper ratio 0.6 and on a composite plan-form wing of aspect ratio 4 with considerable taper. The wing-plus-interference pressure drag coefficient for both plan forms was found to vary approximately linearly with the square of the mean thickness ratio at low supersonic speeds.

NACA RM L52F05

LONGITUDINAL STABILITY, TRIM, AND DRAG CHARACTERISTICS OF A ROCKET-PROPELLED MODEL OF AN AIRPLANE CONFIGURATION HAVING A 45° SWEPTBACK WING AND AN UNSWEPT HORIZONTAL TAIL. James H. Parks and Alan B. Kehlet. August 1952. 29p. diagrs., photos., tab. (NACA RM L52F05)

The longitudinal aerodynamic characteristics of a swept-wing rocket-propelled model of an airplane configuration with a fixed horizontal tail were investigated in free flight at Mach numbers from 0.63 to 1.16. Static and dynamic longitudinal-stability data were obtained by a pulse rocket technique and continuous values of trim lift and drag at trim lift were determined.

NACA RM L52F06

LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A CANARD MISSILE CONFIGURATION FOR MACH NUMBERS FROM 1.1 TO 1.93 AS DETERMINED FROM FREE-FLIGHT AND WIND-TUNNEL INVESTIGATIONS. Howard J. Curfman, Jr., and Carl E. Grigsby. August 1952. 28p. diagrs., tab. (NACA RM L52F06)

A comparison has been made of the static longitudinal stability and control characteristics of a canard missile configuration as determined from supersonic free-flight and wind-tunnel tests to a Mach number of 1.93. Correlation was shown for the lift and moment curve slopes, including the nonlinear variations with angle of attack. Frequency-response curves are presented using derivatives obtained from both flight and wind-tunnel tests.

NACA RM L52F09

PRELIMINARY FREE-FLIGHT INVESTIGATION OF THE EFFECTS OF RIVETS AND LAP JOINTS ON THE DRAG OF BODIES AT ZERO LIFT AT SUPERSONIC MACH NUMBERS TO 2.1. Russell N. Hopko. August 1952. 12p. diagrs., photos., tab. (NACA RM L52F09)

The effects of protruding rivets and lap joints on the drag of bodies at zero lift at supersonic Mach numbers to 2.1 were measured in free flight. Brazier head rivets caused the smallest drag increases while forward-facing lap joints caused the largest drag increases.

NACA RM L52F10

PRELIMINARY DATA AT A MACH NUMBER OF 2.40 OF THE CHARACTERISTICS OF FLAP-TYPE CONTROLS EQUIPPED WITH PLAIN OVERHANG BALANCES. James N. Mueller and K. R. Czarnecki. September 1952. 43p. diagrs., photos. (NACA RM L52F10)

The preliminary results of an investigation to determine the aerodynamic characteristics of plain overhang balances on flap-type controls are presented for a Mach number of 2.40 and a Reynolds number of 0.78×10^6. The values of section hinge moment, pitching moment, normal force, and chord force as a function of flap deflection and angle of attack for a basic wing equipped with flaps of 38-, 60-, and 82-percent balance are included. Some effects of gap size are shown for the flap of least balance.

NACA RM L52F30

FREE-FLIGHT TESTS AT MACH NUMBERS FROM 0.8 TO 1.4 TO DETERMINE THE EFFECT ON ZERO-LIFT DRAG OF INCREASING THE LEADING-EDGE BLUNTNESS OF A 45° SWEPTBACK WING HAVING AN NACA 65A009 AIRFOIL. William B. Pepper, Jr. August 1952. 15p. diagrs., photos., tabs. (NACA RM L52F30)

The effect on zero-lift drag of increasing the leading-edge bluntness of a 45° sweptback wing of aspect ratio 6 having NACA 65A009 airfoil sections has been measured by rocket-propelled free-flight models for a range of Mach numbers from 0.8 to 1.4. An increase in the wing leading-edge bluntness increased the wing-plus-interference drag coefficient approximately 0.002 through a range of Mach numbers from 0.8 to 1.2, and 0.006 at a Mach number of 1.37.

NACA RM L53F09

WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF GEOMETRIC DIHEDRAL ON THE AERODYNAMIC CHARACTERISTICS IN PITCH AND SIDESLIP OF AN UNSWEPT- AND A 45° SWEPTBACK-WING-FUSELAGE COMBINATION AT HIGH SUBSONIC SPEEDS. Richard E. Kuhn and John W. Draper. July 1953. 41p. diagrs., photos. (NACA RM L53F09)

This report presents the effect of geometric dihedral on the aerodynamic characteristics in pitch and sideslip on two wing-fuselage configurations. The wings had sweepback angles of 3.6° and 45° at the quarter-chord line, aspect ratio of 4, taper ratio of 0.6, and an NACA 65A006 airfoil section parallel to the fuselage center line. The tests covered a Mach number range from 0.40 to 0.95 (Reynolds numbers from 1.8 to 3.0×10^6), an angle-of-attack range from -3° to 24°, sideslip angles from -3° to 12°, and dihedral angles of -10°, -5°, 5°, and 10°.

NACA RM L53F10

A PRELIMINARY INVESTIGATION OF THE POWER REQUIREMENTS OF SLOTTED TEST SECTIONS. John S. Dennard. July 1953. 32p. diagrs. (NACA RM L53F10)

A series of preliminary tests has been conducted to examine the nature of bleed-air power losses of slotted tunnels and to examine methods of reducing these losses. The use of a sharpened slot cutoff at the downstream end of the slot together with an auxiliary pump for bleed-air removal provided operation for Mach numbers less than 1.2 at power parameters

less than those for any other configuration tested. The installation in the open-ejector-type test section of a small volume bleed-flow passage together with a slot diffuser in place of the original plenum did not radically change the longitudinal Mach number distribution of the basic slotted test section and resulted in operation at Mach numbers above 1.2 at power parameters less than those for any other configuration tested.

NACA RM L53F11

SLOTTED-BOUNDARY INTERFERENCE EFFECTS ON WEDGE AIRFOILS AT LOW SUPERSONIC MACH NUMBERS. William J. Nelson and Allen R. Vick. July 1953. 27p. diagrs., photos. (NACA RM L53F11)

An investigation of shock reflection and boundary interference effects at Mach numbers between 1.0 and 1.5 has been conducted in a two-dimensional jet with flat, slotted boundaries above and below the test models. The 1/16-inch slots were separated by 1/4-inch rectangular bars of 1/2-inch depth providing a free area equal to 20 percent of the slotted-wall area. Three simple wedges with apex angles of 4°, 6°, and 10° were tested at 0° angle of attack over a range of model to wall spacings from 3/8 to 1-7/8 times the model chord. Surface pressure variations with Mach number are compared with interference-free data and shock theory to determine the magnitude of the slotted wall interference.

NACA RM L53F17a

REVIEW AND INVESTIGATION OF UNSATISFACTORY CONTROL CHARACTERISTICS INVOLVING INSTABILITY OF PILOT-AIRPLANE COMBINATION AND METHODS FOR PREDICTING THESE DIFFICULTIES FROM GROUND TESTS. William H. Phillips, B. Porter Brown, and James T. Matthews, Jr. August 1953. 57p. diagrs., photos. (NACA RM L53F17a)

A number of examples are presented of control difficulties which appear to result from a tendency for dynamic instability of the combination of the pilot, control system, and airplane. These difficulties have occurred in both conventional and power control systems. Tests of a bomber and a fighter airplane equipped with hydraulic-power controls have been made to study this problem. The effect of friction in the control valves of the power control systems is discussed. An analytical study of the problem and a method of detecting such control difficulties by means of ground simulator tests are presented.

NACA RM L53F24

EFFECT OF REDUCTION IN THICKNESS FROM 6 TO 2 PERCENT AND REMOVAL OF THE POINTED TIPS ON THE SUBSONIC STATIC LONGITUDINAL STABILITY CHARACTERISTICS OF A 60° TRIANGULAR WING IN COMBINATION WITH A FUSELAGE. William E. Palmer. August 1953. 44p. diagrs., photo., tab. (NACA RM L53F24)

Lift, drag, and pitching-moment data are presented to show the effect of reducing the thickness ratio of a 60° triangular wing from 6 percent to 2 percent at Mach numbers from 0.15 to 0.40 and Reynolds numbers from 0.9×10^6 to 9×10^6. Presented, in addition, are the effects of removing the outer 24.9 percent of the span of the 6-percent-thick wing through a range of Mach number from 0.40 to 0.85 at Reynolds numbers of 3×10^6 to 6×10^6. Angles of attack range from -4° to 36° for all tests except where limited by tunnel choke.

NACA RM L53H18

A TRANSONIC WIND-TUNNEL INVESTIGATION OF THE LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A 0.09-SCALE MODEL OF THE BELL X-5 RESEARCH AIRPLANE AND COMPARISON WITH FLIGHT. Ralph P. Bielat and George S. Campbell. October 1953. 65p. diagrs., photo. (NACA RM L53H18)

An investigation was conducted in the Langley 8-foot transonic tunnel to determine the longitudinal stability and control characteristics of a 0.09-scale model of the Bell X-5 research airplane. Tests were made for the wing swept back 60°. Lift, drag, pitching-moment, elevator hinge-moment, and pressure-distribution results are presented at Mach numbers varying from 0.60 to 1.10 and Reynolds numbers varying from 2.86×10^6 to 3.56×10^6 based on the mean aerodynamic chord. The wind-tunnel results and dynamic-response calculations based on wind-tunnel data are compared with flight data.

NACA RM L54F23

COMPARISON BETWEEN THEORETICAL AND EXPERIMENTAL RATES OF ROLL OF TWO MODELS WITH FLEXIBLE RECTANGULAR WINGS AT SUPERSONIC SPEEDS. John M. Hedgepeth and Robert J. Kell. August 1954. 21p. diagrs., photo., tabs. (NACA RM L54F23)

A comparison is presented between the experimentally measured and theoretically calculated (by the method of NACA TN 3067) rates of roll of two rocket-propelled models with flexible rectangular wings.

NACA RM L54F24

STATIC LONGITUDINAL STABILITY CHARACTERISTICS OF A COMPOSITE-PLAN-FORM WING MODEL INCLUDING SOME COMPARISONS WITH A 45° SWEPTBACK WING AT TRANSONIC SPEEDS. Walter D. Wolhart. August 1954. 36p. diagrs., photo., tabs. (NACA RM L54F24)

Results are presented of an investigation of the low-speed static longitudinal stability characteristics of a composite-plan-form wing tested as a wing-fuselage combination and as a complete model. The Mach number for these tests was 0.16 corresponding to a Reynolds number of 1.98×10^6. Also included are the wing-alone transonic-speed characteristics obtained from tests of small-scale semispan models of the composite-plan-form wing and the conventional sweptback wing from which the composite-plan-form wing was derived. The Mach number range of these tests was 0.70 to 1.09 corresponding to a Reynolds number range of 1.07×10^6 to 1.25×10^6 based on the mean aerodynamic chord of the composite-plan-form wing.

NACA RM L54F29a

SOME EFFECTS OF EXTERNAL WING TIP STORES ON THE ROLLING EFFECTIVENESS AND DRAG OF PLAIN AND HALF-DELTA TIP AILERONS ON A 4-PERCENT-THICK, TAPERED, UNSWEPT WING. Roland D. English. August 1954. 14p. diagrs., photos., tab. (NACA RM L54F29a)

An investigation has been made of some effects of external wing tip stores on the rolling effectiveness and drag of plain and half-delta tip ailerons on a 4-percent-thick, unswept, tapered wing. The results indicate that the addition of tip tanks to the wing reduces the rolling effectiveness of the plain aileron but increases slightly the rolling effectiveness of the tip aileron over the test Mach number range from 0.6 to 1.5. Drag coefficient was increased by essentially the same amount for both control configurations by the addition of tip tanks.

NACA RM SL54D16

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NO. 103 **JULY 13, 1956**

CURRENT NACA RESEARCH REPORTS

NACA Rept. 1220

CALCULATIONS OF LAMINAR HEAT TRANSFER AROUND CYLINDERS OF ARBITRARY CROSS SECTION AND TRANSPIRATION-COOLED WALLS WITH APPLICATION TO TURBINE BLADE COOLING. E. R. G. Eckert and J. N. B. Livingood. 1955. ii, 21p. diagrs., tabs. (NACA Rept. 1220. Supersedes RM E51F22)

An approximate method for development of flow and thermal boundary layers in laminar regime on cylinders with arbitrary cross section and transpiration-cooled walls is obtained by use of Karman's integrated momentum equation and an analogous heat-flow equation. Incompressible flow with constant property values throughout boundary layer is assumed. Shape parameters for approximated velocity and temperature profiles and functions necessary for solution of boundary-layer equations are presented as charts, reducing calculations to a minimum. The method is applied to determine local heat-transfer coefficients and surface temperatures in the laminar region of transpiration-cooled turbine blades for a given flow rate. Coolant flow distributions necessary for maintaining uniform blade temperatures are also determined.

NACA Rept. 1228

CALCULATED SPANWISE LIFT DISTRIBUTIONS, INFLUENCE FUNCTIONS, AND INFLUENCE COEFFICIENTS FOR UNSWEPT WINGS IN SUBSONIC FLOW. Franklin W. Diederich and Martin Zlotnick. 1955. ii, 69p. diagrs., tabs. (NACA Rept. 1228. Supersedes TN 3014)

Spanwise lift distributions have been calculated for 19 unswept wings with various aspect ratios and taper ratios and with a variety of angle-of-attack or twist distributions, including flap and aileron deflections, by means of the Weissinger method with eight control points on the semispan. Also calculated were aerodynamic influence coefficients which pertain to a certain definite set of stations along the span, and several methods are presented for calculating aerodynamic influence coefficients for stations other than those stipulated.

NACA RM 56D27

STABILITY OF SYSTEMS CONTAINING A HEAT SOURCE - THE RAYLEIGH CRITERION. Boa-Teh Chu, Johns Hopkins University. June 1956. 25p. diagrs. (NACA RM 56D27)

The stability of systems containing a heat source is examined from the energy point of view. Rayleigh's criterion is derived. In the case of a flame, it is found that Rayleigh's criterion must be modified slightly if the specific-heat ratios γ of the burned and unburned gases are different.

NACA TN 3275

INVESTIGATION OF THE EFFECT OF IMPACT DAMAGE ON FATIGUE STRENGTH OF JET-ENGINE COMPRESSOR ROTOR BLADES. Albert Kaufman and André J. Meyer, Jr. June 1956. 25p. diagrs., photos. (NACA TN 3275)

Compressor rotor blades, which had suffered impact damage from a foreign object while being run in an axial-flow engine, were fatigue tested to determine the reduction in structural endurance. The most serious damage was nicks at the blade edges. The farther the damage was from the maximum-vibratory-stress section of the airfoil and from the edges the less detrimental it was. The strength of the dented blades was restored by reworking them.

NACA TN 3277

SPACE HEATING RATES FOR SOME PREMIXED TURBULENT PROPANE-AIR FLAMES. Burton D. Fine and Paul Wagner. June 1956. 26p. diagrs., tab. (NACA TN 3277)

Space heating rate measurements can yield information that is useful in characterizing turbulent combustion. For Bunsen burner flames stabilized over a field of pipe-induced turbulence, the space heating rate decreased with increasing linear flow and burner diameter, and was independent of pilot conditions. Calculated space heating rates, at 1-atmosphere pressure, were in the range of 2×10^7 to 6×10^7 Btu per cubic foot per hour. Turbulent burning velocities over the same flow range were correlated by linear velocity at constant burner diameter, but the variation with burner diameter could not be expressed by a simple correlation.

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NACA TN 3279

EFFECT OF PHOSPHATE COATINGS ON TEMPERATURE OF METAL PARTS EXPOSED TO FLAME ENVIRONMENTS. George C. Fryburg, Norman H. Katz, and Sidney L. Simon. July 1956. 20p. diagrs., photo., tabs. (NACA TN 3279)

The effect of phosphate coatings on the temperature of metal specimens placed in a flame environment was investigated. Since flames contain large numbers of atoms and radicals that react on metal surfaces liberating heat, it was thought that a phosphate coating might decrease the temperature of the metal by poisoning the surface to these reactions. Temperature lowerings of about 100° to 200° F were obtained. These are shown to arise mainly from the high emittance (about 1) of the phosphate coating rather than from a poisoning action.

NACA TN 3644

LIFT AND MOMENT COEFFICIENTS FOR AN OSCILLATING RECTANGULAR WING-AILERON CONFIGURATION IN SUPERSONIC FLOW. Julian H. Berman. July 1956. 46p. diagrs. (NACA TN 3644)

The problem of a partial-span rectangular control surface, hinged at its leading edge and harmonically oscillating in supersonic flow, is treated by linearized flow theory. The velocity potentials for a wing-aileron configuration performing vertical translation, wing pitching, and aileron rotation are derived as power series in terms of a frequency parameter to the fifth power of the frequency of oscillation. Expressions for force and moment coefficients at any spanwise location are presented. These expressions are applied to a flutter study of a rectangular wing-aileron configuration with the aileron in different spanwise positions.

NACA TN 3654

PERFORMANCE ANALYSIS OF FIXED- AND FREE-TURBINE HELICOPTER ENGINES. Richard P. Krebs and William S. Miller, Jr. June 1956. 49p. diagrs. (NACA TN 3654)

Generalized performance charts are given for these engines and comparison is made of off-design specific fuel consumption, altitude performance, power-speed characteristics, and response times. Flight performance results for an assumed 30,000-pound helicopter powered by the fixed- and free-turbine engines are given. Flight range, hovering duration, and rates of climb are compared for the two power-plant installations. A comparison of the dynamic response and stability of both engines in combination with a rotor is included.

NACA TN 3675

THE EFFECTS OF COMPRESSIBILITY ON THE UPWASH AT THE PROPELLER PLANES OF A FOUR-ENGINE TRACTOR AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10[1]. Armando E. Lopez and Jerald K. Dickson. July 1956. 38p. diagrs., photos., tab. (NACA TN 3675. Supersedes RM A53A30a)

The upflow angles at the horizontal center lines of the propeller planes were measured at Mach numbers up to 0.92 on a wing-fuselage-nacelle combination and on an isolated nacelle. A comparison is made between the experimental and theoretical values of the variation of the upwash angle with angle of attack.

NACA TN 3682

TIME CORRELATOR FOR PROBLEMS IN AERODYNAMICS. George Tolmie Skinner, California Institute of Technology. June 1956. 32p. diagrs. (NACA TN 3682)

An instrument of fairly simple design for measuring time correlation functions of two stationary random electrical signals is discussed. It is intended primarily for use in problems connected with aerodynamically produced acoustic fields but has suitable properties for application to a rather wide range of aerodynamic problems involving turbulent fields. It has been designed and constructed with a view to economy and simplicity of operation and makes extensive use of the general statistical properties of the problems for which it is intended.

NACA TN 3686

EXPERIMENTAL MEASUREMENTS OF FORCES AND MOMENTS ON A TWO-DIMENSIONAL OSCILLATING WING AT SUBSONIC SPEEDS. Sherman A. Clevenson and Edward Widmayer, Jr. June 1956. 28p. diagrs., tab. (NACA TN 3686. Supersedes RM L9K28a)

Experimental results of lifts and moments about the quarter chord of a two-dimensional wing at subsonic Mach numbers are presented. A comparison of the experimental magnitude of the lift vector with the theory as given by Dietze showed good agreement. Comparisons of the moments and the quadrature component of lift with theory indicated that some refinements in the testing technique are necessary for the experimental determination of these quantities in the transonic range.

NACA TN 3695

AN ANALYSIS OF BUZZING IN SUPERSONIC RAM JETS BY A MODIFIED ONE-DIMENSIONAL NON-STATIONARY WAVE THEORY. Robert L. Trimpi. July 1956. 72p. diagrs., photos. (NACA TN 3695. Supersedes RM L52A18)

Experimental instantaneous pressure records of simulated ram-jet models without heat addition showed that they buzzed in a manner governed internally by quasi-one-dimensional (plane-wave) theory, a manner which is not compatible with the laws of the Helmholtz theory. A theory applicable to the buzzing problem was obtained through modification of the one-dimensional, unsteady-flow theory. Theoretical computations of the pressure-time curves agreed closely with the experimental records. A possible simulation of the buzzing in ram jets with combustion by the test of a cold-flow model in which a contraction in area replaces the combustion chamber is also discussed.

NACA TN 3698

PRELIMINARY INVESTIGATION OF SELF-EXCITED VIBRATIONS OF SINGLE PLANING SURFACES. Elmo J. Mottard. June 1956. 19p. diagrs., photos., tab. (NACA TN 3698. Supersedes RM L55J27)

The effect of various planing-surface shapes, conditions of restraint, loads, trims, and speeds on the occurrence of self-excited vibrations was sought. It was found that vibration occurs with high aspect ratio (order of 10) of the wetted portion with freedom in rise. It may occur without freedom in trim. Limiting the aspect ratio (by the use of dead rise or a pointed trailing edge, for example) tends to reduce or eliminate the vibrations. Data are presented for the range of variables likely to be encountered with airplane hydro-skis.

NACA TN 3702

MEASUREMENTS OF ATMOSPHERIC TURBULENCE OVER A WIDE RANGE OF WAVELENGTH FOR ONE METEOROLOGICAL CONDITION. Harold L. Crane and Robert G. Chilton. June 1956. 18p. diagrs., photo. (NACA TN 3702)

A power spectrum of gust vertical velocity over a wide range of wavelengths, 10 feet to 60,000 feet, has been obtained by a simultaneous set of measurements in flight. The method used, which had the advantage of not involving airplane transfer functions, proved to be practicable. The data were obtained on film records and the power spectrum was calculated by digital methods.

NACA TN 3703

THE FLOW PAST AN UNSWEPT- AND A SWEPT-WING—BODY COMBINATION AND THEIR EQUIVALENT BODIES OF REVOLUTION AT MACH NUMBERS NEAR 1.0. Walter F. Lindsey. June 1956. 18p. diagrs., photos. (NACA TN 3703. Supersedes RM L54A28a)

The complete flow fields past an unswept- and a swept-wing—body combination and their equivalent bodies of revolution at Mach numbers around 1.0 have been observed by means of motion-picture schlieren photography. The results of these observations indicate that the shock growth and positions on the wing-body combinations are closely reproduced in the flow past their respective equivalent bodies.

NACA TN 3705

AN INVESTIGATION OF FORWARD-LOCATED FIXED SPOILERS AND DEFLECTORS AS GUST ALLEVIATORS ON AN UNSWEPT-WING MODEL. Delwin R. Croom, C. C. Shufflebarger, and Jarrett K. Huffman. June 1956. 26p. diagrs., photo. (NACA TN 3705)

The present paper presents the results and discussion of an investigation in the Langley 300-MPH 7- by 10-foot tunnel and the Langley gust tunnel to determine the longitudinal aerodynamic characteristics and the gust-alleviation capabilities of forward-located fixed spoilers, deflectors, or spoiler-deflector combinations on a simulated transport airplane model having an unswept wing. Analysis indicates that a forward-located fixed deflector would be a practicable and an effective alleviator of gust loads when turbulence is encountered inasmuch as it reduces the normal accelerations, aids in slowdown, and requires small attitude and trim changes.

NACA TN 3707

FLUTTER OF THIN PROPELLER BLADES, INCLUDING EFFECTS OF MACH NUMBER, STRUCTURAL DAMPING, AND VIBRATORY-STRESS MEASUREMENTS NEAR THE FLUTTER BOUNDARIES. Harvey H. Hubbard, Marvin F. Burgess, and Maurice A. Sylvester. June 1956. 25p. diagrs., tab. (NACA TN 3707)

Experimental results are presented of an investigation on the flutter of thin propeller blades with three different plan forms. Flutter boundaries are presented for a highly twisted blade for which several modes of flutter were observed. Some effects of Mach number and structural damping on the flutter boundaries are described and it is noted that these effects may be beneficial in alleviating flutter. Vibratory-stress measurements in the region of the stall flutter boundary indicate that an increase in the internal blade damping is beneficial in reducing the magnitudes of the stresses.

NACA TN 3710

PRELIMINARY INVESTIGATION OF THE EFFECTS OF EXTERNAL WING FUEL TANKS ON DITCHING BEHAVIOR OF A SWEPTBACK-WING AIRPLANE. Ellis E. McBride. July 1956. 21p. diagrs., photos., tab. (NACA TN 3710)

An experimental investigation was made by use of a 1/10-scale dynamically similar model of a typical sweptback-wing airplane equipped with external wing fuel tanks to determine the effects of the tanks on the ditching behavior. The tanks used were of two fineness ratios, three fuel capacities, and various cross-section shapes. Data on the various tank configurations and on the basic model without tanks are presented in tabular form, time-history curves of acceleration and attitude, and sequence photographs.

NACA TN 3718

THEORETICAL WAVE DRAG OF SHROUDED AIRFOILS AND BODIES. Paul F. Byrd. June 1956. 40p. diagrs. (NACA TN 3718)

Formulas for the wave drag of shrouded symmetrical airfoils and shrouded bodies of revolution of arbitrary shape are derived by means of linearized theory. In the case of the airfoils, the shroud consists of flat plates and for the bodies of revolution the shroud is a cylindrical shell. The results obtained hold for a Mach number range dependent on the geometry of the configuration. Expressions are also given for determining a class of body shapes for which the wave drag is theoretically zero.

NACA TN 3719

APPLICATION OF SCATTERING THEORY TO THE MEASUREMENT OF TURBULENT DENSITY FLUCTUATIONS BY AN OPTICAL METHOD. Howard A. Stine and Warren Winovich. June 1956. 21p. diagrs., (NACA TN 3719)

It is shown that photometric measurements in the scattered field produced by passing an unpolarized plane light wave through a nonabsorbing turbulent fluid can be used to define an average integral scale and average intensity of density fluctuations. The analysis is based upon the scattering coefficient deduced by Booker and Gordon for a turbulence model possessing isotropic fluctuations and an exponentially decaying correlation function. A limited number of experimental results are presented which demonstrate the functional adequacy of the derivation.

NACA TN 3721

AN EVALUATION OF FOUR EXPERIMENTAL METHODS FOR MEASURING MEAN PROPERTIES OF A SUPERSONIC TURBULENT BOUNDARY LAYER. George J. Nothwang. June 1956. 34p. diagrs., photos. (NACA TN 3721)

Surveys were made through the flat plate turbulent boundary layer at a Mach number of 3 using a pitot probe, an X-ray densitometer, and cold-wire and hot-wire probes. The first three methods indicated consistent mean values of pitot pressure, density, and total temperature; the hot-wire probe, however, indicated larger values of mean mass flow. The assumption of constant total temperature through the boundary layer yielded negligible errors in velocity distribution, and displacement and momentum thicknesses.

NACA TN 3740

PRELIMINARY WIND-TUNNEL TESTS OF TRIANGULAR AND RECTANGULAR WINGS IN STEADY ROLL AT MACH NUMBERS OF 1.62 AND 1.92. Clinton E. Brown and Harry S. Heinke, Jr. June 1956. 36p. diagrs., tabs. (NACA TN 3740. Supersedes RM L8L30)

Damping-in-roll coefficients for a series of triangular plan-form wings and two rectangular plan-form wings have been obtained from supersonic-tunnel tests. The wings were mounted on a body of revolution and tested at Mach numbers of 1.62 and 1.92.

BRITISH REPORTS

N-42973 *

Aeronautical Inspection Directorate (Gt. Brit.)
THE PLUNGER RHEOMETER. LAW OF FLOW FOR A NEWTONIAN LIQUID. G. S. Smith. March 1956. 6p. (AID Chem.8)

N-44016*

Aeronautical Research Council (Gt. Brit.)
THE AERODYNAMICS OF THE COOLING OF AIRCRAFT RECIPROCATING ENGINES.
A. S. Hartshorn and L. F. Nicholson. 1956. ii, 135p. diagrs., tabs. (ARC R & M 2498. Supersedes RAE Aero 2290 (Monograph 2.1.12))

This report gives an account of the work done at RAE during the period 1939-1946 on the aerodynamics of cooling. Reference is also made to work performed by the Bristol Aeroplane Co., and to information of overseas origin. It is divided into 12 chapters, each dealing with a specific part of the general problem. These chapters do not give the whole of the work done, but show in a general way the historical progress and indicate the present opinion.

N-44017*

Aeronautical Research Council (Gt. Brit.)
CHOKING EFFECTS AND SOME REYNOLDS NUMBER EFFECTS ON THE MACH NUMBER DISTRIBUTION ROUND A TWO-DIMENSIONAL AEROFOIL IN THE RAE 10-FT X 7-FT HIGH-SPEED TUNNEL. D. A. Clarke and H. E. Gamble. 1955. 30p. diagrs., photo., tabs. (ARC R & M 2912; ARC 13,123. Supersedes: RAE Aero 2337)

A two-dimensional airfoil of NACA 0015 section was tested at zero incidence. Measurements were made of (a) static pressure on the airfoil surface at Reynolds numbers of 1.4×10^6 to 5.5×10^6 and (b) static pressure on the airfoil surface, on the tunnel walls and in the stream between the airfoil and the walls at $R = 2.8 \times 10^6$. All tests were made at Mach numbers of 0.7 upwards and were continued past the choking Mach number of 0.764 until either the maximum permissible fan speed was reached or the maximum available power was being used.

N-44018*

Aeronautical Research Council (Gt. Brit.)
MEASUREMENT OF LIFT, PITCHING MOMENT AND HINGE MOMENT ON A TWO-DIMENSIONAL CAMBERED AEROFOIL TO ASSIST THE ESTIMATION OF CAMBER DERIVATIVES. H. C. Garner and A. S. Batson. 1955. 34p. diagrs., tabs. (ARC R & M 2946. Supersedes: ARC 15,456; S & C 2709)

Aerodynamic camber derivatives are used in predicting three-dimensional control characteristics, in estimating wind-tunnel interference, and in applying model data to full scale. Experiments were performed to confirm empirical formulas for the derivatives of lift and pitching moment and to check widely differing formulas for the hinge-moment derivative. A two-dimensional airfoil (RAE 102) with a 4-percent parabolic center line and plain control surfaces of chord ratios 0.2 and 0.4 has been tested at low speed and RN of 0.95×10^6. Particular attention was given to boundary-layer transition. Aerodynamic coefficients were obtained from measured forces and moments and from the pressure distribution at one section.

N-44019*

Aeronautical Research Council (Gt. Brit.)
NOTES ON THE TRANSONIC MOVEMENT OF WING AERODYNAMIC CENTRE. S. B. Gates. 1956. 34p. diagrs., tabs. (ARC R & M 2785; ARC 12,430. Supersedes RAE Aero 2325)

These notes aim at providing a framework to display what is known of the backward movement of the aerodynamic center of wing shapes likely to be used for transonic operation, as the flow progresses from incompressible through subsonic to supersonic, the shock-wave regime being ignored. A new geometrical parameter δ is taken as the main variable because (a) it gives a neat classification of the various wing shapes, (b) it expresses the results of supersonic theory in a simple form, (c) it simplifies the subsonic analysis by making direct use of the similarity law for three-dimensional compressible flow, and so (d) it is possible to display on one diagram most of the theoretical and experimental data at present available.

N-44020*

Aeronautical Research Council (Gt. Brit.)
HINGE-MOMENT DERIVATIVES FOR AN OSCILLATING CONTROL. C. S. Sinnott. 1955. 11p. diagrs. (ARC R & M 2923. Supersedes ARC 15,670, 0.1044, S & C 2744 & ARC 16,130, 0.1044a, S & C 2744a)

The semiempirical "equivalent profile" method of W. P. Jones is extended to the case of an airfoil with an oscillating control. The oscillatory hinge-moment derivatives for such an airfoil-control combination in a low-speed wind tunnel are estimated, an allowance for tunnel wall interference effects being included. A comparison with measured values of the control derivatives is made for two values of the control chord ratio, representing an aileron and a tab. The method of this report gives results in much better agreement with experiment than those obtained by vortex-sheet theory.

N-44021*

Aeronautical Research Council (Gt. Brit.)
AN EXPERIMENTAL INVESTIGATION OF A THICK-AEROFOIL NOZZLE CASCADE. S. J. Andrews and N. W. Schofield. 1956. 13p. diagrs., photos., tab. (ARC R & M 2883; ARC 13,632. Supersedes NGTE Memo.M.84)

The cascade tests on a thick-airfoil turbine nozzle blade suitable for a cooled turbine show that it has a good performance over a wide incidence range up to $M = 0.8$. Above this value the loss coefficient rises and does not fall again as $M = 1$ is approached. Several methods of indication of the transition point have been tried and results show that the method depending on the evaporation of crystals gives a position inconsistent with three other methods, that is, lamp-black deposit, surface total-head measurement, and stethoscope search tube. The effect of the thick trailing edge on loss coefficient is almost that predicted assuming zero velocity behind the blade trailing edge. The heat-transfer increase due to transition is probably not large, and is no worse than that on a conventional turbine section.

N-44022*

Aeronautical Research Council (Gt. Brit.)
AEROFOIL DESIGN IN TWO-DIMENSIONAL SUBSONIC COMPRESSIBLE FLOW. L. C. Woods. 1955. 54p. diagrs., tabs. (ARC R & M 2845. Supersedes ARC 14,708, FM 1688)

The method of two-dimensional airfoil design in incompressible flow due to Lighthill is extended to compressible subsonic flow. Lighthill's equations are derived as special cases of more general equations due to the author, and some advances are made in the application of these equations to airfoil design. The method of reference 1 requires that the velocity distribution be prescribed analytically, whereas this paper deals with distributions defined numerically. The compressible flow theory is based on an approximation to the equation of flow not unlike the Kármán-Tsien approximation for calculating the flow about a given airfoil. A method of estimating the effects of a modification to the designed airfoil shape on the velocity distribution is also given. Five examples have been calculated.

N-44023*

Aeronautical Research Council (Gt. Brit.)
WIND-TUNNEL FLUTTER TESTS ON A MODEL DELTA WING UNDER FIXED AND FREE ROOT CONDITIONS. D. R. Gaukroger, E. W. Chapple, and A. Milln. 1955. 10p. diagrs., tab. (ARC R & M 2826; ARC 13,721. Supersedes RAE Structures 89)

Wind-tunnel tests on a model wing of delta plan form are described. Tests have been made with the wing root fixed and also with the root free in pitch and vertical translation. Critical flutter speed and frequency are given for a wide range of variation of wing and fuselage inertia parameters. The results show that, under root-free conditions, body freedom flutter occurs at low values of fuselage pitching moment of inertia, but that at higher values the flutter is similar to that obtained with root-fixed conditions.

N-44024*

Aeronautical Research Council (Gt. Brit.)
ANALYSIS OF REYNOLDS NUMBER EFFECTS IN FLUID FLOW THROUGH TWO-DIMENSIONAL CASCADES. D. J. K. Stuart. 1955. 39p. diagrs., tab. (ARC R & M 2920; ARC 15,260)

In this report particular emphasis has been placed on the causes of high loss, especially at very low Reynolds numbers. Separation of both the laminar and turbulent boundary layers is verified as sources of low efficiency in this particular type of flow and these phenomena have been studied in considerable detail. Mach number effects were specifically avoided in the experimental work although a wide range of Reynolds number was covered (RN = 30,000 to 500,000); the effect of compressibility has not been considered in the main analysis. It is shown that design methods can be modified to insure improved performance at a specified Reynolds number or over a range of Reynolds numbers.

N-44025*

Aeronautical Research Council (Gt. Brit.)
TESTS IN THE R.A.E. 10-FT x 7-FT HIGH SPEED WIND TUNNEL ON DROP TANKS FITTED TO TWO SWEPT-BACK WINGS. PART I. COMPARISON OF UNDER-WING AND WING-TIP INSTALLATIONS. D. E. Hartley and A. B. Haines. PART II. COMPARISON OF VARIOUS UNDER-WING DROP-TANK ARRANGEMENTS. By Staff of R.A.E. High Speed Wind Tunnel. 1956. 45p. diagrs., photos., tabs. (ARC R & M 2951; ARC 14,653; ARC 15,402. Supersedes RAE Aero 2442 & RAE Tech.Note Aero 2177)

Two wings, having the same plan form with a sweepback of 40° and an aspect ratio of 3.5, but differing in thickness/chord ratio, being 10 percent and 8.5 percent thick, respectively, were tested. Part 1 compares the results obtained with the drop tanks mounted in two alternative positions on the 10 percent thick wing: under the wing at about midsemispan, supported by an 8.5 percent thick strut or at the wing tip in a midwing position. Part 2 compares the results obtained with several different types of underwing installation, for example, with different designs of strut or alternatively dispensing with the strut and fitting the tanks directly on to the lower surface of the wing. Most of the tanks had a fineness ratio of 8:1.

N-44026*

Aeronautical Research Council (Gt. Brit.)
WIND-TUNNEL TESTS ON THE SYMMETRIC AND ANTISYMMETRIC FLUTTER OF SWEPT-BACK WINGS. D. R. Gaukroger. 1955. 21p. diagrs., photo., tab. (ARC R & M 2911; ARC 15,054; ARC 16,080. Supersedes RAE Structures 123 & RAE Structures 143)

Wind-tunnel tests to determine the symmetric and antisymmetric flutter characteristics of a sweptback wing are described. The investigation covers the separate experimental treatment of the symmetric and antisymmetric body freedoms over a range of wing sweepback angles. Consideration is also given to the effect on critical flutter speed and frequency of variations in overall center-of-gravity position, fuselage pitching moment of inertia, fuselage rolling moment of inertia, fuselage mass and tail plane volume coefficient.

N-44027*

Aeronautical Research Council (Gt. Brit.)
THE THEORY OF TORSIONAL VIBRATIONS OF A FOUR-BOOM THIN-WALLED CYLINDER OF RECTANGULAR CROSS-SECTION. E. H. Mansfield. 1955. 16p. diagrs., tab. (ARC R & M 2867; ARC 14,024. Supersedes RAE Structures 103)

Torsional vibrations of a four-boom cylinder of doubly symmetrical rectangular cross section are considered and the differential equation of motion is derived on the assumption that the ribs maintain the section shape but do not themselves resist any warping out of their plane and that the walls of the cylinder are effective only in shear. Frequency equations are derived for a length of cylinder, free at both ends and prevented from rotating at the midsection. Complete behavior of the cylinder is determined by two nondimensional parameters; curves are given from which the frequencies for any such cylinder may be determined. Higher frequencies in particular may be underestimated by between 40 to 80 percent if warping constraint effects are ignored. An approximate method is given for estimating the torsional frequencies of a cylinder with nonuniform characteristics.

N-44028*

Aeronautical Research Council (Gt. Brit.)
THE CALCULATION OF THE LOADING AND PRESSURE DISTRIBUTION ON CRANKED WINGS.
G. G. Brebner. 1955. 31p. diagrs., tab. (ARC R & M 2947; ARC 15,933. Supersedes RAE Aero 2483)

Using distributions of vortices and sources over the airfoil surface, approximate formulas are developed for finding the spanwise and chordwise loadings of cranked wings (i. e., wings with discontinuous changes of sweep), and the chordwise pressure distribution at the crank, in incompressible flow. The method can be extended to subcritical compressible flow by considering the "analogous wing." Calculations by the present method are compared with experimental results on two wings and with calculations by another method for wings of M, W, and Λ plan form. Agreement with experiment is good. Comparison with the other method shows satisfactory agreement between the spanwise loadings, but the present method yields more information about chordwise distributions, and is quicker.

N-44029*

Aeronautical Research Council (Gt. Brit.)
THEORETICAL REQUIREMENTS OF TUNNEL EXPERIMENTS FOR DETERMINING STABILITY DERIVATIVES IN OSCILLATORY LONGITUDINAL DISTURBANCES. S. Neumark and A. W. Thorpe. 1955. 14p. diagrs. (ARC R & M 2903; ARC 13,667. Supersedes RAE Tech.Note Aero 2059)

The need of using stability derivatives of unsteady (oscillatory) motion is explained, and requirements of tunnel experiments for determining them are established. These are based on simple theoretical considerations, valid for both incompressible and compressible (subsonic and supersonic) flow. Two alternative schemes of experimental tests are critically examined. *Nondimensional derivatives* are defined and applied in modified stability equations, referred to fixed or moving systems of coordinate axes.

N-44030*

Aeronautical Research Council (Gt. Brit.)
ROLLING POWER MEASUREMENTS AND COMPARATIVE CALCULATIONS FOR A FLEXIBLE MODEL WING CONSTRUCTED FROM XYLONITE.
N. C. Lambourne, A. S. Batson, and A. Chinneck.
Appendix: APPLICATION OF LIFTING LINE THEORY. H. C. Garner. 1955. 35p. diagrs., photos., tabs. (ARC R & M 2895. Supersedes ARC 13,322, 0.884, S & C 2422 & ARC 14,608, 0.884a, S & C 2422a)

Partly to gain experience of aeroelastic models constructed from Xylonite, and partly to provide information regarding loss of rolling power due to wing distortion, a tip-to-tip model of the wings of a Spitfire aircraft was constructed. It was mounted on a longitudinal axis in a wind tunnel so that it could roll continuously. Rates of rolling were measured for a range of airspeeds and the results are compared with those of calculations. The variation of rolling power with airspeed was calculated by (a) the Collar and Broadbent method which is based on strip theory and (b) a method developed by H. C. Garner based on lifting-line theory.

N-44031*

Aeronautical Research Council (Gt. Brit.)
A FULL-SCALE INVESTIGATION INTO THE HYDRODYNAMIC BEHAVIOUR OF A HIGHLY FAIRED FLYING-BOAT HULL. J. A. Hamilton. 1956. 36p. diagrs., photos., tab. (ARC R & M 2899; ARC 15,196. Supersedes MAEE F/Res/223)

This report describes an investigation into the hydrodynamic qualities of a Sunderland flying-boat hull, weight 50,000 pounds, fitted with a main-step fairing of fairing ratio 17:1. The fairing was equipped with ventilating ducts, drawing air at atmospheric pressure through ports on the hull side, and discharging it through exit vents on the afterbody planing bottom. No pumping apparatus was fitted, the air flow being induced by the subatmospheric pressures on the fairing. The general conclusion of the investigation is that successful hulls may be designed without conventional steps, provided that sufficient internal ventilation is provided.

N-44032*

Aeronautical Research Council (Gt. Brit.)
LOW-SPEED WIND-TUNNEL TESTS ON A MODEL OF A JET TAILLESS AIRCRAFT. J. Trouncer and G. F. Moss. 1956. 36p. diagrs., tabs. (ARC R & M 2843; ARC 10,616. Supersedes RAE Aero 2181)

This report gives the results of longitudinal and lateral stability tests made on a model of a jet tailless aircraft. It includes the effects of split flaps, dive-recovery flaps, and four types of antitip-stalling device (slats, nose flaps, double split flaps, and letter-box slots). It also includes the effect of the ground in the landing condition.

N-44035*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF IMPEDANCE MISMATCH ON THE FREQUENCY RESPONSE OF A SUPERHET RECEIVER. M. B. Barnes. December 1955. 18p. diagrs., tabs. (RAE Tech.Note GW 392)

In this note the effects of impedance mismatches between crystal mixer, preamplifier, and I. F. amplifier on the frequency response of a superhet receiver are described. The method of measuring and matching the output impedance of the mixer crystal is described. A sensitive method of estimating the input impedance of the I. F. amplifier, and of matching it to the Z_0 of the input cable, is developed. This method could equally well be used to form an estimate of the output impedance of the preamplifier. It was necessary to take special matching precautions to achieve an overall frequency response which was smooth and flat-topped to within 0.1 db over the band 44-46 mc/s when the mixer, preamplifier, and I. F. amplifier were separated by long lengths of cable. The Appendix gives details of the X Band wobbulation method used for adjusting the overall frequency response of the receiver.

MISCELLANEOUS

NACA RM E55G27a

Errata on "IDEAL TEMPERATURE RISE DUE TO CONSTANT-PRESSURE COMBUSTION OF A JP-4 FUEL." S. C. Huntley. September 27, 1955.

NACA TN 2992

Errata on "APPLICATION OF A CHARACTERISTIC BLADE-TO-BLADE SOLUTION TO FLOW IN A SUPERSONIC ROTOR WITH VARYING STREAM-FILAMENT THICKNESS." Eleanor L. Costilow. August 1953.

NACA TN 3450

Errata on "PRELIMINARY INVESTIGATION OF PROPERTIES OF HIGH-TEMPERATURE BRAZED JOINTS PROCESSED IN VACUUM OR IN MOLTEN SALT." C. A. Gyorgak and A. C. Francisco. May 1955.

N-41002

SOME NACA RESEARCH ON THE EFFECT OF TRANSIENT HEATING ON AIRCRAFT STRUCTURES. John E. Duberg. (Presented at a conference of the Aviation Division of ASME, Los Angeles, California, March 1956). 24p. diagrs., photos.

A brief presentation is made of the radiant heating apparatus developed by the NACA to simulate aerodynamic heating of aircraft structures. Some results of the effects of thermal stresses on the stiffness and deflection of aircraft structures are demonstrated by tests incorporating the radiant heating apparatus.

N-41520

EXPERIMENTAL RESEARCH ON AIRCRAFT STRUCTURES AT ELEVATED TEMPERATURES. Joseph N. Kotanchik. (Presented to the Society of Experimental Stress Analysis Spring Meeting, Pittsburgh, Pennsylvania, May 1956). 35p. diagrs., photos.

The equipment and methods used at the Langley Laboratory of the NACA in experimental research on aircraft structures at elevated temperatures are reviewed. The equipment ranges from conventional steady-state furnaces for stress-strain tests to transient radiant-heating apparatus and aerodynamic heating and loading in a supersonic air jet.

N-45035

Advisory Group for Aeronautical Research and Development. COLLECTED PAPERS ON AVIATION MEDICINE. (Presented at Aeromedical Panel Meetings of the Advisory Group for Aeronautical Research and Development, Palais de Chaillot, Paris). vi, 209p. diagrs., photos., tabs. (Advisory Group for Aeronautical Research and Development. AGARDograph 6)

Contents: LA RECHERCHE AÉROMÉDICALE ET LA TECHNIQUE AÉRONAUTIQUE. P. Bergeret, Armée de l'Air Francaise. A BRIEF SURVEY OF AVIATION MEDICINE. P. B. Lee-Potter, R. A. F. AEROMEDICAL INTERESTS—LOOKING FORWARD. Otis O. Benson, U. S. A. F. LES VARIATIONS DE TOLERANCE A LA RESPIRATION EN SURPRESSION. R. Grandpierre et F. Violette, Centre d'Etudes de Biologie Aéronautique. LA VITESSE INSPIRATOIRE DANS L'ANOXIE ANOXIQUE COMME METHODE D'EXPLORATION DE LA FONCTION RESPIRATOIRE. T. Lo Monaco, Armee de l'Air Italienne. MEDICAL TESTS FOR DETECTING LATENT EPILEPSIA AND FLUCTUATIONS IN THE LEVEL OF CONSCIOUSNESS. P. M. van Wulfften Palthe, National Aeromedical Centre. ARCTIC SURVIVAL PROBLEMS. Kaare Rodahl, University of Oslo. BRITISH THEORY AND PRACTICE IN THE LAYOUT OF AIRCRAFT COCKPITS. H. P. Ruffell Smith, R. A. F. PHYSIOLOGICAL REQUIRMENTS OF PRESSURE CABINS. H. L. Roxburgh, R. A. F. CONSEQUENCES OF LOSS OF CABIN PRESSURE. D. I. Fryer, R. A. F. RECENT ADVANCES OF INSTRUMENTATION OF INTEREST IN AVIATION MEDICINE. Clayton S. White, W. Randolph Lovelace, II, James Clark, and Frederic G. Hirsh, Lovelace Foundation of Medical Education and Research. THE NATURE OF COLD-INDUCED TISSUE INJURY. Robert B. Lewis, U. S. A. F. THE HIGH INTENSITY NOISE PROBLEM IN THE U. S. NAVY. Clifford P. Phoebus, U. S. Navy. TOLERANCE TO ABRUPT DECELERATION. John P. Stapp, U. S. A. F. LA VISION NOCTURNE. Armand Mercier. SOME PROBLEMS IN TESTING COLOUR VISION. M. A. Bouman and P. L. Walraven, National Defense Research Council. HETEROPHORIA. G. Ten Doesschate, Netherlands National Aeromedical Center. PRACTICAL ASPECTS OF HETEROPHORIA IN AVIATION. J. C. Neely.

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1252

QUASI-CYLINDRICAL THEORY OF WING-BODY INTERFERENCE AT SUPERSONIC SPEEDS AND COMPARISON WITH EXPERIMENT. Jack N. Nielsen. 1955. ii, 56p. diagrs., tabs. (NACA Rept. 1252. Supersedes TN 2677; TN 3128)

A theoretical method is presented for calculating the flow field about wing-body combinations employing bodies deviating only slightly in shape from a circular cylinder. The method is applied to the calculation of the pressure field acting between a circular cylindrical body and a rectangular wing. The case of zero body angle of attack and variable wing incidence is considered as well as the case of zero wing incidence and variable body angle of attack. An experiment was performed especially for the purpose of checking the calculative examples.

NACA RM E56E11

USE OF TRUNCATED FLAPPED AIRFOILS FOR IMPINGEMENT AND ICING TESTS OF FULL-SCALE LEADING-EDGE SECTIONS. Uwe H. von Glahn. July 1956. 29p. diagrs., photos., tabs. (NACA RM E56E11)

Experimental studies were made with an NACA 65_1-212 airfoil section truncated at the 30- and 50-percent-chord stations and equipped with a trailing-edge flap. When the truncated airfoils were compared with the full-chord airfoils, the velocity distribution and the impingement characteristics were similar with the flap properly deflected, but were altered substantially without flap deflection. Use of flapped truncated airfoils permits impingement and icing studies in icing tunnels to be conducted with full-scale leading-edge sections over a greater range of conditions than previously possible.

NACA RM L56C27

STATIC-THRUST CHARACTERISTICS OF THE NACA 8.75-(5) (05)-037 DUAL-ROTATION PROPELLER. Harry T. Norton, Jr. July 1956. 16p. diagrs., photo. (NACA RM L56C27)

This paper presents the static-thrust characteristics of the NACA 8.75-(5) (05)-037 dual-rotation propeller having six and eight blades.

NACA RM L56D16

ZERO-LIFT DRAG OF A SERIES OF BOMB SHAPES AT MACH NUMBERS FROM 0.60 TO 1.10. William E. Stoney, Jr., and John F. Royall. July 1956. 12p. diagrs., photos., tabs. (NACA RM L56D16)

Zero-lift drag data were obtained on a series of six bomb shapes. Five configurations had the same body shape, the only difference being in the body-surface conditions and the profile and plan form of the fins, while the sixth configuration had a different and longer body shape. The models were launched from a helium gun (at the Langley Pilotless Aircraft Research Station at Wallops Island, Va.), and data were obtained for Mach numbers from 0.60 to 1.10 with corresponding Reynolds numbers based on body length of 5×10^6 to 10×10^6. It was found that at subsonic speeds the blunt trailing edge of the fins contributed a large share of the drag while the effect of the blunt leading edge was negligible. Two models whose roughness did not exceed 20 rms microinches had measurably lower subsonic drag coefficients than the remaining models whose roughness varied between 100 and 250 rms microinches.

NACA TM 1422

ON LANDING GEAR STRESSES. (Sur les Sollicitations des Atterrisseurs). A. Gentric. July 1956. 45p. diagrs., photos. (NACA TM 1422. Trans. from Docaéro, no.25, January 1954, p.17-38).

This paper presents the French viewpoint on ground loads problems and discusses their current efforts and new research equipment. Some data are presented on tangential forces due to wheel spin-up effects and on longitudinal oscillations of landing gears. The subject of fatigue failures resulting from longitudinal oscillations is discussed and several case histories are presented. Overall suggestions for improvement in landing-gear design techniques are given and the areas where additional research is needed are indicated.

NACA TN 3688

STATIC-THRUST MEASUREMENTS OF THE AERODYNAMIC LOADING ON A HELICOPTER ROTOR BLADE. John P. Rabbott, Jr. July 1956. 22p. diagrs., photos. (NACA TN 3688)

Plots of the chordwise and spanwise aerodynamic loading measured on a helicopter rotor blade in static

thrust are presented. A comparison of the spanwise loading with the strip-analysis theoretical loading, as modified by a simple correction for the number of blades, shows fair agreement. The data also suggest that a tip-loss factor for performance calculations should be a function of the thrust coefficient, rather than a constant factor.

NACA TN 3701

COMPARISON OF SEVERAL METHODS FOR OBTAINING THE TIME RESPONSE OF LINEAR SYSTEMS TO EITHER A UNIT IMPULSE OR ARBITRARY INPUT FROM FREQUENCY-RESPONSE DATA. James J. Donegan and Carl R. Huss. July 1956. 39p. diagrs., tabs. (NACA TN 3701)

Several methods of obtaining the time response of linear systems to either a unit impulse or an arbitrary input from frequency-response data are described and compared. Comparisons indicate that all of the methods give good accuracy when applied to a second-order system; the main difference is the required computing time to obtain the same degree of accuracy. When applied to higher order systems, however, the methods generally classified as inverse Laplace transform methods were found most effective. Some discussion is given of the use of the methods as flight-data-analysis techniques in predicting loads and motions for a flexible aircraft when the aircraft frequency response is known.

NACA TN 3706

INVESTIGATION OF THE LAMINAR AERODYNAMIC HEAT-TRANSFER CHARACTERISTICS OF A HEMISPHERE-CYLINDER IN THE LANGLEY 11-INCH HYPERSONIC TUNNEL AT A MACH NUMBER OF 6.8. Davis H. Crawford and William D. McCauley. July 1956. 38p. diagrs., photos. (NACA TN 3706)

A program to investigate the aerodynamic heat transfer of a nonisothermal hemisphere-cylinder has been conducted in the Langley 11-inch hypersonic tunnel at a Mach number of 6.8 and a Reynolds number from approximately 1.09×10^5 to 1.03×10^6 based on diameter and free-stream conditions. The experimental heat-transfer coefficients were slightly less over the whole body than those predicted by the Stine and Wanlass theory (NACA TN 3344) for an isothermal surface. For stations within 45° of the stagnation point the heat-transfer coefficients could be correlated by a single relation between local Stanton number and local Reynolds number.

NACA TN 3717

THREE-DIMENSIONAL TRANSONIC FLOW THEORY APPLIED TO SLENDER WINGS AND BODIES. Max. A. Heaslet and John R. Spreiter. July 1956. 72p. diagrs. (NACA TN 3717)

Integral equations for transonic flow around slender wings and bodies are derived assuming shock waves are present. For sonic flow, Oswatitsch's equivalence rule is extended to lifting cases at small angles of attack. Relationships are presented between the pressure distributions and integrated forces on slender wings and bodies having the same longitudinal distribution of cross-section area. Specific application is made to slender cone-cylinders of elliptic cross sections of varying eccentricity. The conclusions are supported both by formal analysis of the order of the error terms and by comparison with existing theoretical and experimental information.

NACA TN 3731

TENSILE PROPERTIES OF INCONEL AND RS-120 TITANIUM-ALLOY SHEET UNDER RAPID-HEATING AND CONSTANT-TEMPERATURE CONDITIONS. George J. Heimerl, Ivo M. Kurg, and John E. Inge. July 1956. 29p. diagrs., photo., tabs. (NACA TN 3731)

Results are presented of rapid-heating tests to determine the tensile strength of Inconel and RS-120 titanium-alloy sheet heated to failure at uniform temperature rates from 0.2° F to 100° F per second under constant load conditions. Yield and rupture stresses, obtained by rapid heating, are conpared with yield and ultimate stresses from elevated-temperature tensile stress-strain tests for 1/2-hour exposure. The applicability of master curves and temperature-rate parameters to the prediction of yield and rupture stresses and temperatures under rapid-heating conditions was investigated.

NACA TN 3732

AN INVESTIGATION OF VERTICAL-WIND-SHEAR INTENSITIES FROM BALLOON SOUNDINGS FOR APPLICATION TO AIRPLANE- AND MISSILE-RESPONSE PROBLEMS. H. B. Tolefson. July 1956. 33p. diagrs., tabs. (NACA TN 3732)

The daily upper-wind soundings taken at one station for a one-year period are analyzed to obtain data on the vertical-wind-shear intensities and frequencies for use in airplane- and missile-response studies. The results indicated maximum shear intensities of about 100 meters per second per kilometer occurring at altitudes from 10 to 15 kilometers during the winter and spring months. The application of these results to the calculation of the normal response of a missile in vertical flight is also considered briefly.

NACA TN 3734

TURBULENT-HEAT-TRANSFER MEASUREMENTS AT A MACH NUMBER OF 3.90. Maurice J. Brevoort. July 1956. 15p. diagrs., tab. (NACA TN 3734)

An axially symmetric annular nozzle was used to obtain essentially flat-plate data on turbulent-heat-transfer coefficients and temperature-recovery factors. The test results of this paper are for a Mach number of 3.90 and for a Reynolds number range of 6.3×10^5 to 7.0×10^7. The heat-transfer-coefficient results are slightly higher than theoretical results for a Mach number of 4.0. The recovery factors show a decrease with Reynolds number from approximately 0.89 at 6.3×10^5 to approximately 0.86 at 7.0×10^7.

NACA TN 3735

BENDING TESTS OF RING-STIFFENED CIRCULAR CYLINDERS. James P. Peterson. July 1956. 14p. diagrs., photos., tab. (NACA TN 3735)

Twenty-five ring-stiffened circular cylinders were loaded to failure in bending. The results are presented in the form of design curves which are applicable to cylinders with heavy rings that fail as a result of local buckling.

NACA TN 3739

FLIGHT INVESTIGATION OF THE PERFORMANCE OF A TWO-STAGE SOLID-PROPELLANT NIKE-DEACON (DAN) METEOROLOGICAL SOUNDING ROCKET. Robert H. Heitkotter. July 1956. 21p. diagrs., photos. (NACA TN 3739)

A flight investigation of two Nike-Deacon (DAN) two-stage solid-propellant rocket vehicles indicated satisfactory performance may be expected from the DAN meteorological sounding rocket. Peak altitudes of 356,000 and 350,000 feet, respectively, were recorded for the two flight tests when both vehicles were launched from sea level at an elevation angle of 75°. Performance calculations based on flight-test results show that altitudes between 358,000 feet and 487,000 feet may be attained with payloads varying between 60 pounds and 10 pounds.

NACA TN 3756

STUDY OF SIZE EFFECT IN SHEET-STRINGER PANELS. J. P. Doman and Edward B. Schwartz, Naval Air Material Center. Appendix B: STATISTICAL ANALYSIS. Edward B. Schwartz. July 1956. 25p. diagrs., photos., tabs. (NACA TN 3756)

An investigation was conducted to determine whether there are significant size effects in compressive strength of large Z-stiffened sheet-stringer panels as compared with geometrically similar smaller models and thus to ascertain whether the prediction of the strength of large panels by model tests is reliable. The specimens studied were manufactured from 7075-T6 aluminum alloy and included four representative types of panel designs, with full- and one-quarter-scale panels of each type.

BRITISH REPORTS

N-44317*

Aeronautical Research Council (Gt. Brit.)
CORRELATED FATIGUE DATA FOR AIRCRAFT STRUCTURAL JOINTS. R. B. Heywood. 16p. diagrs., tab. (ARC CP 227)

Results of fatigue tests carried out at R. A. E. on typical aircraft wing structural joints are correlated to give an indication of general fatigue behavior. The results are plotted in the form of S - Log N curves, and these indicate that the mode of behavior cannot be attributed to any single factor, such as the type of aluminum alloy, the ultimate tensile strength, or the mean stress of the fatigue cycle. The detailed method of design undoubtedly has a predominant influence on behavior, but this quality is not revealed by a broad classification according to the proportion of load transmitted at holes.

N-44418*

Royal Aircraft Establishment (Gt. Brit.)
THE DYNAMIC PERFORMANCE OF ANALOGUE COMPUTING ELEMENTS. P. R. Benyon. March 1956. 10p. tab. (RAE Tech.Note GW 406)

This paper proposes a method of specifying the dynamic performance of a computing element by defining frequencies at which (a) amplitude or phase errors exceed an arbitrary specified value; and (b) errors due to dynamic overload occur. These frequencies are tabulated for a number of typical computing elements.

N-44419*

Royal Aircraft Establishment (Gt. Brit.)
SOLUTION OF THE PROBLEM OF THE CANTILEVER SQUARE PLATE BY THE USE OF INFLUENCE COEFFICIENTS AND A HIGH SPEED DIGITAL COMPUTER. D. Williams and P. C. Birchall. March 1956. 11p. diagr. (RAE Tech.Note Structures 178; M.S.25)

A method is described for deriving, by means of a high-speed digital computer, the influence coefficients for a square cantilever plate subjected to transverse loads. The results of a worked example are shown to compare favorably with those produced by an electrical analogy, and be in good agreement with experiment.

N-44420*

Royal Aircraft Establishment (Gt. Brit.)
A THERMOSTATIC BATH FOR LABORATORY USE AT TEMPERATURES UP TO 350° C. G. Kinner. March 1956. 7p. diagrs. (RAE Tech.Note Chem.1275)

A description is given of a thermostatic bath for laboratory use at temperatures up to 350° ± 0.1° C. A clear liquid is used as the bath medium and windows permit uninterrupted horizontal vision. Suggestions are made whereby even closer temperature control could be achieved and the range of operation extended to a temperature of 400° C.

N-44426*

Aeronautical Research Council (Gt. Brit.)
LOADING CONDITIONS FOLLOWING AN AUTOMATIC PILOT FAILURE (ELEVATOR CHANNEL). D. R. Puttock. 1956. 50p. diagrs. (ARC CP 243)

A proposal is made for a standard procedure for calculating the critical loading conditions ensuing from an automatic pilot failure in the elevator channel. General expressions are derived through response theory for the increments in normal acceleration at the c. g. of the aircraft, normal acceleration at the tail, and aerodynamic load on the tail plane which result from the sequence of elevator movements assumed to follow a failure. Analysis of these general expressions leads to formulas suitable for assessing the numerical values of the critical loads on the wing and tail plane. The influence of the sequence of elevator movements on the loading conditions is discussed with reference to an example.

N-44427*

Aeronautical Research Council (Gt. Brit.)
TESTS OF HUMIDITY EFFECTS ON FLOW IN A WIND TUNNEL AT MACH NUMBERS BETWEEN 2.48 AND 4. R. J. Monaghan. 1956. 33p. diagrs. (ARC CP 247)

Static and pitot pressure distributions were measured in the working section of a 5-inch by 5-inch supersonic wind tunnel over ranges of absolute humidity at the inlet from 5×10^{-5} to 3×10^{-3}.

N-44428*

Aeronautical Research Council (Gt. Brit.)
FULL SCALE SPINNING TESTS ON THE PERCIVAL PROVOST MK.1 INCLUDING THE INVERTED SPIN. T. H. Kerr. 1956. 32p. diagrs., photos., tabs. (ARC CP 240)

Instrumented spinning tests on this aircraft were completed in both the normal and inverted attitudes. The normal spin showed the characteristics of the smooth and oscillatory type depending upon the control configuration; being oscillatory with pro-spin aileron and smooth with antispin aileron. The recovery was satisfactory in each case. Inverted spins of up to six turns were completed and showed satisfactory characteristics both for the spin and the recovery.

N-44429*

Aeronautical Research Council (Gt. Brit.)
INVESTIGATION OF THE FATIGUE OF EXTRUDED TUBULAR BOOMS. W. A. P. Fisher and H. Yeomans. 1956. 15p. diagrs., photos., tabs. (ARC CP 234)

Three types of specimen made from aluminum alloy DTD 364 were tested and the results compared. The types of specimen were: (a) extruded tube specimens lightly machined on the outside - having transverse holes drilled through the tube (these represented the critical section of the Viking replacement and Valetta spar boom), (b) plain extruded tube with the center portion reduced to ensure failure in the test section, and (c) solid polished bar specimens made from the walls of the extruded tubes. The results showed that the fatigue strength of the plain tube, with the original extruded bore, was less than half that of the polished bar. Fatigue cracking started in every tube from an obvious flaw on the inner surface.

N-44430*

Aeronautical Research Council (Gt. Brit.)
THE INFLUENCE OF PRE-LOADING ON THE FATIGUE LIFE OF AIRCRAFT COMPONENTS AND STRUCTURES. R. B. Heywood. 1956. 27p. diagrs., photos. (ARC CP 232)

Tests on aircraft components and structures are described which show that preloading can have a marked influence on fatigue behavior. Tensile preloading may increase the life - in one instance a hundredfold improvement was obtained - and compressive preloading may reduce the life. The effect is attributed to residual stresses and to load redistributions induced by preloading.

N-44431*

Aeronautical Research Council (Gt. Brit.)
TURBULENCE ENCOUNTERED BY COMET 1 AIRCRAFT. J. R. Heath-Smith. 1956. 32p. diagrs., tabs. (ARC CP 248)

Acceleration records have been obtained of the turbulence encountered by B. O. A. C. Comet aircraft in 680,000 miles of operational flying on routes connecting London with South Africa and the Far East. It is shown that turbulence decreases with increasing altitude. Of all gusts greater than 10 ft/sec E. A. S. 91 percent were encountered below 27,500. Above 27,500 ft, about 75 percent of gusts greater than 10 ft/sec E. A. S. occur in cumuliform cloud. In flight sectors where conditions favor the formation of cumuliform cloud, gusts may be several times more numerous on average than over widespread routes.

N-44432*

Aeronautical Research Council (Gt. Brit.)
OPTIMUM DESIGNS FOR REINFORCED CIRCULAR HOLES. E. H. Mansfield. 1956. 26p. diagrs. (ARC CP 239)

The design of reinforced circular holes in an infinite sheet is considered theoretically. The stress system in the main body of the sheet is assumed to be one in which the principal stresses are in the ratio 1:-1 (i. e., shear), 1:0 (i. e., tension), 1:1 or $1:\frac{1}{2}$. The reinforcement may vary round the hole and families of such reinforcements with constant total weight are considered. The peak stresses in the sheet are evaluated so that optimum weight-strength designs are determined.

N-44433*

Aeronautical Research Council (Gt. Brit.)
SOME WORK ON TENSION PADS FOR STRUCTURAL TESTS. J. K. Oaks and P. B. Hovell. 1956. 15p. diagrs., photos. (ARC CP 238)

Sorbo rubber tension pads glued with Bostik adhesive have been developed for loading aircraft components during static and fatigue strength tests. The gluing technique, detail tests, and pilot test on a typical component are described. A safe working stress for this type of pad is suggested. An account is given of some component approval tests in which tension pads were used.

N-44434*

Aeronautical Research Council (Gt. Brit.)
THE THEORETICAL WAVE DRAG OF OPEN-NOSE AXISYMMETRICAL FOREBODIES WITH VARYING FINENESS RATIO, AREA RATIO AND NOSE ANGLE. J. H. Willis and D. G. Randall. 1956. 33p. diagrs., tab. (ARC CP 245)

Existing results for the wave drag of open-nose axisymmetrical forebodies are for bodies whose profiles are straight lines or parabolic arcs. These results are here extended to a family of profiles which includes the straight line and the parabolic arc as special cases. Slender body theory is employed throughout.

N-44437*

Aeronautical Research Council (Gt. Brit.)
LOW SPEED WIND TUNNEL CALIBRATION OF A MK. 9A PITOT-STATIC HEAD. J. E. Nethaway. 1956. 7p. diagrs., tab. (ARC CP 244)

This note describes the calibration of a Mark 9A pitot-static head in the No. 2 11-1/4 foot wind tunnel. The results show the variation of pitot and static pressure error coefficients with incidence, at constant tunnel speed.

N-44453*

Aeronautical Research Council (Gt. Brit.)
THE LAMINAR BOUNDARY-LAYER WITH DISTRIBUTED SUCTION ON AN INFINITE YAWED CYLINDER. K. D. P. Sinha. 1956. 54p. diagrs., tabs. (ARC CP 214)

Rott and Crabtree have considered the chordwise boundary-layer flow on a yawed infinite cylinder with chordwise stream velocity $U = cx^m$. They showed that this yields "similar" velocity distributions, and when there is no suction, the spanwise velocity profiles are approximately coincident with the exact Blasius profile, on a scale determined by the ratio of the normal coordinate to the momentum thickness. This phenomenon has been further examined, and an explanation of it is given. The work has been further extended to the case of distributed suction: and numerical solutions have been obtained for the spanwise flow for those cases for which the chordwise solutions were available. Exact analytical solutions of the spanwise flow have also been obtained. The effect of suction on the momentum thickness and displacement thickness is discussed. Finally, the behavior of the spanwise flow in the boundary layer is compared with the chordwise flow, and certain conclusions are drawn for varying pressure gradients.

N-44454*

Aeronautical Research Council (Gt. Brit.)
A CORRECTED SPEED TACHOSCOPE. R. Staniforth. 1956. 15p. diagrs., photos. (ARC CP 224)

It is often desirable in testing aerodynamic compressors to take all readings at fixed corrected speeds rather than true speeds. This corrected speed is defined as the actual shaft speed divided by the square root of the ratio of the absolute air inlet temperature to the standard temperature (288° K). With the instrument described, this is possible with high accuracy (error < 0.1 percent) without further complication than the setting of a dial to the observed air inlet temperature. The latter operation could be dispensed with and the correction obtained directly from a temperature sensitive device such as a thermistor or a resistance thermometer element.

N-44455*

Aeronautical Research Council (Gt. Brit.)
PRESSURE-CABIN DESIGN. A DISCUSSION OF SOME OF THE STRUCTURAL PROBLEMS INVOLVED, WITH SUGGESTIONS FOR THEIR SOLUTION. D. Williams. 51p. diagrs., tab. (ARC CP 226)

The problems that arise in the design of a pressure cabin are almost entirely due to the numerous structural discontinuities that inevitably break up the otherwise smooth distribution of stress. Some of the main discontinuities, such as are caused by windows, doors, canopies, floors, formers, bulkheads, and domes, are discussed here, and design suggestions are made for dealing with them. Particular attention is called to Appendix D and the Addendum based on it, which refers to a scheme for making pressure cabins safe against catastrophic failure with little weight penalty.

N-44456*

Aeronautical Research Council (Gt. Brit.)
DEVELOPMENT OF AN AIR MASS-FLOW RATE METER. W. J. G. Cox. 1956. 47p. diagrs., photos. (ARC CP 230)

The development of a meter to cover a very wide range is described which, essentially an analog computer, gives a two-sweep pointer direct presentation of air mass-flow rate, independent of pressure, temperature, and velocity changes within the range of the instrument. The pointers are driven by a servo system which is error-actuated from the computing bridge network, secondary feedback being employed to maintain stability with a saturated angular output rate of approximately 33° per second. Specifications and performance figures are given for the individual transducer elements and the complete instrument, error estimates are made, and the servo stability is discussed.

N-44457*

Aeronautical Research Council (Gt. Brit.)
AN AUTOMATIC SELF-BALANCING CAPSULE MANOMETER. G. F. Midwood and R. W. Hayward. 1956. 21p. diagrs., photos. (ARC CP 231)

A brief description is given of an automatic self-balancing capsule manometer which has been developed primarily for the measurement of pressures encountered in the operation of supersonic wind tunnels. A remote indicating system is employed which is suitable for use with digital recording and card punching apparatus. The instrument is designed to cover a range of 0-2 atmospheres absolute and has been adjusted and calibrated to give an accuracy of 0.01 inch Hg over the range 0.5 inch Hg to 60 inches Hg absolute.

N-44458*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF LACING WIRE ON AXIAL COMPRESSOR STAGE PERFORMANCE AT LOW SPEEDS. S. J. Andrews and H. Ogden. 1956. 21p. diagrs. (ARC CP 225)

Four stages of free vortex blades were tested at low speed in the 106 compressor to determine the effects of lacing wire upon stage efficiency and temperature rise. With lacing wire of 0.14 in. diameter in the rotor and stator, and with blades of height $2\frac{1}{2}$ in., the loss in stage efficiency is about 12 percent, but if 0.14-in. diameter tubular lacing is deformed within the blade pitch to a more streamlined section of $2\frac{1}{2}$:1 fineness ratio, the drop in stage efficiency would be about 5 percent. It is estimated that for the circular wire 30 percent of the increase in loss is due to the wire drag itself and 70 percent is due to interference by the wire in the normal blade flow.

N-44459*

Aeronautical Research Council (Gt. Brit.)
THE BUCKLING UNDER LONGITUDINAL COMPRESSION OF A SIMPLY SUPPORTED PANEL THAT CHANGES IN THICKNESS ACROSS THE WIDTH. E. C. Capey. 1956. 26p. diagrs. (ARC CP 235)

An exact solution is obtained for the buckling under longitudinal compression of a simply supported panel made up of three strips in which the central strip differs in thickness from the outer strips. The critical buckling stress is calculated numerically for a number of different ratios between thicknesses and widths of the central and outer strips. Some comparative results are given for the case when the longitudinal edges are clamped.

N-44460*

Aeronautical Research Council (Gt. Brit.)
METHODS FOR REDUCING SEAPLANE TAKE-OFF DISTANCES TO STANDARD CONDITIONS. J. A. Hamilton. 1955. 45p. diagrs., photos., tabs. (ARC CP 219)

Methods for reducing seaplane take-off distances to standard conditions of weight, wind, and ambient temperature are developed which are applicable to the waterborne run and to the airborne run up to the 50 ft height point. The methods may be applied to take-off with simulated engine failure. Theoretical results are in good agreement with measurements made on reciprocating engined seaplanes of 9000 lb and 78,000 lb weight for winds up to 20 knots, weight changes of 20 percent and a temperature range of 2 to 32° C. The general application of the corrections should be limited to temperature changes of less than 10° C and wind changes of less than 10 knots. These ranges should be adequate for the majority of flight trials conducted in one location.

N-44461*

Aeronautical Research Council (Gt. Brit.)
VELOCITY CALCULATIONS BY CONFORMAL MAPPING FOR TWO-DIMENSIONAL AEROFOILS. D. A. Spence and N. A. Routledge. 1956. 47p. diagrs., tabs. (ARC CP 241)

A method is derived for computing the conformal transformation between the plane of an airfoil of arbitrary shape (symmetrical or cambered), and the plane of its velocity potential at zero lift (in which the airfoil contour becomes a slit), in order to permit calculations of the velocity at points off the surface. The integral equation which relates the contours is derived by an application of Cauchy's theorem, and solved to the order of the square of thickness ratio. The solution is found by representing the ordinate distribution by a Fourier series. The rapid tailing-off of the Fourier coefficients for all smooth airfoil shapes then leads to high accuracy being achieved with a comparatively small amount of effort.

N-44462*

Aeronautical Research Council (Gt. Brit.)
VARIATIONS IN THE STRENGTH OF ALUMINUM ALLOY SHEET. D. T. Jones. 1956. 10p. diagrs. (ARC CP 229)

In the design of aircraft structures, allowance is made for variation in the material strength of sheet, but the thickness of the sheet is usually assumed to be constant at the nominal value for the gage used. Thickness variation may appreciably affect the tensile strength of nominally identical pieces of sheet, especially when the tolerance range in thickness is wide. A method is given in this note for calculating the distribution of strength when the mean and scatter of material strength and the mean and scatter of thickness of pieces are known. Expressions are given for the mean and scatter in strength of pieces and, for those cases where the distribution of the strength can be taken as normal, design values can readily be deduced from the expressions.

N-44473*

Aeronautical Research Council (Gt. Brit.)
LOADING CONDITIONS FOLLOWING AN AUTOMATIC PILOT FAILURE (RUDDER CHANNEL). D. R. Puttock. 1956. 35p. diagrs., tab. (ARC CP 242)

A method is presented for the determination of the critical loading conditions of aircraft that ensue

from an automatic pilot failure in the rudder channel. General expressions have been derived through response theory for the angle of sideslip, fin-and-rudder load and lateral acceleration both at the c.g. of the aircraft and at the tail, that result from the sequence of rudder movements assumed to follow an automatic pilot failure. Analysis of these general expressions leads to formulas suitable for assessing the numerical values of the critical loading conditions, and it is suggested that these formulas might form a basis for the interpretation of the appropriate design requirement. An example is given to illustrate the type of response produced by a rudder channel failure and the calculation procedure.

N-44474*

Aeronautical Research Council (Gt. Brit.)
REPORT OF THE FIRST YEAR'S FLYING ON THE DEVELOPMENT OF FLIGHT TESTING TECHNIQUES FOR FINDING AND MEASURING NATURAL ICING CONDITIONS. G. C. Abel. 1956. 44p. diagr., photos., tabs. (ARC CP 221)

Results of the first year's flying using a Viking aircraft are given. Special meteorological forecasts of icing conditions have proved to be reasonably reliable. Good photographs of droplets that have been sampled from a cloud can now be obtained at will and they give direct measurement of droplet sizes although, when frozen particles and supercooled droplets are present together, the interpretation of the photograph is still subject to doubt. The rotating disk ice accretion meter, especially when coupled to a Hussenot recorder, has proved, within certain limitations, to be a valuable instrument for measuring both the liquid water content of the cloud and the rate at which ice is building up. The immediate program is outlined and the future program discussed.

N-44475*

Aeronautical Research Council (Gt. Brit.)
WAKE SURVEY AND STRAINGAUGE MEASUREMENTS ON AN INCLINED PROPELLER IN THE R.A.E. 24FT TUNNEL. PART II. COMPARISON OF MEASURED AND CALCULATED 1P STRESSES. R. Doust and E. J. Hellier. 1956. 23p. diagrs. (ARC CP 228)

The general nature of the problem of 1P vibratory stresses has been delt with in part I of this report, together with a description of the instrumentation, test procedure and prediction of the fluctuating loading on the blades. This part of the report deals with the comparison between measured strain-gage results and the values computed from the predicted loadings.

N-44476*

Aeronautical Research Council (Gt. Brit.)
REPORT OF THE THIRD YEAR'S FLYING ON THE DEVELOPMENT OF FLIGHT TESTING TECHNIQUES FOR FINDING AND MEASURING NATURAL ICING CONDITIONS. G. C. Abel. 1956. 27p. diagrs., photos., tabs. (ARC CP 223)

This report covers the third year's search for natural icing conditions together with some results for the whole 3-year period. Flying this year was limited to approximately 4 months. The technique of photographing the leading edge of the tail plane has produced several interesting studies of ice formation. Due partly to the limited flying time no great advance in instrumentation has been achieved this year.

N-44477*

Aeronautical Research Council (Gt. Brit.)
A TECHNIQUE FOR THE MEASUREMENT OF PRESSURE DISTRIBUTION ON OSCILLATING AEROFOILS, WITH RESULTS FOR A RECTANGULAR WING OF ASPECT RATIO 3.3. W. G. Molyneux and F. Ruddlesden. 1956. 24p. diagrs., tabs. (ARC CP 233)

Details are given of a strain-gage pressure transducer developed for this purpose. The transducer characteristics are shown to be well suited to oscillatory measurements, and in particular the transducer output can be measured directly on a sensitive galvanometer without the need for preamplification. Pressure measurements have been made on a rectangular wing oscillating in modes of pitch and roll. Values for the aerodynamic derivatives have been obtained from the integrated pressure distributions and are compared with those derived from overall force measurements and with theoretical values.

N-44550*

Forest Products Research Lab., Dept. of Scientific and Industrial Research (Gt. Brit.) INVESTIGATIONS INTO GLUES AND GLUING. PROGRESS REPORT NINETY-ONE - FEBRUARY 1956. THE COMPARATIVE DURABILITY OF ASSEMBLY GLUES IN ENGLAND AND IN NIGERIA. ANALYSIS AFTER $3\frac{1}{2}$ YEARS EXPOSURE. J. F. S. Carruthers. 9p. tabs. (Supersedes Progress Reports Seventy-Nine - December 1953 and Eighty-Eight - March 1955) (Forest Products Research Lab., Dept. of Scientific and Industrial Research)

The wood tested was African mahogany in "ash tray" specimens using casein, animal, urea-formaldehyde, phenol-formaldehyde, and resorcinol-formaldehyde type glues.

N-44551*

Royal Aircraft Establishment (Gt. Brit.)
FILAMENT LAMP FAILURES IN AIRCRAFT. J. W. Sparke. August 1955. 4p. (RAE Tech. Note EL. 100)

The failure rates of filament lamps in aircraft are becoming excessive, particularly in the rear fuselage and tail region of jet aircraft. It is believed that the primary cause of failure is due to vibration at frequencies above 150 cps. It is not possible to design 28 volt filament lamps to withstand these conditions and the best solution appears to be to use anti-vibration mountings for the lighting fittings. The use of a lower voltage supply for small wattage lamps would improve reliability.

N-44552*

Royal Aircraft Establishment (Gt. Brit.)
A REVIEW OF HEAT TRANSFER DATA ON THE EVAPORATION OF LIQUIDS AT SUB-ATMOSPHERIC PRESSURES. T. D. Patten. April 1956. 22p. diagrs., tab. (RAE Tech.Note Mech.Eng.216)

This note collects the available information on evaporation of liquids, particularly water, at and below normal atmospheric conditions. Attention is drawn to the theories of heat transfer during boiling, of the types likely to be met in practice, and suggestions made for further work. A graph compiled from existing data, which can be used as a rough guide to the heat transfer of boiling water at low pressure, is presented.

N-44554*

Ministry of Supply (Gt. Brit.)
FATIGUE TESTS ON MATERIAL TO SPECIFICATION B. A. C. E. 54 (D. T. D. 551). P. J. Frith. October 18, 1954. 18p. diagrs., photos., tabs. (Ministry of Supply. S & T Memo.16/55)

The tests reported show that material DTD 551 and heat treated to B.A.C.E. specification 54 has excellent mechanical properties with relation to crankshaft design. The high proof stress values, good fatigue properties, particularly in the presence of stress concentration after nitriding, and satisfactory surface hardness in the nitrided condition are eminently suited for highly stressed parts subjected to repeated or alternating loading. Under conditions of combined bending and torsion, the safe stress range for any combination may be calculated with confidence, provided the fatigue limits in bending and torsion have been determined with care.

N-44555*

Ministry of Supply (Gt. Brit.)
INVESTIGATION OF BALL RACE STEELS. January 19, 1955. 8p. diagrs., tabs. (Ministry of Supply. S & T Memo.17/55)

Investigations included (1) hardness tests after various thermal treatments of IU and JJ steels, (2) fatigue tests on JJ steel, and (3) fatigue tests on high speed steel. The results of these tests are given together with details of chemical composition, heat treatment, depth hardness curves obtained after nitriding, coefficient of linear expansion, and density.

N-44556*

Ministry of Supply (Gt. Brit.)
STUDY OF THE FATIGUE PROPERTIES OF SHEET CONFORMING TO SPECIFICATIONS DTD.546B AND DTD.646B WHICH HAS BEEN COLD FORMED TO Z SECTION. 14p. diagrs., photos., tabs. (Ministry of Supply. S & T Memo.18/55)

This report shows that the fatigue strength of Alclad material, DTD 546B was on the average lower than that of uncoated material, DTD 646B, when complete sections were tested, although the results were confused by considerable scatter. At an endurance of 2×10^6 cycles the fatigue strength of DTD 546B sections was ± 4.0 tons/sq in. compared with ± 5.0 tons/sq in. for DTD 646B material. The fatigue strength of the latter sections was approximately the same as that obtained from tests on unmachined Z section extrusion of material conforming to specification DTD 364B. Reversed bending fatigue tests were carried out on small coupons cut from the webs of the sections. The fatigue strength as determined from these tests was higher than that obtained from the complete sections.

N-44557*

Ministry of Supply (Gt. Brit.)
THE INVESTIGATION OF IMPROVED METHODS OF ULTRASONIC FLAW DETECTION. D. O. Sproule and L. H. Wells. 1955. 26p. diagrs., photos. (Ministry of Supply. S & T Memo.19/55)

This report describes the methods evolved for more reliable testing of billets and the extension of these to tackle new materials including cast iron, copper, refractory blocks, and brass billets, which previously were impossible or difficult to inspect with ultrasonics. Single probe and double probe working is discussed. It is shown that both techniques are necessary if a wide range of problems is to be tackled and that any industrial instrument should enable either to be used. Examples are given of a wide range of new probes now available including waterproof types for immersion testing. An alternative form of presentation is described in which a picture in many ways similar to a radiograph is obtained.

N-45557*

Forest Products Research Lab., Dept. of Scientific and Industrial Research (Gt. Brit.) RADIO FREQUENCY AND OTHER HEATING PROCESSES. THE AGEING OF RADIO FREQUENCY SET GLUED JOINTS. PROGRESS REPORT TWELVE, MARCH 1956. J. F. S. Carruthers, P. M. C. Lacey, and G. E. Soane. 6p. diagrs., tabs. (Supersedes Progress Report Eleven, April, 1954) (Forest Products Research Lab., Dept. of Scientific and Industrial Research)

The sample, which consisted of a laminated beech block, was tested by measuring the force needed to separate the laminates on either side of each glue line in turn. The adhesives under test were of the urea-, phenol-, and resorcinol-formaldehyde types and one animal glue.

MISCELLANEOUS

NACA TN 3529

Errata on "THE TRANSONIC CHARACTERISTICS OF 36 SYMMETRICAL WINGS OF VARYING TAPER, ASPECT RATIO, AND THICKNESS AS DETERMINED BY THE TRANSONIC-BUMP TECHNIQUE." Warren H. Nelson, Edwin C. Allen, and Walter J. Krumm. December 1955.

N-45472

THE MEASUREMENT AND ASSESSMENT OF REPEATED LOADS ON AIRPLANE COMPONENTS. Philip Donely. (Presented to the 3rd meeting of the Structures and Materials Panel of Advisory Group for Aeronautical Research and Development, Langley Field, Virginia, April 12, 1956). 37p. diagrs.

An attempt is made to give a unified picture of repeated loads information available through NACA studies. Three load sources and their effectiveness in producing repeated loads are considered as being of possible significance to any airplane. These types are gust, maneuver, and ground loads of airplanes of any type and their components. The discussion is restricted to the more general aspects of each loading and to NACA work. Since work in the field of repeated loads has been concentrated in the past on gust loads, the reader will find that the material is more extensive in regard to gust loads.

UNPUBLISHED PAPERS

N-14408*

TURBULENT FLOW IN CONVERGENT CHANNELS. (Turbulente Strömungen in konvergenten Kanälen). W. Szablewski. 18p. diagrs. (Trans. from Ingenieur-Archiv, v.20, no.1, 1952, p.37-45)

An equation is derived to predict the friction factor for the turbulent incompressible flow of fluid in a converging channel. The empirical coefficients of the logarithmic velocity profile employed for the boundary layer are found to be independent of pressure gradient. Agreement with the experimental results of Nikuradse for half angles of convergence of 2°, 4°, and 8° is good.

N-22676*

INVESTIGATIONS OF BRAKE SYSTEMS ON AUTOMOBILES. (Bremswerkuntersuchungen am Kraftfahrzeug). H. Klaue. May 1956. 68p. diagrs., photos., tabs. (Trans. from Deutsche Kraftfahrtforschung, no.13, 1938, p.1-26)

The decisive factor for utilization of the interlocking forces between wheel and road for the braking of automobiles is the friction coefficient, between brake lining and brake drum on one hand, between tire and road on the other. After detailed theoretical considerations, the brake coefficients utilizable in braking are represented as functions of the slip for various road conditions, and the friction coefficients between brake lining and brake drum are determined. The brake-force distribution and its influence on the attainable braking deceleration are investigated and a brake-force distributor for hydraulic brakes is examined particularly with respect to its locking-preventive effect.

N-29795*

REPRESENTATION OF THE FREE VIBRATIONS OF A WING IN THE WIND WITH THE AID OF THE CONCEPT OF MEMORY. (Représentation des vibrations libres d'une aile dans le vent á l'aide de la notion de la mémoire). R. Mazet. May 1956. 29p. diagrs. (Trans. of Office National d'Etudes et de Récherches Aéronautiques, Note Technique No. 19. 1954)

The free vibrations of a lifting surface in an aerodynamic medium resulting from an arbitrary initial impulse is the problem studied. It is of a certain interest for the determination of the critical speeds since these latter, by definition, separate the case where the free vibration until failure occurs. The object of the note is to show the advantage which one may derive, with regard to a solution of the problem, from the approximate method (the so-called generalized method). It is known that this half-theoretical, half-generalized method has already been successfully applied to the practical study of the behavior of physical systems around their states of equilibrium.

N-45372*

STUDIES OF STRESSES IN RIVETS OF SHELL STRUCTURES. (Studio sulle sollecitazioni nelle chiodature delle strutture a guscio). L. Lazzarino. 21p. diagrs., photos. (Trans. from Aerotecnica, v.21, no.7-8, July-August, 1941, p.1-20)

A study was made of the forces on rivets which attach the stringers and frames to the skin of skin-stringer structures. Formulas for the quantitative evaluation of these forces are given for an unbuckled structure subjected to an arbitrary loading. An approximate analysis of the increase in load in the rivets caused by buckling of the skin is given.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification July 20, 1956.

#NACA MR dated August 31, 1944
#NACA MR L5A25a
#NACA MR L5G04

NACA RM A50H09

THE USE OF AREA SUCTION FOR THE PURPOSE OF DELAYING SEPARATION OF AIR FLOW AT THE LEADING EDGE OF A 63° SWEPT-BACK WING. Woodrow L. Cook, Roy N. Griffin, Jr., and Gerald M. McCormack. November 22, 1950. 68p. diagrs., photo., tab. (NACA RM A50H09)

An investigation was conducted to determine the effectiveness of area suction used to delay the separation of air flow at the leading edge of a 63° swept-back wing. The results obtained indicate that area suction was effective on a wing swept back 63° and increased the wing lift coefficient at which leading-edge air-flow separation first occurred from 0.25 to 0.67. The results also indicate that theory can be used to estimate the spanwise and chordwise extent of area suction necessary but the actual flow coefficient required in this preliminary investigation is considerably greater than that estimated by theory.

NACA RM A50K06

THE EFFECTS OF BOUNDARY-LAYER CONTROL ON THE LONGITUDINAL CHARACTERISTICS OF A SWEPT-BACK WING USING SUCTION THROUGH STREAMWISE SLOTS IN THE OUTBOARD PORTION OF THE WING. Gerald M. McCormack and William H. Tolhurst, Jr. January 5, 1951. 34p. diagrs., photo., tabs. (NACA RM A50K06)

The results are presented of an investigation to determine whether the aerodynamic characteristics of sweptback wings could be improved at lift coefficients below the maximum by the application of suction to short streamwise slots in the forward part of the outboard portion of the wing. The application of boundary-layer control in this simplified form to a 63° sweptback wing delayed the occurrence of detrimental effects of separation from an angle of attack of 8.5° to an angle of attack of 14°. Within this range separation was eliminated and the longitudinal characteristics of the wing were improved. Beyond this range separation occurred inboard of the slots and nullified the effects of boundary-layer control.

NACA RM A51G24

EXPERIMENTAL AND THEORETICAL STUDY OF THE EFFECTS OF BODY SIZE ON THE AERODYNAMIC CHARACTERISTICS OF AN ASPECT RATIO 3.0 WING-BODY COMBINATION. Edward J. Hopkins and Hubert C. Carel. October 1951. 52p. diagrs., photos., tabs. (NACA RM A51G24)

Measurements of the forces and moments were made for a wing (aspect ratio 3.0), for three geometrically similar bodies of revolution (fineness ratio 12.5), for the wing in the presence of each of the bodies, and for the wing combined with each of the bodies. The ratios of body diameter to wing span were 0.196, 0.259, and 0.343. Good agreement between the experimental and calculated results was obtained by including the velocities induced by the body on the wing and the velocities induced by the wing on the body in the theoretical analyses.

NACA RM A51J24

THE USE OF AREA SUCTION FOR THE PURPOSE OF DELAYING SEPARATION OF AIR FLOW AT THE LEADING EDGE OF A 63° SWEPT-BACK WING - EFFECTS OF CONTROLLING THE CHORDWISE DISTRIBUTION OF SUCTION-AIR VELOCITIES. Woodrow L. Cook and Mark W. Kelly. January 1952. 51p. diagrs., photo., tab. (NACA RM A51J24)

The results obtained from the investigation of area suction applied to a 63° sweptback wing with an NACA 64A006 section parallel to the plane of symmetry indicate that area suction is effective in preventing leading-edge air-flow separation with the chordwise distributions of suction-air velocities controlled to be equal at all chordwise points. The occurrence of separation was delayed from a lift coefficient of 0.25 to a lift coefficient of 0.77 with a flow coefficient of 0.0034. The results also indicate that area suction was effective when applied with a trailing-edge flap deflected 45°.

NACA RM A52G02

AN INVESTIGATION AT SUBSONIC SPEEDS OF THE ROLLING EFFECTIVENESS OF A SMALL PERFORATED SPOILER ON A WING HAVING 45° OF SWEEPBACK. Angelo Bandettini. September 1952. 37p. diagrs., photos. (NACA RM A52G02)

The report presents the results of an investigation over a Mach number range of 0.25 to 0.96 and at a Reynolds number of 1,500,000 to determine the rolling effectiveness of a partial-span, perforated spoiler. Data were also obtained to determine the influence of the spoiler on the lift coefficient, drag coefficient, and pitching-moment coefficient. The wing had 45° of sweepback of the leading edge, an aspect ratio of 3, and a taper ratio of 0.4. The thickness-chord ratio parallel to the plane of symmetry was 0.03. The spoiler had an average projection of 6.3 percent of the local wing chord and extended over 24.6 percent of the semispan. Rolling-moment data obtained over the Mach number range of the test were used in the prediction of rate of roll. Tests were also made at Reynolds numbers of 3,000,000 and 6,000,000 at a Mach number of 0.25.

NACA RM A52G07

THE EFFECTS OF OSCILLATION AMPLITUDE AND FREQUENCY ON THE EXPERIMENTAL DAMPING IN PITCH OF A TRIANGULAR WING HAVING AN ASPECT RATIO OF 4. Benjamin H. Beam. September 1952. 44p. diagrs., photo., tab. (NACA RM A52G07)

Results are presented of a wind-tunnel investigation of the variation of the damping-in-pitch parameter $C_{m_q} + C_{m_{\dot{\alpha}}}$ with Mach number, Reynolds number, angle of attack, oscillation frequency, oscillation amplitude, and pitching axis for a model triangular wing of aspect ratio 4 and NACA 0006-63 section combined with a slender, sharp-nosed body in the subsonic Mach number range. The results show a large effect of Reynolds number for certain test conditions and a region of dynamic instability at high subsonic Mach numbers.

NACA RM A54G14

EFFECT OF ROTATION OF AN NACA 1-SERIES E-TYPE COWLING ON THE INTERNAL FLOW AND FORCE CHARACTERISTICS OF THE COWLING AT MACH NUMBERS UP TO 0.84 AND AT AN ANGLE OF ATTACK OF 0°. Robert I. Sammonds and Robert M. Reynolds. October 1954. 54p. diagrs., photos., tabs. (NACA RM A54G14)

The pressure recovery and flow angle in the duct, the flow through the cowl gap, and the thrust and torque of an NACA E-type cowl without a propeller are presented for various inlet velocity and advance ratios. All tests were made at a Reynolds number of 1.72 million, based on the maximum diameter of the cowl.

NACA RM A54H09

EXPERIMENTAL AND PREDICTED LONGITUDINAL RESPONSE CHARACTERISTICS OF A LARGE FLEXIBLE 35° SWEPT-WING AIRPLANE AT AN ALTITUDE OF 35,000 FEET. Henry A. Cole, Jr., Stuart C. Brown, and Euclid C. Holleman. November 1954. 63p. diagrs., photo., tabs. (NACA RM A54H09)

Longitudinal dynamic response to elevator motions in the form of frequency response and transfer functions is presented for a large flexible swept-wing airplane over a range of Mach numbers and center-of-gravity locations at an altitude of 35,000 feet. Comparisons are made between predicted transfer functions for the rigid and flexible airplane, and experimental transfer functions evaluated from transient flight data.

NACA RM A54I21

A PRELIMINARY INVESTIGATION OF THE USE OF CIRCULATION CONTROL TO INCREASE THE LIFT OF A 45° SWEPTBACK WING BY SUCTION THROUGH TRAILING-EDGE SLOTS. Woodrow L. Cook, Roy N. Griffin, Jr., and David H. Hickey. December 1954. 56p. diagrs., photo., tabs. (NACA RM A54I21)

The effectiveness of circulation control for increasing lift on a 45° sweptback wing was investigated. Circulation control was accomplished by suction of air through slots at the trailing edge of the wing. The results indicate that appreciable increases in lift can be obtained without change in incidence on a sweptback wing.

NACA RM A55D14

THE EFFECTS OF FLEXIBILITY ON THE LONGITUDINAL AND LATERAL-DIRECTIONAL RESPONSE OF A LARGE AIRPLANE. Henry A. Cole, Jr., Stuart C. Brown, and Euclid C. Holleman. May 1955. 16p. diagrs. (NACA RM A55D14)

Longitudinal response to elevator control and lateral-directional response to aileron and rudder controls are presented in the form of frequency responses and transfer functions for a large flexible swept-wing airplane. Comparisons are made between predicted transfer function coefficients for the rigid and flexible airplane and those evaluated from transient flight data. Acceleration frequency responses to elevator motion for a number of locations on the airplane are compared with the calculated free-free normal modes of the airplane.

NACA RM A55J21

MEASUREMENT OF THE LONGITUDINAL MOMENT OF INERTIA OF A FLEXIBLE AIRPLANE. Henry A. Cole, Jr., and Frances L. Bennion. January 1956. 30p. diagrs., photos., tabs. (NACA RM A55J21)

A method for measuring the longitudinal moment of inertia of a flexible airplane by ground oscillation tests is presented. The effects of flexibility on the fundamental frequency for various combinations of springs and knife edges are shown, and a method which minimizes flexibility effects is developed. A description and results of tests which were conducted by this method are presented.

#NACA RM E7F10a
#NACA RM E7G25
#NACA RM E7J02
#NACA RM E7J20
#NACA RM E8F10
#NACA RM E8F10a
#NACA RM E8F10b
#NACA RM E8F10c
#NACA RM E8F10d

NACA RM E51G13

RELATION OF ENGINE TURBINE-BLADE LIFE TO STRESS-RUPTURE PROPERTIES OF THE ALLOYS, STELLITE 21, HASTELLOY B, CAST S-816, FORGED S-816, X-40, NIMONIC 80, REFRACTALOY 26, N-155, AND INCONEL X. F. B. Garrett and C. Yaker. August 1951. 59p. diagrs., photos., tabs. (NACA RM E51G13)

An investigation was conducted to relate the engine performance of the heat-resistant alloys, Stellite 21, Hastelloy B, cast S-816, forged S-816, X-40, Nimonic 80, Refractaloy 26, N-155, and Inconel X to their stress-rupture properties. The engine test consisted of the repetition of a 20-minute cycle, 15 minutes at rated speed and approximately 5 minutes at idle. The results of the investigation indicated a direct correlation between stress-rupture lift and blade life for the relatively low-strength alloys. The stress-rupture life and blade life for the relatively high-strength alloys did not correlate because of the effects of the vibratory stresses and the corrosive-gas atmosphere.

NACA RM E52C24

EFFECT OF FUEL PROPERTIES ON CARBON DEPOSITION IN ATOMIZING AND PREVAPORIZING TURBOJET COMBUSTORS. Jerrold D. Wear and William P. Cook. June 1952. 21p. photos., diagrs., tabs. (NACA RM E52C24)

Carbon deposition of various fuels obtained in fuel-prevaporizing and fuel-atomizing single tubular combustors was evaluated by smoking tendency, NACA K factor, and function of smoking tendency and volumetric average boiling temperature. The independent effects of change in sulfur, gum, and olefins on

carbon deposition were determined in either or both combustors. NACA K factor and smoking tendency were equally effective in relating carbon deposition from prevaporizing and atomizing combustors. The function of smoking tendency and volumetric average boiling temperature best related the carbon-deposition data obtained in prevaporizing combustor. Increases in sulfur conteht of two or three times and gum content of at least five times the maximum allowed by specification MIL-F-5624A would probably be possible before appreciable increase in carbon deposition would be obtained. Large increases in olefin content had no effect on carbon deposition.

NACA RM E52G07

TEMPERATURE RESPONSE OF TURBINE-BLADE METAL COVERED WITH OXIDE COATINGS SUPPLIED BY FUEL ADDITIVES. Richard J. McCafferty and Helmut F. Butze. August 1952. 20p. diagrs., photos., tab. (NACA RM E52G07)

The effects of turbine-blade oxide coatings, supplied by tetraethyl orthosilicate (producing silicon dioxide) and triamyl borate (producing boric oxide) used as fuel additives, on heat transfer from combustor-exhaust gases in the temperature range of 1400° to 2000° F to an S-816 alloy blade were determined. Results showed that the fuel additives provided that an oxide coating on all metal parts exposed to the exhaust gas and that the coating formed had no measurable effect on blade temperature at either static or transient exhaust-gas temperature conditions.

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NACA RM E52G18

ANALYTICAL PROCEDURES FOR RAPID SELECTION OF COOLANT PASSAGE CONFIGURATIONS FOR AIR-COOLED TURBINE ROTOR BLADES AND FOR EVALUATION OF HEAT-TRANSFER, STRENGTH, AND PRESSURE-LOSS CHARACTERISTICS. Robert R. Ziemer and Henry O. Slone. September 1952. 53p. diagrs., tabs. (NACA RM E52G18)

A method based on geometric factors of the coolant passage was evolved for the rapid selection and evaluation of coolant passage configurations for air-cooled turbine rotor blades. The more promising coolant passage configurations, as selected by the simple blade evaluation criteria, are then analyzed by detailed methods to obtain absolute values of the required cooling-air weight flow, the pressure loss, and the strength characteristics. As a verification of the simple criteria, a comparison was made of three configurations for an air-cooled blade designed for use in a centrifugal-flow-compressor turbojet engine using both the simple criteria and detailed analytical methods. Analytical and experimental blade temperatures for two different coolant passage configurations of a blade used in a turbojet engine with a centrifugal compressor were compared. The simple criteria and the detailed analytical methods were used to select a coolant passage configuration for a turbine blade to be used in a turbojet engine having an axial-flow compressor.

NACA RM E53E14

EFFECT OF CERTAIN COMBINATIONS OF WALL CONTOURING AND DESIGN EXIT VELOCITY DISTRIBUTION ON PREDICTION OF TURBINE-NOZZLE MASS FLOW. Warner L. Stewart, Warren J. Whitney, and Thomas R. Heaton. July 1953. 17p. diagrs., tab. (NACA RM E53E14)

An investigation was conducted to determine if certain combinations of design nozzle-exit velocity distribution and wall contouring, employed to increase annulus area, can alter the three-dimensional flow characteristics such that nozzle mass flow cannot be predicted by ordinary two-dimensional design techniques. Four nozzle configurations with different wall contours and velocity distributions were analyzed in the axial-radial plane (axial symmetry was assumed) to determine the effect of the three-dimensional flow characteristics on the maximum mass flow. The accuracy of the method of analysis was established by comparing the maximum mass flow obtained by analysis with the maximum obtained experimentally. The results of the analysis indicated that two-dimensional design techniques were inadequate for use in predicting mass flow for the nozzle configuration designed for a nontwisted rotor and having a convex inswept inner wall. It was therefore concluded that certain combinations of nozzle-exit velocity distribution and wall contouring employed to vary annulus area can alter the three-dimensional flow characteristics to a point where two-dimensional design techniques are inadequate for predicting mass flow. Consideration of the three-dimensional flow characteristics must therefore be included in the design of nozzles to insure satisfactory turbine performance.

#NACA RM L9L14

NACA RM L50G12

INVESTIGATION OF DOWNWASH, SIDEWASH, AND MACH NUMBER DISTRIBUTION BEHIND A RECTANGULAR WING AT A MACH NUMBER OF 2.41. D. Adamson and William B. Boatright. September 14, 1950. 115p. diagrs., photos., tab. (NACA RM L50G12)

An investigation of the nature of the flow field behind a rectangular circular-arc wing at a Mach number of 2.41 has been made. Pitot- and static-pressure measurements in the flow field behind the wing and detailed pitot surveys throughout the viscous wake were made. The flow direction was measured by means of a weathercocking vane. Theoretical calculations of both sidewash and downwash using Lagerstrom's superposition method have been made and are compared with experiment. Modifications, where they are necessary to bring about better agreement between theory and experiment, are shown and discussed. These include the effect of the finite thickness of the wing and the displacement of the vortex sheet.

NACA RM L51G06

DAMPING IN ROLL OF ROCKET-POWERED TEST VEHICLES HAVING SWEPT, TAPERED WINGS OF LOW ASPECT RATIO. E. Claude Sanders, Jr., and James L. Edmondson. October 1951. 25p. diagrs., photos., tab. (NACA RM L51G06)

Rocket-powered test vehicles were utilized to determine the damping in roll of a group of swept, tapered wings designed for flight in the transonic speed region. The Mach number range of the tests was from approximately 0.7 to 1.4.

NACA RM L51G11

PRELIMINARY INVESTIGATION OF A SUPERSONIC SCOOP INLET DERIVED FROM A CONICAL-SPIKE NOSE INLET. Charles E. Witliff and Robert W. Byrne. September 1951. 25p. diagrs., photos. (NACA RM L51G11)

A preliminary investigation has been conducted on a supersonic scoop inlet derived from a conical-spike nose inlet at Mach numbers of 1.3, 1.6, and 1.9. The influence of the boundary layer ahead of the inlet on the pressure recovery has been investigated. The pressure recovery has been measured for various boundary-layer suction-slot heights and various amounts of suction applied to the slot.

NACA RM L51G18

FLIGHT INVESTIGATION AT SUBSONIC, TRANSONIC, AND SUPERSONIC VELOCITIES OF THE HINGE-MOMENT CHARACTERISTICS, LATERAL-CONTROL EFFECTIVENESS, AND WING DAMPING IN ROLL OF A 60° SWEPTBACK DELTA WING WITH HALF-DELTA TIP AILERONS. (Revised.) C. William Martz and James D. Church. September 1951. 32p. diagrs., photos. (NACA RM L51G18)

Hinge-moment coefficients, damping-in-roll coefficients, aileron rolling-moment coefficients, and lateral-control effectiveness were obtained at zero angle of attack from a free-flight rocket-model test of a 60° sweptback half-delta wing-tip aileron mounted on a 60° sweptback delta wing. The wings were mounted on a pointed cylindrical body and tested over a Mach number range of 0.69 to 1.52 at aileron deflections from -5° to 5°. Comparisons are made with linearized theory and previous rocket-test results.

NACA RM L51K15

THE EFFECTS OF SUCTION THROUGH POROUS LEADING-EDGE SURFACES ON THE AERODYNAMIC CHARACTERISTICS OF A 47.5° SWEPTBACK WING-FUSELAGE COMBINATION AT A REYNOLDS NUMBER OF 4.4 x 10^6. Jerome Pasamanick and William I. Scallion. March 1952. 61p. diagrs., photo., tabs. (NACA RM L51K15)

Results of the investigation in the Langley full-scale tunnel of suction through porous leading-edge surfaces on a wing-fuselage configuration having 47.5° leading-edge sweep are presented. The wing aspect ratio was 3.4; the taper ratio was 0.51; and the airfoil sections normal to the quarter-chord line were NACA 64_1A112. The data include the effects of varying the chordwise and spanwise extent of suction and suction-flow quantities on the force, surface-pressure distribution, and internal flow measurements at zero yaw over a range of angle of attack. The Reynolds number of the tests was 4.4 x 10^6 and corresponds to a Mach number of approximately 0.07.

NACA RM L52D16

A SUMMARY AND ANALYSIS OF THE LOW-SPEED LONGITUDINAL CHARACTERISTICS OF SWEPT WINGS AT HIGH REYNOLDS NUMBER. G. Chester Furlong and James G. McHugh. August 1952. ii, 227p. diagrs., tabs. (NACA RM L52D16)

An analysis of the longitudinal characteristics of swept wings which is based on available large-scale low-speed data and supplemented with low-scale data when feasible is presented. The emphasis has been placed on the differentiation of the characteristics by a differentiation between the basic flow phenomenon involved. Insofar as possible all large-scale data available as of August 15, 1951 have been summarized in tabular form for ready reference.

NACA RM L52G11a

WIND-TUNNEL INVESTIGATION OF THE STATIC LATERAL STABILITY CHARACTERISTICS OF WING-FUSELAGE COMBINATIONS AT HIGH SUBSONIC SPEEDS. SWEEP SERIES. Richard E. Kuhn and Paul G. Fournier. September 1952. 30p. diagrs., photos. (NACA RM L52G11a)

This report presents the aerodynamic characteristics in sideslip of wing-fuselage combinations and of the fuselage alone. The wings have an aspect ratio of 4, taper ratio of 0.6, sweep angles from 3.6° to 60° at the quarter-chord line, and a 65A006 airfoil section. The tests covered a Reynolds number range from 2 million to 3.5 million, a Mach number range from 0.4 to 0.95, and an angle-of-attack range from -3° to 24°.

NACA RM L52G17

INVESTIGATION AT A MACH NUMBER OF 1.2 OF TWO 45° SWEPTBACK WINGS UTILIZING NACA 2-006 AND NACA 65A006 AIRFOIL SECTIONS. Homer B. Wilson, Jr. September 1952. 20p. diagrs., photo., tab. (NACA RM L52G17)

An investigation has been made to determine the lift, drag, and moment characteristics of a wing employing an airfoil section designed for high maximum lift at low speed (NACA 2-006) and having 45° sweepback, aspect ratio 4, and taper ratio 0.6. A similar wing with the NACA 65A006 airfoil section was also investigated to provide comparative data. The investigation was made at a Mach number of 1.2 and Reynolds numbers of 1.0 x 10^6 and 3.0 x 10^6 or 3.5 x 10^6. The gains at low speed associated with the use of the NACA 2-006 section can be obtained without penalty at Mach numbers of the order of 1.2, at least for the type of wing plan form considered in the present investigation.

NACA RM L52G18a

AERODYNAMIC LOAD MEASUREMENTS OVER A LEADING-EDGE SLAT ON A 40° SWEPTBACK WING AT MACH NUMBERS FROM 0.10 TO 0.91. Jones F. Cahill and Robert J. Nuber. September 1952. 32p. diagrs., photos., tab. (NACA RM L52G18a)

Data are presented showing the aerodynamic loads on a partial-span leading-edge slat on a 40° sweptback wing having NACA 64_1-112 airfoil sections perpendicular to the 0.273-chord line at Mach numbers from 0.10 to 0.91. Loads for the slat-retracted configuration were obtained from surface pressure measurements, and for the slat-extended condition from strain-gage balance readings. Slat load data cover a range of attack from zero lift to nearly maximum lift.

NACA RM L52L17

NACA 65-SERIES COMPRESSOR ROTOR PERFORMANCE WITH VARYING ANNULUS-AREA RATIO, SOLIDITY, BLADE ANGLE, AND REYNOLDS NUMBER AND COMPARISON WITH CASCADE RESULTS. Wallace M. Schulze, John R. Erwin, and George C. Ashby, Jr. February 1953. 62p. diagrs., photos., tab. (NACA RM L52L17)

An axial-flow compressor rotor was tested at low speed and without guide vanes or stators in a 28-inch test compressor. The rotor was designed for a free-vortex type blade loading using NACA 65-series 10-percent-thick airfoil sections. In these tests, the effects of changes of blade-setting angle, annulus area ratio, solidity and Reynolds number on rotor performance were determined for a range of quantity flows. Rotor data are compared with estimations based on uncorrected and corrected cascade data.

NACA RM L53A09a

INVESTIGATION OF THE EFFECTS OF LEADING-EDGE CHORD-EXTENSIONS AND FENCES IN COMBINATION WITH LEADING-EDGE FLAPS ON THE AERODYNAMIC CHARACTERISTICS AT MACH NUMBERS FROM 0.40 TO 0.93 OF A 45° SWEPTBACK WING OF ASPECT RATIO 4. Kenneth P. Spreemann and William J. Alford, Jr. February 1953. 46p. diagrs., photo., tabs. (NACA RM L53A09a)

An investigation was conducted in the Langley high-speed 7- by 10-foot tunnel over a Mach number range of 0.40 to 0.93 to determine the effects of a number of wing leading-edge modifications and fences on the aerodynamic characteristics in pitch of a wing-fuselage combination with the wing quarter-chord line swept back 45°, aspect ratio 4.0, taper ratio 0.3, and an NACA 65A006 airfoil section. Lift, drag, and pitching moment were obtained for all configurations over an angle-of-attack range of about -2° to 24°.

NACA RM L53G06

RESULTS OF MEASUREMENTS OF MAXIMUM LIFT AND BUFFETING INTENSITIES OBTAINED DURING FLIGHT INVESTIGATION OF THE NORTHROP X-4 RESEARCH AIRPLANE. Thomas F. Baker. August 1953. 22p. diagrs., photos., tab. (NACA RM L53G06)

The variation of the intensity of buffeting experienced throughout the operational region of the semitailless Northrop X-4 airplane and the values of maximum and peak normal-force coefficients in the Mach number range from 0.42 to 0.92 have been determined. The results are compared with data obtained with the swept-wing Douglas D-558-II airplane.

NACA RM L53G06a

MEASUREMENTS OF FLUCTUATING PRESSURES ON THE WINGS AND BODY OF A SWEPTBACK WING-BODY COMBINATION IN THE LANGLEY 16-FOOT TRANSONIC TUNNEL. Louis W. Habel and Donald R. Bowman. September 1953. 24p. diagrs., photos. (NACA RM L53G06a)

Results are presented from tests to determine the pressure fluctuations at eight locations on the body and one location on each wing of a sweptback wing-body combination in the Langley 16-foot transonic tunnel. Four model configurations were tested: the basic configuration, the wing-aft configuration for which the wing was effectively shifted about one wing root chord towards the rear of the body, a wing-leading-edge chord-extension configuration, and a wing leading-edge slat configuration.

NACA RM L53G09

STATIC LATERAL STABILITY CHARACTERISTICS OF AN AIRPLANE MODEL HAVING A 47.7° SWEPTBACK WING OF ASPECT RATIO 6 AND THE CONTRIBUTION OF VARIOUS MODEL COMPONENTS AT A REYNOLDS NUMBER OF 4.45×10^6. Roland F. Griner. September 1953. 83p. diagrs., photos., tabs. (NACA RM L53G09)

Presented herein are the results of an investigation conducted in the Langley 19-foot pressure tunnel to determine the low-speed characteristics in yaw of an airplane model and of the model main components at a Reynolds number of 4.45×10^6. The angle-of-yaw and angle-of-attack range are -10° to 29° and -2° to 30°, respectively. Limited studies of scale effect and of the effects of leading-edge flaps, fences, and double-slotted flaps are included. Emphasis is placed on the effectiveness of the sweptback vertical tail, the importance of tail length, and on the effective air flow at the vertical tail behind a fuselage or a midwing-fuselage combination having a 47.7° sweptback wing. Included are limited sidewash-angle and dynamic-pressure-ratio data from airflow surveys in the vicinity of a vertical-tail location behind the wing without the fuselage, the fuselage alone, and the wing-fuselage combination.

NACA RM L53G09a

WIND-TUNNEL INVESTIGATION AT HIGH SUBSONIC SPEEDS OF THE STATIC LONGITUDINAL AND STATIC LATERAL STABILITY CHARACTERISTICS OF A WING-FUSELAGE COMBINATION HAVING A TRIANGULAR WING OF ASPECT RATIO 2.31 AND AN NACA 65A003 AIRFOIL. James W. Wiggins. August 1953. 28p. diagrs., photos. (NACA RM L53G09a)

This paper presents results of an investigation to determine the static longitudinal and static lateral stability characteristics of a wing-fuselage configuration with a delta wing having a leading-edge sweep of 60°, aspect ratio of 2.31, and an NACA 65A003 airfoil section parallel to the fuselage center line. A limited investigation was made to determine the effects of notches in the leading edge of the wing on the static longitudinal stability characteristics.

NACA RM L53G09b

LOW-SPEED INVESTIGATION OF THE AERODYNAMIC, CONTROL, AND HINGE-MOMENT CHARACTERISTICS IN SIDESLIP OF A DELTA-WING-FUSELAGE MODEL WITH HORN-BALANCE-TYPE AILERONS AND WITH AND WITHOUT NACELLES. William I. Scallion. August 1953. 31p. diagrs., photo., tabs. (NACA RM L53G09b)

Results are presented of an investigation to determine the low-speed aerodynamic, control, and control hinge-moment characteristics in sideslip of a 60° sweptback-delta-wing—fuselage combination with horn-balance-type ailerons of 10.2 percent total wing area. The airfoil section was NACA 65A003 and the aspect ratio was 2.31. The model was tested with and without chord-plane nacelles at several angles of attack and sideslip. The Reynolds number was 2.3×10^6 and the Mach number was 0.10.

NACA RM L53G10b

SOME FLUTTER EXPERIMENTS AT A MACH NUMBER OF 1.3 ON CANTILEVER WINGS WITH TUBULAR AND CLOSED BODIES AT THE TIPS. John Locke McCarty and W. J. Tuovila. October 1953. 17p. diagrs., tab. (NACA RM L53G10b)

Flutter tests of 39 cantilever wings with tubular bodies or closed bodies at the tips have been made in a small intermittent-flow supersonic wind tunnel where the testing technique involved changing the structural parameters so that the combinations would flutter at the tunnel Mach number of 1.3. The experimental results are compared with an analysis that uses two-dimensional supersonic air forces on the wing and tube forces derived from a modified slender body theory. The effects of some parameters on the flutter-speed coefficient are determined from the experimental results.

NACA RM L53G13

INVESTIGATION OF THE EFFECTS OF LEADING-EDGE FLAPS ON THE AERODYNAMIC CHARACTERISTICS IN PITCH AT MACH NUMBERS FROM 0.40 TO 0.93 OF A WING-FUSELAGE CONFIGURATION WITH A 45° SWEPTBACK WING OF ASPECT RATIO 4. Kenneth P. Spreemann and William J. Alford, Jr. August 1953. 36p. diagrs., photo., tabs. (NACA RM L53G13)

An investigation was conducted in the Langley high-speed 7- by 10-foot tunnel over a Mach number range of 0.40 to 0.93 to determine the effects of full-span and various partial-span combinations of leading-edge flaps on the aerodynamic characteristics in pitch of a wing-fuselage combination with the wing quarter-chord line swept back 45°, aspect ratio 4.0, taper ratio 0.3, and an NACA 65A006 airfoil section. Lift, drag, and pitching moments were obtained for all configurations over an angle-of-attack range of about -2° to 24°.

NACA RM L53G14a

WIND-TUNNEL INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS IN PITCH AND SIDESLIP AT HIGH SUBSONIC SPEEDS OF A WING-FUSELAGE COMBINATION HAVING A TRIANGULAR WING OF ASPECT RATIO 4. Paul G. Fournier. August 1953. 23p. diagrs., photos. (NACA RM L53G14a)

This report presents the aerodynamic characteristics in pitch and sideslip at high subsonic speeds of a wing-fuselage combination having a triangular wing of aspect ratio 4, a leading-edge sweep angle of 45°, and with an NACA 65A006 airfoil section parallel to the plane of symmetry. The tests covered a range of Mach number from 0.40 to 0.95, a range of Reynolds number from 2.4×10^6 to 3.9×10^6, and a range of angle of attack from -3° to 24°.

NACA RM L53G21

AN ANALYTICAL STUDY OF SIDESLIP ANGLES AND VERTICAL-TAIL LOADS IN ROLLING PULLOUTS AS AFFECTED BY SOME CHARACTERISTICS OF MODERN HIGH-SPEED AIRPLANE CONFIGURATIONS. Ralph W. Stone, Jr. October 1953. 41p. diagrs., tabs. (NACA RM L53G21)

This paper presents the results of an analytic study of the variations of angle of sideslip in rolling-pullout maneuvers. The effects of variations in yawing-moment stability derivatives and possible errors in these derivatives on sideslip angle are discussed, as are the effects of oscillations in the vertical-tail load.

NACA RM L53G22

FLIGHT MEASUREMENT OF AERODYNAMIC LOADS AND MOMENTS ON AN EXTERNAL STORE MOUNTED UNDER THE WING OF A SWEPT-WING FIGHTER-TYPE AIRPLANE. Thomas C. O'Bryan. November 1953. 25p. diagrs., photo., tab. (NACA RM L53G22)

Flight measurements of external store characteristics have been obtained using a 245-gallon external fuel tank mounted under the wing of a North American F-86A airplane. The external-store normal- and side-load distributions were measured,

by means of an integrating pressure system, at three Mach numbers (M = 0.55, 0.75, and 0.83) for a range of lift coefficients up to the attainment of heavy buffeting. The results are presented in the form of load-coefficient distributions and their corresponding overall force and moment coefficients.

NACA RM L53G29a

DAMPING-IN-PITCH CHARACTERISTICS AT HIGH SUBSONIC AND TRANSONIC SPEEDS OF FOUR 35° SWEPTBACK WINGS. William B. Kemp, Jr., and Robert E. Becht. October 1953. 21p. diagrs., tab. (NACA RM L53G29a)

Free-oscillation tests in pitch have been conducted on four semispan-wing models having an aspect ratio of 3.0, a taper ratio of 0.6, and 35° sweepback of the quarter-chord line. Thickness ratios of 6 percent and 10.5 percent were investigated and two model sizes were used giving maximum Reynolds numbers of about 0.5×10^6 and 4×10^6 at maximum Mach numbers of 1.05 and 0.97, respectively. The effects of leading-edge roughness were determined for each model.

NACA RM L53G31

A PRELIMINARY STUDY BY MEANS OF ELECTRICAL FREQUENCY-ANALYSIS TECHNIQUES OF THE RESPONSE OF AN AIRPLANE STRUCTURE DURING BUFFETING. John E. Yeates, Jr., and Jim Rogers Thompson. December 1953. 41p. diagrs., tab. (NACA RM L53G31)

A study of flight buffeting records was made utilizing electrical frequency analysis techniques in order to investigate in detail the response of an airplane structure during buffeting. It was found that buffeting response occurred principally at the lower natural frequencies of the structure; that the relative amplitude of different modes varied with flight condition; and the response in each mode was not steady but consisted of a series of bursts at random time intervals.

NACA RM L53L23

EXPERIMENTAL INFLUENCE COEFFICIENTS FOR THE DEFLECTION OF THE WING OF A FULL-SCALE, SWEPT-WING BOMBER. Alton P. Mayo and John F. Ward. April 1954. 25p. diagrs., tabs. (NACA RM L53L23)

The results of deflection measurements on the wing of a swept-wing, jet bomber airplane are presented in the form of structural influence coefficients relating the deflection of a system of points on the wing to point loads applied on the wing spars. The procedures used for obtaining the coefficients are presented along with a comparison of wing deflections calculated with experimental influence coefficients and those measured in the manufacturers static proof test. Also presented are curves of wing twist in the streamwise direction due to point loads applied along the wing one-quarter-chord line.

NACA RM L54G01

EXPERIMENTAL INVESTIGATION OF THE FORCES AND MOMENTS DUE TO SIDESLIP OF A SERIES OF TRIANGULAR VERTICAL- AND HORIZONTAL-TAIL COMBINATIONS AT MACH NUMBERS OF 1.62, 1.93, AND 2.41. Donald E. Coletti. August 1954. 32p. diagrs., photo., tabs. (NACA RM L54G01)

An experimental investigation was made at Mach numbers of 1.62, 1.93, and 2.41 of the sideslip derivatives for tail arrangements consisting of a triangular vertical tail attached symmetrically to a triangular horizontal tail. Comparisons are made with the theoretical derivatives presented in NACA TN 3071 and NACA TN 2412.

NACA RM L54G09a

A FLIGHT STUDY OF COMPRESSIBILITY EFFECTS ON THE GUST LOADS OF A 35° SWEPTBACK-WING AIRPLANE. Harry C. Mickleboro and Jack Funk. August 1954. 23p. diagrs., tabs. (NACA RM L54G09a)

A swept-wing airplane was flown at different speeds in rough air to investigate the effects of compressibility or Mach number on gust loads. Data were obtained at a constant altitude over a Mach number range from 0.4 to 0.85. For the test airplane, the measured gust loads increased more rapidly than a direct (one to one) variation with forward speed. The experimental results for the variation of loads with Mach number for the airplane without external tanks were in agreement with calculations based on lift-curve slopes corrected for compressibility and two-dimensional unsteady-lift functions for compressible flow. The addition of external tanks caused a more rapid increase in gust loads with Mach number for the test airplane.

NACA RM L54G12

SOME EFFECTS OF TAIL HEIGHT AND WING PLAN FORM ON THE STATIC LONGITUDINAL STABILITY CHARACTERISTICS OF A SMALL-SCALE MODEL AT HIGH SUBSONIC SPEEDS. Albert G. Few, Jr., and Thomas J. King, Jr. August 1954. 63p. diagrs., photo. (NACA RM L54G12)

The present paper presents some effects of horizontal tail height and wing plan form on the static longitudinal characteristics of a complete model at high subsonic speeds. All wings had an aspect ratio of 3, quarter-chord sweeps of 25°, 30°, and 35°, and NACA 65A004 airfoil sections parallel to free stream. The Mach number range extended from about 0.80 to 0.94 with corresponding Reynolds numbers ranging from about 1.17×10^6 to 1.29×10^6.

NACA RM L54I02

CASCADE INVESTIGATION OF A RELATED SERIES OF 6-PERCENT-THICK GUIDE-VANE PROFILES AND DESIGN CHARTS. James C. Dunavant. November 1954. 48p. diagrs., tabs. (NACA RM L54I02)

A new guide-vane blade series for high critical speeds of improved section characteristics has been derived. Low-speed cascade tests were made of four blade sections of this series at solidities of 0.75, 1.00, and 1.50. From these tests, design angles of attack were selected and are presented as a method of determining camber for guide-vane turning angles as high as 50°. The results of a number of simple computations made to estimate the high-speed characteristics of the blade series are presented.

NACA RM L54L21

LOW-SPEED WIND-TUNNEL INVESTIGATION OF LEADING-EDGE POROUS SUCTION ON A 4-PERCENT-THICK 60° DELTA WING. E. Carson Yates, Jr. March 1955. 73p. diagrs., photo., tabs. (NACA RM L54L21)

A 60° delta-wing–fuselage model employing a 4-percent-thick airfoil section with large leading-edge radius was tested to determine the effectiveness of porous leading-edge suction in delaying and reducing leading-edge separation and the accompanying high drag. Mach numbers for the tests were between 0.06 and 0.20, and Reynolds numbers were between 5.8×10^6 and 17.4×10^6. Lift, drag, pitching moment, and leading-edge pressure-distribution data are given. Fences at the outboard end of the suction area and outboard droop-nose chord-extensions were tested on the delta wing. For some of the tests, the wing tips outboard of the suction area were removed. The resulting clipped wing was also tested with inboard and full-span split flaps.

NACA RM L55B17

FLIGHT TESTS OF A DELTA-WING VERTICALLY RISING AIRPLANE MODEL POWERED BY A DUCTED FAN. Powell M. Lovell, Jr. April 1955. 23p. diagrs., photos., tab. (NACA RM L55B17)

The results of a free-flight investigation of the stability and control characteristics of a delta-wing vertically rising airplane model powered by a ducted fan in take-offs, landings, and in hovering and forward flight are presented. Some effects of various artificial stabilizing devices were determined.

NACA RM L55E18a

INVESTIGATION OF EFFECT OF REDUCTION OF VALVE FRICTION IN A POWER CONTROL SYSTEM BY USE OF A VIBRATOR. William H. Phillips. July 1955. 11p. diagrs., photo. (NACA RM L55E18a)

Brief ground tests were made to determine the effect of reduction of valve friction in a power control system of a fighter airplane by use of a vibrator. The vibrator was found to be an effective means of overcoming adverse effects of valve friction on the control characteristics.

NACA RM L55J05

LOW-SPEED CASCADE INVESTIGATION OF LOADED LEADING-EDGE COMPRESSOR BLADES. James C. Emery. January 1956. 76p. diagrs., photo., tabs. (NACA RM L55J05)

Loaded leading-edge compressor-blade sections have been investigated systematically in cascade at low speed. Blade cambers having isolated-airfoil lift coefficients of 0.6, 1.2, 1.8, and 2.4 were tested over the usable angle-of-attack range for inlet-air angles of 30°, 45°, and 60° at solidities of 1.0 and 1.5. A comparative evaluation has been made of the results of this and previous cascade investigations of compressor blades having uniform chordwise loading as isolated airfoils and those having more loading at the trailing edge.

NACA RM SA8B04
NACA RM SE7L09
NACA RM SL8B12
NACA RM SL8G26
NACA RM SL9B24

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1246

THE HYDRODYNAMIC CHARACTERISTICS OF MODIFIED RECTANGULAR FLAT PLATES HAVING ASPECT RATIOS OF 1.00, 0.25, AND 0.125 AND OPERATING NEAR A FREE WATER SURFACE. Kenneth L. Wadlin, John A. Ramsen, and Victor L. Vaughan, Jr. 1955. ii, 50p. diagrs., photos. (NACA Rept. 1246. Supersedes TN 3079; TN 3249)

Results are presented from an investigation of the hydrodynamic forces and moments acting on modified rectangular flat plates with aspect ratios of 1.00, 0.25, and 0.125 mounted on a single strut and operating near the free water surface. A simplified method of obtaining the lift characteristics in unseparated flow at large depths is presented. The experimental effects of changing the angle of attack, depth of submersion, and aspect ratio are presented. The effects of cavitation and two types of high-angle leading-edge separation are also presented.

NACA Rept. 1248

AN EXPERIMENTAL STUDY OF APPLIED GROUND LOADS IN LANDING. Benjamin Milwitzky, Dean C. Lindquist, and Dexter M. Potter. 1955. ii, 34p. diagrs., photos., tab. (NACA Rept. 1248. Supersedes and extends TN 3246)

This report presents a study of the applied ground loads and the coefficient of friction during wheel spin-up in impacts of a small landing gear under controlled conditions on a concrete landing strip in the Langley impact basin. The basic investigation included impacts with forward speed, impacts with forward speed and reverse wheel rotation to simulate higher horizontal velocities, and spin-up drop tests. The effects of wheel prerotation to reduce the relative horizontal velocity were also investigated. An attempt has been made to interpret the experimental data so as to obtain an insight into the physical phenomena involved in the wheel spin-up process, particularly the factors which influence the magnitude and variation of the coefficient of friction between the tire and the ground.

NACA RM L56G10

MODEL DITCHING INVESTIGATION OF A JET TRANSPORT AIRPLANE WITH VARIOUS ENGINE INSTALLATIONS. William C. Thompson. August 1956. 27p. diagrs., photos., tabs. (NACA RM L56G10)

The ditching characteristics of a jet transport airplane with various engine configurations were investigated in Langley tank No. 2. A dynamic model was used to determine the probable ditching behavior in calm water and the best ditching procedure. Various conditions of damage, engine installations, landing attitude, and speed were investigated. Data were obtained from visual observations, acceleration records, and motion pictures.

NACA TM 1395

THE FATIGUE STRENGTH OF RIVETED JOINTS AND LUGS. (De vermoeiingssterkte van Klinkverbindingen en pengatverbindingen). J. Schijve. August 1956. 54p. diagrs., tabs. (NACA TM 1395. Trans. of Nationaal Luchtvaartlaboratorium, Rapport M.1952, May 1954)

This report deals with a number of tests on riveted joints and lugs for the primary purpose of comparing the several types of riveted joints and to study the effect of various factors on the fatigue strength of lugs. A check was made to ascertain whether or not an estimate of the fatigue life at a certain loading could be made from the dimensions of the joint and the fatigue data of the unnotched material. Recommendations are made on the proportioning of joints to obtain better fatigue behavior.

NACA TM 1423

SAFEGUARDS AGAINST FLUTTER OF AIRPLANES. (Précautions a prendre pour éviter les vibrations aérodynamiques des avions. I - Voilure. II - Empennages). Gerhard De Vries. August 1956. 94p. diagrs. (NACA TM 1423. Trans. from: La Recherche Aéronautique, no.12, 1949, p.15-30. La Recherche Aéronautique, no.13, 1950, p.27-43)

This report is a compilation of practical rules, derived both from theory and from experience, intended to guide the aeronautical engineer in the design of flutter-free airplanes. Rules applicable to the wing, the ailerons, the flaps, tabs, tail surfaces, and fuselage are discussed. Five appendixes are included.

NACA TN 3273

COMPRESSIBILITY FACTOR, DENSITY, SPECIFIC HEAT, ENTHALPY, ENTROPY, FREE-ENERGY FUNCTION, VISCOSITY, AND THERMAL CONDUCTIVITY OF STEAM. Lilla Fano, John H. Hubbell, and Charles W. Beckett, National Bureau of Standards. August 1956. 61p. diagrs., tabs. (NACA TN 3273)

The NBS-NACA tables of thermal properties of steam are grouped together for convenient use. They include the compressibility factor, density, specific heat at constant pressure, enthalpy, entropy, free-energy function, viscosity, and thermal conductivity for the real gas and the specific heat, enthalpy, entropy, and free-energy function for the ideal gas. Conversion factors to frequently used units are given to facilitate use of the tables in dimensionless form.

NACA TN 3276

PROPERTIES OF AIRCRAFT FUELS. Henry C. Barnett and Robert R. Hibbard. August 1956. 152p. diagrs., tabs. (NACA TN 3276. Supersedes RM E53A21; RM E53I16)

The primary objective of this report is to collect fuel data that should aid in the design of aircraft fuel systems. It includes a survey of recent production jet fuels and shows the ranges of fuel properties which can be encountered for each grade of fuel. The effect of temperature and pressure on many of these properties is given. In the future fuel oils may be used in jet aircraft; and, therefore, these fuels have also been treated. In addition there are discussions on the development of jet fuel specifications and the pertinence of fuel properties to fuel-system design. The practical problems associated with the use of aircraft fuels are also discussed.

NACA TN 3278

ATTENUATION IN A SHOCK TUBE DUE TO UNSTEADY-BOUNDARY-LAYER ACTION. Harold Mirels. August 1956. 60p. diagrs. (NACA TN 3278)

A method is presented for obtaining the attenuation of a shock wave in a shock tube due to the unsteady boundary layer along the shock-tube walls. It is assumed that the boundary layer is thin relative to the tube diameter and induces one-dimensional longitudinal pressure waves whose strength is proportional to the vertical velocity at the edge of the boundary layer. The method is shown to be in reasonably good agreement with existing experimental data.

NACA TN 3656

A SELF-BALANCING LINE-REVERSAL PYROMETER. Donald Buchele. August 1956. 68p. diagrs., photos., tabs. (NACA TN 3656)

A self-balancing line-reversal pyrometer is described that measures gas temperatures from 2900° to 4500° R. Its two optical components are a reflector and a fully enclosed unit containing a projection lamp, spectroscope, and photoelectric detector of line reversal. An automatic balancing mechanism permits remote operation by semiskilled personnel. Local-temperature measurements can be made by injection of a narrow stream of sodium-containing powder into the gas from a probe upstream of the point of measurement. In a comparison with a thermocouple pyrometer and a pneumatic-probe pyrometer, the average deviation of the line-reversal method from the mean of all measurements was 60° R.

NACA TN 3694

METHOD FOR CALCULATING THE AERODYNAMIC LOADING ON AN OSCILLATING FINITE WING IN SUBSONIC AND SONIC FLOW. Harry L. Runyan and Donald S. Woolston. August 1956. 76p. diagrs., tabs. (NACA TN 3694)

A method is presented for calculating the loading on a finite wing oscillating in subsonic or sonic flow. The method is applicable to any plan form and may be used for determining the loading on deformed wings. The procedure is approximate and requires a numerical integration over the wing surface.

NACA TN 3723

CALCULATIONS OF THE FLOW OVER AN INCLINED FLAT PLATE AT FREE-STREAM MACH NUMBER 1. Walter G. Vincenti, Cleo B. Wagoner, and Newman H. Fisher, Jr. August 1956. 70p. diagrs., tabs. (NACA TN 3723)

A numerical solution is given of the complete equations of inviscid compressible flow for the case of an inclined flat plate at free-stream Mach number 1. The calculations are carried as far as the end of the separated region that appears on the upper surface of the plate near the leading edge. The results, which are for an angle of attack of 13°, show the pressure distribution on the lower surface and the detailed flow field about the lower surface and the leading edge.

NACA TN 3724

CHARACTERISTICS OF FOUR NOSE INLETS AS MEASURED AT MACH NUMBERS BETWEEN 1.4 AND 2.0. George B. Brajnikoff and Arthur W. Rogers. August 1956. 48p. diagrs., photos. (NACA TN 3724. Supersedes RM A51C12)

The performance characteristics of two open-nose and two conical-shock diffusers were measured at supersonic speeds between $M_0 = 1.4$ and 2.0 at angles of attack of 0°, 3°, 6°, and 9°. Schlieren photographs of flow about the models at 0° angle of attack were used to calculate external wave drag; these values of drag agreed well with those obtained by direct force measurements after addition of skin-friction drag, except in cases of reduced mass-flow ratios.

NACA TN 3726

COMPRESSIVE AND TORSIONAL BUCKLING OF THIN-WALL CYLINDERS IN YIELD REGION. George Gerard, New York University. August 1956. 42p. diagrs., tabs. (NACA TN 3726)

Based on assumptions which have led to the best agreement between theory and test data on inelastic buckling of flat plates, a general set of equilibrium differential equations for the plastic buckling of cylinders has been derived. These equations have been used to obtain solutions for the compressive and torsional buckling of long cylinders in the yield region. Test data are presented which indicate satisfactory agreement with the theoretical plasticity-reduction factors in most cases.

NACA TN 3727

INFLUENCE OF HOT-WORKING CONDITIONS ON HIGH-TEMPERATURE PROPERTIES OF A HEAT-RESISTANT ALLOY. John F. Ewing and J. W. Freeman, University of Michigan. August 1956. 134p. diagrs., photos., tabs. (NACA TN 3727)

A study was made to determine the influence of various hot-working conditions on the high-temperature properties of a heat-resistant alloy. The effects of hot-working on response to subsequent heat treatment were also studied. The working conditions varied were temperature, amount of reduction, and a combination of both. The evaluation of the effects of rolling was based on rupture and creep tests, hardness measurements, microstructural examination, and lattice-parameter measurements.

NACA TN 3728

STUDY OF ALUMINUM DEFORMATION BY ELECTRON MICROSCOPY. A. P. Young, C. W. Melton, and C. M. Schwartz, Battelle Memorial Institute. August 1956. 39p. diagrs., photos. (NACA TN 3728)

The slip-line structure in a series of aluminum single crystals at various stages during deformation was examined in an electron microscope. The slip-line structure was also investigated in crystals strained after various degrees of prestraining. On the basis of the data from this study and from other investigations a theory is proposed for the deformation mechanism in aluminum crystals. The possible effects of short-range ordering on deformation modes are discussed.

NACA TN 3729

MECHANICAL TESTS ON SPECIMENS FROM LARGE ALUMINUM-ALLOY FORGINGS. James A. Miller and Alfred L. Albert, National Bureau of Standards. August 1956. 25p. diagrs., photos., tabs. (NACA TN 3729)

Results of tensile and bend tests on specimens in the T6 condition from 12- by 12- by 24-inch hand forgings of 7075 (75S) and 2014 (14S) aluminum alloy are presented. Properties are given for specimens from various locations within the forgings as well as for specimens oriented in both the longitudinal and transverse directions.

NACA TN 3730

THE INTERFERENCE EFFECTS OF A BODY ON THE SPANWISE LOAD DISTRIBUTIONS OF TWO 45° SWEPTBACK WINGS OF ASPECT RATIO 8.02 FROM LOW-SPEED TESTS. Albert P. Martina. August 1956. 47p. diagrs., photo., tabs. (NACA TN 3730. Supersedes RM L51K23)

Tests of two wing-body combinations have been conducted in the Langley 19-foot pressure tunnel at a Reynolds number of 4×10^6 to determine the effects of the bodies on the wing span load distributions. The wings had aspect ratios of 8.02, taper ratios of 0.45, and incorporated 12-percent-thick airfoil sections streamwise. One wing was untwisted and uncambered; the second wing was twisted and cambered. Identical bodies of revolution of 10:1 fineness ratio were mounted in mid-high-wing positions. The effects of wing incidence, wing fences, and flaps were determined for the plane wing.

NACA TN 3733

PROBABILITY AND FREQUENCY CHARACTERISTICS OF SOME FLIGHT BUFFET LOADS. Wilber B. Huston and T. H. Skopinski. August 1956. 52p. diagrs., tabs. (NACA TN 3733)

The frequency characteristics and statistical properties of the buffet loads measured on the unswept wing and tail of a fighter airplane have been studied in the stall and in the shock regime. The results indicate that the wing loads in buffeting can be treated as the Gaussian response of a simple elastic system. The tail loads appear to represent a more complicated process.

NACA TN 3736

POISSON'S RATIOS AND VOLUME CHANGES FOR PLASTICALLY ORTHOTROPIC MATERIAL. Elbridge Z. Stowell and Richard A. Pride. August 1956. 28p. diagrs., photos. (NACA TN 3736)

Measurements of Poisson's ratios have been made in three orthogonal directions on aluminum-alloy blocks in compression and on stainless-steel sheet in both tension and compression. These measurements, as well as those obtained by density determinations, show that there is no permanent plastic change in volume within the accuracy of observation. A method is suggested whereby a correlation may be effected between the measured individual values of the Poisson's ratios and the stress-strain curves for the material. Allowance must be made for the difference in the stress-strain curves in tension and compression; this difference, wherever it appears, is accompanied by significant changes in the Poisson's ratios.

NACA TN 3738

THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE SUBSONIC-FLOW FIELDS BENEATH SWEPT AND UNSWEPT WINGS WITH TABLES OF VORTEX-INDUCED VELOCITIES. William J. Alford, Jr. August 1956. 91p. diagrs., photo., tabs. (NACA TN 3738)

The flow characteristics around swept and unswept wings necessary in first-order estimations of aerodynamic loadings, trajectories, and jettison characteristics of missiles, fuel tanks, or bombs as determined experimentally are compared with the flow fields as calculated by potential-flow theory. The theoretical predictions of the flow-field characteristics were qualitatively correct in all cases considered, although there were indications that the magnitude of the downwash angles tended to be overpredicted as the tip of the swept wing was approached and that the sidewash angles ahead of the swept wing were underpredicted.

NACA TN 3742

TENSILE PROPERTIES OF HK31XA-H24 MAGNESIUM-ALLOY SHEET UNDER RAPID-HEATING CONDITIONS AND CONSTANT ELEVATED TEMPERATURES. Thomas W. Gibbs. August 1956. 20p. diagrs., tabs. (NACA TN 3742)

Specimens of HK31XA-H24 magnesium-alloy sheet from an experimental batch were heated to failure at nominal temperature rates from 0.2° F to 100° F per second under constant-load conditions. Rapid-heating yield and rupture stresses are presented and compared with the yield and ultimate stresses from elevated-temperature tensile stress-strain tests for 1/2-hour exposure. Linear temperature-rate parameters were used to correlate rapid-heating results by constructing master curves which can be used for predicting yield stresses and temperatures and for estimating rupture stresses and temperatures.

NACA TN 3757

TORSIONAL INSTABILITY OF HINGED FLANGES STIFFENED BY LIPS AND BULBS. George Gerard, New York University. August 1956. 12p. diagrs. (NACA TN 3757)

Based on torsional instability theory, buckling charts are presented for determining the critical strain of hinged flanges stiffened by idealized lip and bulb elements.

NACA TN 3759

ANALYSIS OF LAMINAR INCOMPRESSIBLE FLOW IN SEMIPOROUS CHANNELS. Patrick L. Donoughe. August 1956. 25p. diagrs., tabs. (NACA TN 3759)

Perturbation solutions for laminar incompressible flow in semiporous and fully porous channels are compared. The perturbation parameter measures the amount of suction or blowing at the porous wall. The velocity profile and the wall friction parameter are more affected by suction or blowing for the semiporous channel than for the fully porous channel. For blowing through the wall, the pressure decreases in channel direction for both channels; with sufficiently high suction rates, the analysis showed that the pressure rises in flow direction for the fully porous channel.

NACA TN 3760

AERODYNAMIC MIXING DOWNSTREAM FROM LINE SOURCE OF HEAT IN HIGH-INTENSITY SOUND FIELD. William R. Mickelsen and Lionel V. Baldwin. August 1956. (ii), 75p. diagrs., photos. (NACA TN 3760)

Theory and measurement showed that the heat wake downstream from a line source is displaced by a transverse standing sound wave in a manner similar to a flag waving in a harmonic mode. With a 147 db, 104 cps standing wave, time-mean temperatures were reduced by an order of magnitude except near the displacement-pattern nodal points. The theory showed that a 161 db, 520 cps standing wave considerably increased the mixing in both the time-mean and instantaneous senses.

BRITISH REPORTS

N-44472*

Aeronautical Research Council (Gt. Brit.)
AN INVESTIGATION OF HIGH ALTITUDE CRUISING CONDITIONS FOR TURBO-JET AIRCRAFT. R. T. Shields, J. Stephenson, and I. E. Utting. 1956. 35p. diagrs., tab. (ARC CP 215)

Specific air range has been measured on the Ashton MK.1 at high altitude using differing techniques. A "quasi-level" procedure consisting of runs at constant speed involving a small rate of climb or descent is recommended for performance measurements near the optimum range conditions and any speed below about m = 1.2. Optimum specific range for the Ashton is obtained at the theoretically predicted conditions for an aircraft cruising below its drag critical Mach number, that is, maximum rpm and m = 1.2; increase of air temperature reduces this specific air range by about 1-3/4 percent per 10° C. An appendix derives and discusses the conditions for maximum specific air range, the argument being extended to the case with compressibility drag effects.

N-44558A*

National Gas Turbine Establishment (Gt. Brit.)
SOME FURTHER JET FLAP EXPERIMENTS.
N. A. Dimmock. May 1956. 70p. diagrs., photos., tabs. (NGTE Memo. M.255)

Results are given of tests on the same airfoil which was used for an earlier work and which had a 12-5 percent thick elliptical cross section with a narrow full-span jet slot. This time, however, the jet deflection is 58.1° from the chord line. In addition to the measurement of the forces and moments acting on the model, the flow pattern in the vicinity of the airfoil was revealed with smoke filaments and was recorded photographically. A comparison with the theory of the previous report is drawn where appropriate and additional support is given to the thrust hypothesis. A check on the effects of RN variation and of the addition of transition wires to the model confirmed the results of the previous experiments. The influence of ground proximity on lift, center of lift position and thrust was investigated and found to be substantial.

N-44670*

Aeronautical Research Council (Gt. Brit.)
ABSTRACTS OF PAPERS PUBLISHED EXTERNALLY. 1955. 10p. (ARC R & M 2916)

N-44671*

Aeronautical Research Council (Gt. Brit.)
ALTERNATING PRESSURES AND BLADE STRESSES IN AN AXIAL-FLOW COMPRESSOR. J. R. Forshaw, H. Taylor, and R. Chaplin. 29p. diagrs., photos., tabs. (ARC R & M 2846; ARC 14,509. Supersedes NGTE R. 92)

An investigation has been made into the origin of the forces exciting vibration in an axial-flow compressor, and their magnitude relative to the calculated gas bending loads. The blade stresses resulting from these forces were measured, and a value obtained for the energy input to a blade when vibrating in the predominant modes under running conditions. The experimental data were obtained from pressure elements and strain gages fitted to the inlet guide vanes and first four stator-blade rows of an early compressor.

N-44673*

Aeronautical Research Council (Gt. Brit.)
PRELIMINARY LOW SPEED WIND TUNNEL TESTS ON FLAT PLATES AND AIR BRAKES: FLOW, VIBRATION AND BALANCE MEASUREMENTS.
R. Fail, T. B. Owen, and R. C. W. Eyre. 1956. 45p. diagrs., tabs. (ARC CP 251)

Flow measurements were made behind sharp edged flat plates (a) at 90° for various shapes, and (b) for a square plate over an incidence range. Measurements of velocity fluctuations were made for (b), showing that a regular shedding of turbulent eddies occurs for $\theta = 50°$ and over, but stops by 40°. Lift, drag, and pitching-moment increments were measured on a square plate mounted on (a) a long cylinder and (b) near the end of several shapes of rear fuselage, to see how the moments on opening the brake could be modified. Comparative tests were made on a cascade brake.

N-44674*

Aeronautical Research Council (Gt. Brit.)
RELATIVE ACCURACY OF DEFLECTIONS AND BENDING MOMENTS (OR STRESSES) DERIVED BY THE METHOD OF R. A. E. REPORT NO. STRUCTURES 168. D. Williams. 1956. 11p. diagrs., tabs. (ARC CP 254)

The relative accuracies of moments and deflections, as derived by the method (ref. 1) are discussed, and it is shown that moments are not expected in general to be less accurate than the deflections.

N-44675*

Aeronautical Research Council (Gt. Brit.)
MEASUREMENTS OF PITCHING MOMENT DERIVATIVES FOR A SERIES OF RECTANGULAR WINGS AT LOW WIND SPEEDS. P. R. Guyett and D. E. G. Poulter. 1956. 52p. diagrs., tabs. (ARC CP 249)

The direct aerodynamic moments for pitching oscillations have been measured on a series of rectangular wings having aspect ratios between 2 and 8 for axis positions at the wing leading edges and trailing edges. Two of the wings were also tested with single end plates which were aerodynamically effective in doubling the wing geometric aspect ratio. The measurements were made at low speeds in an open jet wind tunnel and covered the range of frequency parameter (based on wing chord) 0.13 to 0.39. The results are in general agreement with theoretical results due to Lawrence and Gerber. Similar tests were also made on a wing fitted with two end plates in an attempt to obtain results for two-dimensional flow.

N-44676*

Aeronautical Research Council (Gt. Brit.)
INVESTIGATION OF HIGH LENGTH/BEAM RATIO SEAPLANE HULLS WITH HIGH BEAM LOADINGS. HYDRODYNAMIC STABILITY. PART 21. SOME NOTES ON THE EFFECT OF WAVES ON LONGITUDINAL STABILITY CHARACTERISTICS. D. M. Ridland. 1956. 58p. diagrs., tabs. (ARC CP 237)

Results are given of tests on three models of the series, designed to provide information on the correlation between stability with disturbance and stability in waves. No correlation was observed, but the results are analyzed and compared with previous work, and some important general conclusions drawn as to the nature of disturbed stability and the behavior of flying boats in waves.

N-44677*

Aeronautical Research Council (Gt. Brit.)
INVESTIGATION OF HIGH LENGTH/BEAM RATIO SEAPLANE HULLS WITH HIGH BEAM LOADINGS. HYDRODYNAMIC STABILITY. PART 13. THE EFFECT OF AFTERBODY ANGLE ON STABILITY AND SPRAY CHARACTERISTICS. D. M. Ridland. 1956. 30p. diagrs., photos., tabs. (ARC CP 236)

The effects of afterbody angle on longitudinal stability, spray, and directional stability characteristics and elevator effectiveness are deduced from the results of tests on three models of the series which were alike in every major respect except that of afterbody angle. The models have afterbody angles of 4°, 6°, and 8°, respectively. It was found that increasing afterbody angle improved longitudinal stability characteristics considerably, both with and without disturbance, increased trim generally, gave a slight improvement in spray and directional stability characteristics, and increased elevator effectiveness. The best hydrodynamic configuration was that with the 8° afterbody angle.

N-44678*

Aeronautical Inspection Directorate (Gt. Brit.)
A SPECTROPHOTOMETRIC METHOD FOR THE DETERMINATION OF UNSATURATED LINKAGES IN ALKENYL SILANE TREATED GLASS FABRIC. E. J. McLauchlan and B. Bedford. February 1956. 6p. diagr., tabs. (AID Chem. 7)

A method for the determination of unsaturated linkages in alkenyl silane treated glass fabric by the absorption of bromine from a standard solution is described. The residual bromine is extracted and determined spectrophotometrically. An estimate of the amount of finish on the glass fabric may also be obtained.

N-44682*

Royal Aircraft Establishment (Gt. Brit.)
AERODYNAMIC DERIVATIVES FOR TWO CROPPED DELTA WINGS AND ONE ARROWHEAD WING OSCILLATING IN DISTORTION MODES. D. L. Woodcock. April 1956. 69p. tabs. (RAE Structures 201)

Aerodynamic derivatives are given for three particular plan forms oscillating with symmetric distortion modes in incompressible flow. The plan forms are: (1) a cropped delta wing of aspect ratio 3 and taper ratio 1/7; (2) a cropped delta wing of aspect ratio 1.2 and taper ratio 1/7; and (3) an arrowhead wing of aspect ratio 1.32, taper ratio 7/18, and angle of sweep of 63.4^{o} at the quarter chord. The results are for modes of the form $|\eta|^{n}$ for $n = 0(1)4$ where η is a nondimensional spanwise coordinate. They have been determined from intermediate results which D. E. Lehrian had earlier obtained by the vortex lattice method. The results are compared, for some cases, with the corresponding values given by very low-aspect-ratio theory.

N-44683*

Royal Aircraft Establishment (Gt. Brit.)
THE TIMING OF THE ATTEMPT ON THE WORLD AIRSPEED RECORD AT FORD ON 10th MARCH, 1956. N. E. G. Hill, W. Goldsmith, and T. H. Kerr. Appendix VI: MEASUREMENT OF POSITION ERROR ON THE FAIREY DELTA 2 (WG. 774). T. H. Kerr. Appendix VII: DATA REDUCTION FOR THE ANALYSIS OF HEIGHT DURING THE WORLD SPEED RECORD ATTEMPT. T. H. Kerr. May 1956. 38p. diagrs., photos., tabs. (RAE Instn. 9)

On March 10, 1956, Mr. L. P. Twiss flying in a Fairey Delta 2 airplane attempted to establish a new world airspeed record at unrestricted altitude. The attempt was made at a height of about 38,000 feet, over a course 15.6 kilometers long near Ford and Chichester, Sussex, and was timed by a team of R. A. E. engineers who determined the speeds achieved by the airplane, and the variations of height during the attempt. The results show that Mr. Twiss kept his airplane within the height tolerances permitted by the F. A. I. Code Sportif, and that his mean speed for two successive transits of the course in opposite directions was 1822 km/hr (1132 statute miles/hr). The global margin of error of the measurement of speed was 0.033 percent at the 99 percent confidence level.

N-44684*

Royal Aircraft Establishment (Gt. Brit.)
IMPROVED EQUIPMENT FOR TIMING WORLD AIRSPEED RECORDS AT HIGH ALTITUDE. N. E. G. Hill and W. Goldsmith. April 1956. 35p. diagrs., photos. (RAE Instn. 6)

Advances in supersonic flight made it necessary to prepare new timing equipment in anticipation of the first British attempt at high altitude on the world airspeed record under the F. A. I. rules. Various techniques of speed measurement were considered, and the photographic camera and chronometer method was chosen although its use is restricted to clear sky conditions. A camera and an electronic chronometer were specially designed and made for the purpose, and are described in some detail in this report; the technique of setting up, calibrating, and using the equipment, and the monitoring of an airplane's height during a speed record attempt, are also described. An analysis of the random errors to be expected in the distance and time measurements suggests that determination of speed with a margin of error of 1 in 2000 should be possible at a height of 40,000 feet. At greater heights larger errors are to be expected.

N-44690*

Aeronautical Research Council (Gt. Brit.)
SOME TESTS ON THE SPREAD OF VELOCITY IN A COLD JET DISCHARGING WITH EXCESS PRESSURE FROM A SONIC EXIT INTO STILL AIR. J. Seddon and L. Haverty. 1956. 15p. diagrs., photos. (ARC CP 246)

This spread has been examined over the range 40 to 200 diameters from the exit. Jet pressure ratios (outside static pressure + jet total pressure) were

from 0.479 to 0.042, corresponding to isentropic Mach numbers from 1.08 to 2.72. Rates of spread are not greatly different from that for a subsonic jet. The effective exit of an underexpanded jet is, however, displaced some distance downstream of the actual exit. For a jet of isentropic Mach number 1.51, the effective exit position is about 8 diameters downstream and the half-velocity circles lie on a cone of semiangle 5.7° from the center of the effective exit.

MISCELLANEOUS

NACA TN 3205

Errata on "THEORETICAL INVESTIGATION AT SUBSONIC SPEEDS OF THE FLOW AHEAD OF A SLENDER INCLINED PARABOLIC-ARC BODY OF REVOLUTION AND CORRELATION WITH EXPERIMENTAL DATA OBTAINED AT LOW SPEEDS." William Letko and Edward C. B. Danforth, III. July 1954.

N-35894, v. 1, v. 2, & v. 3

REVISION I TO VOLUME 1, 2, AND 3 OF ADVISORY GROUP FOR AERONAUTICAL RESEARCH AND DEVELOPMENT FLIGHT TEST MANUALS.

UNPUBLISHED PAPERS

N-45680*

National Bureau of Standards. THE CREEP BAHAVIOR OF STRUCTURAL JOINTS OF AIRCRAFT MATERIALS UNDER CONSTANT LOADS AND TEMPERATURES. Leonard Mordfin and Alvin C. Legate. April 20, 1955. 33p. diagrs., tabs. (National Bureau of Standards. Rept. 4052)

A method is described by which the time to rupture and the mode of rupture may be predicted. This method utilizes creep rupture data on the materials from which the joint is fabricated, and its accuracy is within the scatter of the materials data. It is shown that the stress concentrations and the interactions between the tensile, shear, and bearing stresses in a joint do not affect the time to rupture. The test data also indicate that the creep rupture properties of spotwelds are different from those of the parent material. The relative merits of various methods of predicting the times to rupture of joints are discussed.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification August 16, 1956.

NACA MR dated April 18, 1944

NACA RM A51H02

LIFT, DRAG, AND PITCHING MOMENT OF LOW-ASPECT-RATIO WINGS AT SUBSONIC AND SUPERSONIC SPEEDS - PLANE TRIANGULAR WING OF ASPECT RATIO 3 WITH NACA 0003-63 SECTION. John C. Heitmeyer. September 1951. 20p. diagrs. (NACA RM A51H02)

This report presents the results of an investigation to ascertain the lift, drag, and pitching moment of a wing-body combination, having a triangular wing of aspect ratio 3 with NACA 0003-63 sections in streamwise planes. Results are shown for Mach numbers from 0.60 to 0.92 and from 1.20 to 1.70 at a Reynolds number of 4.80 million. The variations of the characteristics with Reynolds number are also shown for several Mach numbers.

NACA RM A51H10

LIFT, DRAG, AND PITCHING MOMENT OF LOW-ASPECT-RATIO WINGS AT SUBSONIC AND SUPERSONIC SPEEDS - PLANE 45° SWEPT-BACK WING OF ASPECT RATIO 3, TAPER RATIO 0.4 WITH 3-PERCENT-THICK, BICONVEX SECTION. John C. Heitmeyer. September 1951. 20p. diagrs. (NACA RM A51H10)

This report presents the results of an investigation to ascertain the lift, drag, and pitching moment of a wing-body combination, having a plane 45° sweptback wing of aspect ratio 3 and taper ratio 0.4 with 3-percent-thick biconvex sections in streamwise planes. Results are shown for Mach numbers from 0.60 to 0.92 and from 1.20 to 1.70 at a Reynolds number of 3.83 million. The variation of the characteristics with Reynolds number is also shown for several Mach numbers.

NACA RM A51H22

LIFT, DRAG, AND PITCHING MOMENT OF LOW-ASPECT-RATIO WINGS AT SUBSONIC AND SUPERSONIC SPEEDS - BODY OF REVOLUTION. John C. Heitmeyer. October 1951. 10p. diagrs. (NACA RM A51H22)

This report presents the results of an investigation to ascertain the lift, drag, and pitching moment of a body of revolution. Results are shown for Mach numbers from 0.60 to 0.92 and from 1.20 to 1.70 at Reynolds numbers of 0.64 million, 1.02 million, and 1.59 million.

NACA RM A54H12a

THE EFFECT OF WING PROFILE ON THE TRANSONIC CHARACTERISTICS OF RECTANGULAR AND TRIANGULAR WINGS HAVING ASPECT RATIOS OF 3 - TRANSONIC BUMP TECHNIQUE. Warren H. Nelson and Joseph L. Frank. October 1954. 33p. diagrs., photo., tab. (NACA RM A54H12a)

Lift, drag, and pitching-moment data are compared for five wings having NACA 63A004, NACA 2-004, and circular-arc profiles. The Mach number range of the tests, in general, was from 0.6 to 1.10 with a Reynolds number range of 1.7 million to 2.8 million. The results indicate that in the transonic Mach number range, these variations in profile had no major effects on the wing characteristics.

NACA RM A54H26

TESTS IN THE AMES 40- BY 80-FOOT WIND TUNNEL OF THE AERODYNAMIC CHARACTERISTICS OF AIRPLANE MODELS WITH PLAIN SPOILER AILERONS. Ralph W. Franks. December 1954. 47p. diagrs., photo., tabs. (NACA RM A54H26)

Data are presented of tests of four wing plan forms equipped with plain spoiler ailerons. For most of the tests the spoilers were mounted along the 70-percent-chord line normal to the wing surface. They were of constant-percent-chord height. Heights of 5-, 10-, and 15-percent chord were tested. The tests were made at Reynolds numbers from 7 to 13 million and at Mach number of 0.13. The data are presented without discussion.

NACA RM A54H26a

THE APPLICATION OF A SIMPLIFIED LIFTING-SURFACE THEORY TO THE PREDICTION OF THE ROLLING EFFECTIVENESS OF PLAIN SPOILER AILERONS AT SUBSONIC SPEEDS. Ralph W. Franks. December 1954. 29p. diagrs., tab. (NACA RM A54H26a)

A method is described for predicting the subsonic rolling effectiveness at zero angle of attack of spoiler ailerons on straight or sweptback wings. A simplified lifting-surface flap theory is used in conjunction with two-dimensional spoiler data and an empirical factor for the effective spanwise location on swept wings. A comparison is made of the predicted rolling moments with experimentally obtained values.

NACA RM E8H24

NACA RM E51H17

AERODYNAMIC CHARACTERISTICS OF A SLENDER CONE-CYLINDER BODY OF REVOLUTION AT A MACH NUMBER OF 3.85. John R. Jack. November 1951. 24p. diagrs., photos. (NACA RM E51H17)

An experimental investigation of the aerodynamics of a slender cone-cylinder body of revolution was conducted at a Mach number of 3.85 for angles of attack of 0° to 10° and a Reynolds number of 3.85×10^{6}. Boundary-layer measurements at zero angle of attack are compared with the compressible-flow formulations for predicting laminar boundary-layer characteristics. Comparison of experimental pressure and force values with theoretical values showed relatively good agreement for small angles of attack. The measured mean skin-friction coefficients agreed well with theoretical values obtained for laminar flow over cones.

NACA RM E51H21

PRELIMINARY INVESTIGATION OF COOLING-AIR EJECTOR PERFORMANCE AT PRESSURE RATIOS FROM 1 TO 10. C. W. Ellis, D. P. Hollister, and A. F. Sargent, Jr. October 1951. 21p. diagrs. (NACA RM E51H21)

Preliminary investigation was made of conical cooling-air ejectors at primary pressure ratios from 1 to 10. The cooling-air flow was maintained at zero and the resulting pressure variation in the shroud indicated pumping ability. The gross thrusts of the ejector and nozzle were compared. Several ratios of the spacing between the nozzle and shroud exit to the nozzle exit diameter were investigated for several shroud to nozzle exit diameter ratios. Maximum gross thrust loss occurred under conditions of zero cooling-air flow and was as much as 35 percent below nozzle jet thrust. For minimum thrust loss, ejectors should be designed with as low diameter and spacing ratio as possible.

NACA RM E52H21

EFFECT OF FUEL ADDITIVES ON CARBON DEPOSITION IN A J33 SINGLE COMBUSTOR. I - THREE METALLIC-ORGANIC ADDITIVES. Edmund R. Jonash, Jerrold D. Wear, and William P. Cook. October 1952. 12p. diagrs., photos., tabs. (NACA RM E52H21)

An investigation was conducted in a J33 single combustor to determine the effects of three fuel additives on the carbon-deposition characteristics of MIL-F-5624A fuel, grades JP-3 and JP-4, and an aromatic fuel blend. The additives considered included a commercial fuel-oil additive (containing cobalt and lead compounds), tetraethyl lead, and lead naphthenate. The combustor was operated for 4-hour periods at simulated full-scale operating conditions at 90 percent of normal rated engine speed, zero Mach number, and 20,000-foot altitude. Small concentrations of all additives reduced carbon deposition significantly. A 0.1-percent concentration of the

fuel-oil additive in JP-3 fuel reduced carbon deposition 23 percent. Of the two lead additives tested, lead naphthenate was the more effective; a 0.005-percent concentration of this additive reduced the carbon deposition obtained with a highly aromatic fuel blend 66 percent. For at least two of the additives tested, there appeared to be optimum concentrations; larger concentrations caused significant metallic-compound deposition which was included in the reported deposition. The effectiveness of the lead naphthenate additive varied considerably for two widely different fuels considered, an aromatic fuel blend and a JP-4 fuel.

NACA RM E54E21
National Advisory Committee for Aeronautics.
INVESTIGATION OF MECHANICAL FASTENINGS FOR SOLID TURBINE BLADES MADE FROM DUCTILE MATERIALS. André J. Meyer, Jr., Albert Kaufman, and W. C. Caywood. August 1954. 45p. diagrs., photos., tabs. (NACA RM E54E21)

Three fir-tree root designs were evaluated in short- and long-time pull tests at temperatures up to 1500° F. The root strength was found to depend on the cross-sectional areas carrying the load and not on the size or number of serrations. The strengths correlated well with the properties of the root materials.

NACA RM E54H12
National Advisory Committee for Aeronautics.
ANALYTICAL DETERMINATION OF EFFECT OF TURBINE COOLING-AIR-IMPELLER PERFORMANCE ON ENGINE PERFORMANCE AND COMPARISON OF EXPERIMENTALLY DETERMINED PERFORMANCE OF IMPELLERS WITH AND WITHOUT INDUCER VANES. Louis J. Schafer, Jr., and Robert O. Hickel. October 1954. 44p. diagrs., photos. (NACA RM E54H12)

An analysis was made of the effect of impeller performance on turbojet-engine thrust and specific fuel consumption for two coolant-flow ratios at 70 and 100 percent of rated engine speed. Experimentally determined total-pressure ratios across two cooling-air impellers having different designs, one with straight radial vanes and the other with an inducer section at the vane inlet, were compared over a range of engine speed and cooling-air weight flow. The analysis showed a small effect of impeller performance.

NACA RM E54H20
National Advisory Committee for Aeronautics.
METHOD OF DESIGNING CORRUGATED SURFACES HAVING MAXIMUM COOLING EFFECTIVENESS WITHIN PRESSURE-DROP LIMITATIONS FOR APPLICATION TO COOLED TURBINE BLADES. Henry O. Slone, James E. Hubbartt, and Vernon L. Arne. December 1954. 103p. diagrs., tab., charts. (NACA RM E54H20)

A method utilizing charts is presented for the systematic determination of a corrugation geometry configuration which, for a specific application to an air-cooled turbine blade, gives the required amount of blade temperature reduction using the minimum amount of coolant flow within pressure-drop limitations. The cooling effectiveness varies appreciably with changes in corrugation geometry, and these changes may be reflected in improvements in the coolant flow and pressure requirements for air-cooled turbine blades. A numerical example is included to illustrate use of the method.

NACA RM E54H23
National Advisory Committee for Aeronautics.
EFFECT OF FUEL ADDITIVES ON CARBON DEPOSITION IN A J33 SINGLE COMBUSTOR. II - SEVEN COMMERCIAL ORGANO-METALLIC ADDITIVES. Vincent F. Hlavin and William P. Cook. November 1954. 12p. diagrs., photos., tabs. (NACA RM E54H23)

Investigations with seven organo-metallic additives in a No. 2 furnace oil (NACA fuel 53-193) and additional tests with two of these additives in a minimum quality MIL-F-5624A, grade JP-4, fuel (NACA fuel 54-41) were conducted to determine their effectiveness in reducing carbon deposits in a J33 single combustor operating at zero flight Mach number, 20,000-foot altitude, and 90-percent rated speed for a 4-hour period. Six of the seven additives in concentrations of 1/4 to 1 gallon per 1000 gallons of fuel reduced carbon deposits of the furnace oil more than 60 percent. The two additives in the JP-4 fuel were less effective in reducing carbon than when used in the furnace oil.

NACA RM E55F30a
National Advisory Committee for Aeronautics.
EFFECT OF FUEL ADDITIVES ON CARBON DEPOSITION IN A J33 SINGLE COMBUSTOR. III - FIVE ORGANO-METALLIC ADDITIVES. Edmund R. Jonash and William P. Cook. September 1955. 11p. diagrs., photos., tabs. (NACA RM E55F30a)

The effectiveness of three commercial additives containing lead and two organo-metallic compounds, cadmium naphthenate and dicyclopentadienyliron, in reducing carbon formation of a low-volatility jet-type fuel was studied in a single turbojet combustor. The largest reduction in carbon deposits, about 80 percent, was obtained with dicyclopentadienyliron. The commercial additives were somewhat less effective, and cadmium naphthenate was ineffective. None of the additives affected exhaust-gas-smoke concentration.

NACA RM L9H05
National Advisory Committee for Aeronautics.
CONTROL EFFECTIVENESS LOAD AND HINGE-MOMENT CHARACTERISTICS OF A TIP CONTROL SURFACE ON A DELTA WING AT A MACH NUMBER OF 1.9. D. William Conner and Ellery B. May, Jr. October 7, 1949. 41p. diagrs., photo. (NACA RM L9H05)

A half-delta control flap composing the outer one-third of a semispan delta wing swept back 60° was tested at control deflections up to 12° and at small angles of attack in the Langley 9- by 12-inch supersonic blowdown tunnel. Aerodynamic data were obtained for the complete wing and for the control alone tested in the presence of the wing. The test Reynolds number was 4×10^6. Comparison is made with rocket test results and with linearized theory.

NACA RM L9H26
National Advisory Committee for Aeronautics.
CONTROL EFFECTIVENESS AND HINGE-MOMENT CHARACTERISTICS OF A TIP CONTROL SURFACE ON A LOW-ASPECT-RATIO POINTED WING AT A MACH NUMBER OF 1.9. D. William Conner and Ellery B. May, Jr. October 5, 1949. 28p. diagrs., photo. (NACA RM L9H26)

A control flap composing the outer 28 percent of a pointed semispan wing of aspect ratio 1.7 was tested through a range of control deflections and at small angles of attack in the Langley 9- by 12-inch supersonic blowdown tunnel. Aerodynamic data were obtained for the complete wing, while normal-force and hinge-moment data were obtained for the control surface. The test Reynolds number was 4,900,000. Comparison is made with test results of a similar wing-control-surface configuration having different conditions of trailing-edge sweep.

NACA RM L9H30
National Advisory Committee for Aeronautics.
FLIGHT INVESTIGATION FROM HIGH SUBSONIC TO SUPERSONIC SPEEDS TO DETERMINE THE ZERO-LIFT DRAG OF A TRANSONIC RESEARCH VEHICLE HAVING WINGS OF 45° SWEEPBACK, ASPECT RATIO 4, TAPER RATIO 0.6, AND NACA 65A006 AIRFOIL SECTIONS. Ellis Katz. October 27, 1949. 16p. diagrs., photos., tab. (NACA RM L9H30)

Rocket-powered flight tests were made at high subsonic, transonic, and supersonic speeds and at high Reynolds numbers to determine the zero-lift drag and base pressure of a transonic wing-body and body-alone configuration. The test wing was of 45° sweepback, aspect ratio 4, taper ratio 0.6, and NACA 65A006 airfoil section. The body had a fineness ratio of 10 and a frontal area equal to 6.06 percent of the wing-plan-form area.

NACA RM L9K25a
National Advisory Committee for Aeronautics.
PRELIMINARY RESULTS FROM A FREE-FLIGHT INVESTIGATION AT TRANSONIC AND SUPERSONIC SPEEDS OF THE LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF AN AIRPLANE CONFIGURATION WITH A THIN STRAIGHT WING OF ASPECT RATIO 3. Clarence L. Gillis, Robert F. Peck, and A. James Vitale. February 14, 1950. 53p. diagrs., photos., tabs. (NACA RM L9K25a)

A flight test was conducted on a rocket-propelled airplane model having a thin straight tapered wing of aspect ratio 3 and hexagonal airfoil sections. The Mach number range covered was from 0.75 to 1.42. Aerodynamic derivatives defining the longitudinal stability, control, trim, and drag characteristics of the configuration were obtained over all or part of this Mach number range. The variation of the various aerodynamic quantities with Mach number in the transonic region was fairly gradual, no unusual stability or control problems being encountered.

NACA RM L50H17
National Advisory Committee for Aeronautics.
INVESTIGATION OF THE DYNAMIC LONGITUDINAL STABILITY OF TWO EQUAL-SIZE MODELS COUPLED IN TANDEM WITH A SINGLE JOINT. PRELIMINARY MODEL FLIGHT TESTS. Robert E. Shanks and David Grana. November 13, 1950. 14p. diagrs., tab. (NACA RM L50H17)

A flight investigation was conducted in the Langley free-flight tunnel to determine the effect of three geometric and mass parameters on the dynamic longitudinal stability of two models of equal size coupled together in tandem. The parameters studied were the amount of aerodynamic restraint on the change in relative angle of pitch between the models, the ratio of the weight of the rear model to that of the front model, and the static stability of the front model.

NACA RM L50H22a
National Advisory Committee for Aeronautics.
BUFFETING INFORMATION OBTAINED FROM ROCKET-PROPELLED AIRPLANE MODELS HAVING THIN UNSWEPT WINGS. Clarence L. Gillis. October 18, 1950. 15p. diagrs., photos. (NACA RM L50H22a)

Flight tests were conducted on rocket-propelled models of an airplane configuration having an unswept low-aspect-ratio wing with 4.5-percent-thick hexagonal airfoil sections. A high positive lift-coefficient range was covered in the Mach number range from 0.75 to 1.35. In the subsonic range some maximum-lift and buffeting information was obtained. Buffeting occurred at a lift coefficient only a little below the maximum. At Mach numbers of 1.0 and above no evidence of buffeting appeared in the lift-coefficient range covered in the tests.

NACA RM L51H06
National Advisory Committee for Aeronautics.
EFFECTS OF REYNOLDS NUMBER ON THE AERODYNAMIC CHARACTERISTICS OF A DELTA WING AT MACH NUMBER OF 2.41. John E. Hatch, Jr., and L. Keith Hargrave. October 1951. 36p. diagrs., photos., tab. (NACA RM L51H06)

The results of an experimental investigation to determine the effects of Reynolds number on force and pressure data of a delta wing at a Mach number of 2.41 are presented. The wing had 68.6° sweepback of the leading edge and an aspect ratio of 1.57. Streamwise airfoil sections of the wing are based on the NACA 00-thickness series with a modified leading edge radius.

NACA RM L51L10
National Advisory Committee for Aeronautics.
WIND-TUNNEL INVESTIGATION AT HIGH SUBSONIC SPEEDS OF SPOILERS OF LARGE PROJECTION ON AN NACA 65A006 WING WITH QUARTER-CHORD LINE SWEPT BACK 32.6°. Raymond D. Vogler. January 1952. 31p. diagrs., tab. (NACA RM L51L10)

Contains the results of a wind-tunnel investigation at high subsonic speeds and angles of attack up to

20° to determine the effects of inboard spoilers having projections up to 25 percent of the wing chord on the aerodynamic characteristics of a wing-fuselage combination with a wing having the quarter-chord line swept back 32.6° and an NACA 65A006 section. Included are measurements of lift, drag, rolling, pitching, and yawing moments, and some comparisons with plain outboard ailerons.

NACA RM L52H05
National Advisory Committee for Aeronautics.
THE USE OF THE ROLLED-UP VORTEX CONCEPT FOR PREDICTING WING-TAIL INTERFERENCE AND COMPARISON WITH EXPERIMENT AT MACH NUMBER OF 1.62 FOR A SERIES OF MISSILE CONFIGURATIONS HAVING TANDEM CRUCIFORM LIFTING SURFACES. Carl E. Grigsby. September 1952. 41p. diagrs., photos. (NACA RM L52H05)

The method for predicting wing-tail interference whereby the trailing vortex system behind lifting wings is replaced by fully rolled-up vortices has been applied to the calculation of tail efficiency parameters, lift characteristics, and center-of-pressure locations for a series of generalized missile configurations. The calculations have been carried out with assumed and experimental vortex locations, and comparisons made with experimental data.

NACA RM L52H06
National Advisory Committee for Aeronautics.
ROCKET-MODEL INVESTIGATION TO DETERMINE THE FORCE AND HINGE-MOMENT CHARACTERISTICS OF A HALF-DELTA TIP CONTROL ON A 59° SWEPTBACK DELTA WING BETWEEN MACH NUMBERS OF 0.55 AND 1.43. C. William Martz, James D. Church, and John W. Goslee. October 1952. 53p. diagrs., photos., tab.
(NACA RM L52H06)

Control-force and hinge-moment characteristics were obtained from a free-flight test of a rocket-powered model equipped with 60° sweptback half-delta tip controls mounted on a 59° sweptback delta wing. Data were obtained for deflections up to ±10° and for angles of attack from ±3° to ±11° between the Mach numbers of 0.55 and 1.43. Comparisons are made with linearized theory and other rocket-test results.

NACA RM L52H08a
National Advisory Committee for Aeronautics.
AN INVESTIGATION AT TRANSONIC SPEEDS OF THE AERODYNAMIC CHARACTERISTICS OF AN AIR INLET INSTALLED IN THE ROOT OF A 45° SWEPTBACK WING. Robert R. Howell and Arvid L. Keith, Jr. October 1952. 47p. diagrs., photos., tabs.
(NACA RM L52H08a)

An investigation has been made in the Langley transonic blowdown tunnel to determine the lift and drag increments due to installation of a triangular-shaped air inlet in the root of a 45° sweptback wing and to study the internal flow characteristics of the inlet. The tests were conducted for a Mach number range from 0.80 to 1.41 at a Reynolds number of approximately 6.5 x 10^6. The measurements included total-pressure recovery at the inlet and at an assumed engine compressor-face station and the lift and drag for ranges of angle of attack and inlet mass-flow ratio from -2.0° to 8.2°, and from 0.34 to 0.77, respectively.

NACA RM L52H13
National Advisory Committee for Aeronautics.
CONTROL HINGE-MOMENT AND EFFECTIVENESS CHARACTERISTICS OF A 60° HALF-DELTA TIP CONTROL ON A 60° DELTA WING AT MACH NUMBERS OF 1.41 AND 1.96. Lawrence D. Guy. October 1952. 40p. diagrs., photo., tab.
(NACA RM L52H13)

A wind-tunnel investigation has been made of a half-delta wing-tip control on a semispan 60° delta-wing—fuselage combination at Mach numbers of 1.41 and 1.96 and at Reynolds numbers of 2.4 and 2.0, respectively. Control-surface hinge moments and bending moments, as well as aerodynamic characteristics of the complete wing-fuselage combination, were obtained throughout a maximum control-deflection range of ±30° and at angles of attack as high as 24°. Comparison is made with previous wind-tunnel test results and with linearized theory. A mathematical analysis of the optical system, used to measure control-surface hinge moments and bending moments, is included in the appendix.

NACA RM L52H14
National Advisory Committee for Aeronautics.
THE LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A 60° DELTA-WING MISSILE HAVING HALF-DELTA TIP CONTROLS AS OBTAINED FROM A FREE-FLIGHT INVESTIGATION AT TRANSONIC AND SUPERSONIC SPEEDS. Martin T. Moul and Hal T. Baber, Jr. October 1952. 35p. diagrs., photos. (NACA RM L52H14)

A 60° delta-wing missile configuration having half-delta tip controls has been flight-tested by means of a rocket-propelled model. The square-wave pulsed-control technique was utilized to determine longitudinal stability derivatives, control effectiveness, and drag characteristics as the model decelerated through the Mach number range 1.65 to 0.70.

NACA RM L52H15
National Advisory Committee for Aeronautics.
PRELIMINARY TANK TESTS OF SOME HYDRO-SKI-WHEEL COMBINATIONS IN THE PLANING CONDITION. Norman S. Land and Rudolph E. Fontana. October 1952. 71p. diagrs. (NACA RM L52H15)

A preliminary investigation was made of the planing characteristics of a few combinations of a wheel and a hydro-ski. The models that were tested included at least two values of the following parameters: Diameter of wheel, width of wheel, cross-section shape of wheel, fore-and-aft location of wheel, lateral location of wheel, gap between wheel and ski, rotation of wheel, protrusion of wheel, and dead rise of ski. The data gathered are presented in the form of plots of resistance, trimming moment, and wetted length against speed at various values of load and trim.

NACA RM L52H18
National Advisory Committee for Aeronautics.
SOME EFFECTS OF SPOILER HEIGHT, WING FLEXIBILITY, AND WING THICKNESS ON ROLLING EFFECTIVENESS AND DRAG OF UNSWEPT WINGS AT MACH NUMBERS BETWEEN 0.4 AND 1.7.
E. M. Fields. October 1952. 20p. diagrs., photo.
(NACA RM L52H18)

Rolling effectiveness and drag tests have been conducted over the Mach number range from 0.4 to 1.7 by the Langley Pilotless Aircraft Research Division utilizing rocket-propelled test vehicles in free flight. The wings with an aspect ratio of 3.7 were unswept and untapered, varied in thickness ratio from 3 percent to 9 percent, and had full-span, solid, sharp-edge spoilers located at the 0.8-chord line. Increasing the wing flexibility increased the rolling effectiveness at subsonic speeds and decreased it at supersonic speeds. Increasing the spoiler height increased the rolling effectiveness linearly near $M = 1.0$ but the increase was nonlinear at the other speeds tested. The rigid-wing rolling effectiveness of the 3-percent-thick wing, compared with that of the 9-percent-thick wing, was lower at subsonic speeds, higher at low supersonic speeds, and about the same at speeds above $M = 1.3$. The drag generally increased linearly with increased spoiler height except at the lower supersonic speeds.

NACA RM L52H29
National Advisory Committee for Aeronautics.
EFFECTS OF THE SPANWISE, CHORDWISE, AND VERTICAL LOCATION OF AN EXTERNAL STORE ON THE AERODYNAMIC CHARACTERISTICS OF A 60° DELTA WING AT MACH NUMBERS OF 1.41, 1.62, AND 1.96. Carl R. Jacobsen. October 1952. 34p. diagrs. (NACA RM L52H29)

An investigation has been made in the Langley 9- by 12-inch supersonic blowdown tunnel to determine the effects of external store location on the lift, drag, and pitching-moment characteristics of a 60° delta wing at Mach numbers of 1.41, 1.62, and 1.96. The chordwise and vertical location of a store having a Douglas Aircraft Company, Inc., store shape of fineness ratio 8.58 was systematically varied at 40 and 60 percent of the wing semispan. For a wing area of 750 square feet, the store would have sufficient volume to contain about 400 gallons of fuel.

NACA RM L53H04
National Advisory Committee for Aeronautics.
PRESSURE DISTRIBUTIONS ON THREE BODIES OF REVOLUTION TO DETERMINE THE EFFECT OF REYNOLDS NUMBER UP TO AND INCLUDING THE TRANSONIC SPEED RANGE. John M. Swihart and Charles F. Whitcomb. October 1953. 39p. diagrs., photo., tab. (NACA RM L53H04)

The effects of varying Reynolds number on the pressure distribution over a transonic body of revolution are presented. Angles of attack from -2° to 15° were investigated through a Mach number range from 0.60 to 1.09. The Reynolds number based on body length varied from 9×10^6 to 39×10^6, and on maximum diameter from 1.35×10^5 to 4.53×10^5. There were small effects of Reynolds number on the axial pressure distributions of these bodies. These effects were of such a nature as to cause an increase of 0.05 in the normal-force coefficient of the body when tested in the subcritical cross-flow Reynolds number range. A comparison between experimental values of incremental pressure coefficient due to angle of attack and theoretical values was made.

NACA RM L53H14a
National Advisory Committee for Aeronautics.
LOW-SPEED LONGITUDINAL CHARACTERISTICS OF TWO UNSWEPT WINGS OF HEXAGONAL AIRFOIL SECTIONS HAVING ASPECT RATIOS OF 2.5 AND 4.0 WITH FUSELAGE AND WITH HORIZONTAL TAIL LOCATED AT VARIOUS VERTICAL POSITIONS.
William M. Hadaway and Patrick A. Cancro.
October 1953. 29p. diagrs., photos.
(NACA RM L53H14a)

Tests have been conducted in the Langley 19-foot pressure tunnel to determine the low-speed horizontal tail effectiveness and static longitudinal characteristics of two unswept wings of aspect ratios 2.5 and 4.0. Both wings had a taper ratio of 0.625 and modified double-wedge 6-percent-chord airfoil sections. Comparisons of the two wings are presented. Tests were made with circular fuselages attached to the wings with and without full-span drooped leading edges and part-span trailing-edge flaps. A horizontal tail at three vertical locations was tested on each configuration. Tests were made at a Mach number of 0.15 corresponding to Reynolds numbers of 6.2×10^6 for the aspect-ratio-4.0 wing and 7.6 for the aspect-ratio-2.5 wing.

NACA RM L53H19a
National Advisory Committee for Aeronautics.
LOW-SPEED INVESTIGATION OF THE EFFECTS OF LOCATION OF A DELTA HORIZONTAL TAIL ON THE LONGITUDINAL STABILITY AND CONTROL OF A FUSELAGE AND THIN DELTA WING WITH DOUBLE SLOTTED FLAPS INCLUDING THE EFFECTS OF A GROUND BOARD. John M. Riebe and Jean C. Graven, Jr. October 1953. 38p. diagrs., tabs. (NACA RM L53H19a)

Results are presented of a wind-tunnel investigation at low speeds of the effect of horizontal-tail location on longitudinal stability and control characteristics of a fuselage and a thin delta wing with double slotted flaps including the effects of a ground board. Satisfactory locations of horizontal tail with flaps deflected were indicated to be lower and more rearward than for the flap-retracted condition. Ground board effects with flaps deflected were similar to the results of previous investigations of other wing plan forms with flaps deflected.

NACA RM L53H24
National Advisory Committee for Aeronautics.
WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF A FENCE AND A LEADING-EDGE NOTCH ON THE AERODYNAMIC LOADING CHARACTERISTICS IN PITCH OF A 45° SWEPTBACK WING AT HIGH SUBSONIC SPEEDS. Richard E. Kuhn, James W. Wiggins, and Andrew L. Byrnes, Jr. October 1953. 56p. diagrs., photo., tabs. (NACA RM L53H24)

The aerodynamic loading characteristics of a 45° sweptback wing of aspect ratio 4, in combination

with a fuselage, as obtained from pressure-distribution measurements are presented for the clean wing and for the wing with fences and leading-edge notches. The tests covered a Mach number range from 0.50 to 0.95 and angles of attack up to 24°.

NACA RM L54H03

THE EFFECT OF GROUND ON THE LOW-SPEED AERODYNAMIC, CONTROL, AND CONTROL HINGE-MOMENT CHARACTERISTICS OF A DELTA-WING—FUSELAGE MODEL WITH TRAILING-EDGE CONTROLS. William I. Scallion. September 1954. 52p. diagrs., photos., tabs. (NACA RM L54H03)

Results are presented of an investigation to determine the low-speed aerodynamic, control, and control hinge-moment characteristics near the ground of a 60° sweptback delta-wing—fuselage combination with trailing-edge and horn-balance-type controls of 10.8 and 10.2 percent total wing area, respectively. The airfoil section was NACA 65A003 parallel to model axis of symmetry and the aspect ratio was 2.31. The Reynolds number was 2.3×10^6 and the Mach number was 0.10.

NACA RM L54H10

WATER-IMPACT THEORY FOR AIRCRAFT EQUIPPED WITH NONTRIMMING HYDRO-SKIS MOUNTED ON SHOCK STRUTS. Emanuel Schnitzer. October 1954. 29p. diagrs. (NACA RM L54H10)

Theoretical equations are derived for the motions of aircraft equipped with shock-mounted hydro-skis impacting on a water surface. A rough approximation to the hydrodynamic-force term is included in a non-dimensional form which permits design-trend study solutions for a wide range of practical impacts. A second, better approximation to the hydrodynamic force is included in a dimensional form. This form allows solutions for various bottom shapes, shock-strut spring types, and exponential damping constants. An appendix gives a simple step-by-step procedure for solving any of the sets of equations derived in the paper.

NACA RM L54H12

WIND-TUNNEL INVESTIGATION AT HIGH SUBSONIC SPEEDS OF THE STATIC LONGITUDINAL STABILITY CHARACTERISTICS OF A COMPLETE MODEL HAVING CROPPED-DELTA, SWEPT, AND UNSWEPT WINGS AND SEVERAL HORIZONTAL-TAIL HEIGHTS. Kenneth W. Goodson and Robert E. Becht. October 1954. 44p. diagrs. (NACA RM L54H12)

The present paper presents static longitudinal stability characteristics at high subsonic speeds of a complete model having a cropped delta wing, a swept wing (quarter-chord line swept 30°), and an unswept (50-percent-chord line unswept) wing and having several horizontal-tail heights. These midwings were of aspect ratio 3 and had taper ratios of 0.143, 0.50, and 0.20, respectively.

NACA RM L54H23

AN INVESTIGATION AT HIGH SUBSONIC SPEEDS OF THE PRESSURE DISTRIBUTIONS ON A 45° SWEPTBACK VERTICAL TAIL IN SIDESLIP WITH AND WITHOUT A 45° SWEPTBACK HORIZONTAL TAIL LOCATED ON THE FUSELAGE CENTER LINE. Harleth G. Wiley and William C. Moseley, Jr. November 1954. 81p. diagrs., photos., 7 tabs. (NACA RM L54H23)

This paper presents the chordwise pressure distributions at high subsonic speeds on a 45° sweptback, untapered vertical tail in sideslip with and without a 45° sweptback, untapered horizontal tail mounted on the fuselage center line. Tests were made at 0°, 4°, and 12° angle of attack through a sideslip range of about -2° to 23° and over a Mach number range of 0.60 to 0.95. Presented are integrated span loadings and section normal-force and moment coefficients for all tests, as well as typical chordwise pressure distributions at six spanwise stations of the vertical tail.

NACA RM L54H25

A TRANSONIC WIND-TUNNEL INVESTIGATION OF THE LONGITUDINAL FORCE AND MOMENT CHARACTERISTICS OF A PLANE AND A CAMBERED 3-PERCENT-THICK DELTA WING OF ASPECT RATIO 3 ON A SLENDER BODY. Dale L. Burrows and William E. Palmer. November 1954. 31p. diagrs., photos., tab. (NACA RM L54H25)

Wind-tunnel tests at Mach numbers from 0.76 to 1.38 have been made on two delta-wing—body combinations to obtain lift, drag, pitching-moment, and base-pressure data at angles of attack from 0° to 20° and at Reynolds numbers of about 5×10^6. A plane wing and a cambered-leading-edge wing with three-percent thickness ratios and an aspect ratio of 3 were tested. Camber provided improvements in maximum lift-drag ratio throughout the Mach number range and improvements in longitudinal stability at high lift and high subsonic Mach numbers.

National Advisory Committee for Aeronautics
Research Abstracts
and
Reclassification Notice

NO. 106 **SEPTEMBER 14, 1956**

CURRENT NACA RESEARCH REPORTS

NACA Rept. 1247

CHARACTERISTICS OF TURBULENCE IN A BOUNDARY LAYER WITH ZERO PRESSURE GRADIENT. P. S. Klebanoff, National Bureau of Standards. 1955. ii, 19p. diagrs. (NACA Rept. 1247. Supersedes TN 3178)

The results of an experimental investigation of a turbulent boundary layer with zero pressure gradient are presented. Measurements with the hot-wire anemometer were made of turbulent energy and turbulent shear stress, probability density and flattening factor of u-fluctuation, spectra of turbulent energy and shear stress, and turbulent dissipation. The importance of the region near the wall and the inadequacy of the concept of local isotropy are demonstrated. Attention is given to the energy balance and the intermittent character of the outer region of the boundary layer. Also several interesting features of the spectral distribution of the turbulent motions are discussed.

NACA RM E56D23

THEORETICAL PERFORMANCE OF JP-4 FUEL AND LIQUID OXYGEN AS A ROCKET PROPELLANT. II - EQUILIBRIUM COMPOSITION. Vearl N. Huff, Anthony Fortini, and Sanford Gordon. September 1956. 47p. diagrs., tabs. (NACA RM E56D23)

Data were calculated for equivalence ratios of 1 to 3, chamber pressures of 300 and 600 pounds per square inch absolute, and pressure ratios of 1 to 1500. Parameters included are specific impulse, combustion and exit temperature, molecular weight, characteristic velocity, coefficient of thrust, ratio of nozzle-exit area to throat area, specific heat at constant pressure, isentropic exponent, viscosity, and thermal conductivity. A correlation is given which permits determination of performance for a wide range of chamber pressures.

NACA TM 1416

TESTS TO DETERMINE THE ADHESIVE POWER OF PASSENGER-CAR TIRES. (Versuche zur Feststellung des Haftvermögens von Personenwagen-Bereifungen). B. Förster. August 1956. 36p. diagrs., photos., tab. (NACA TM 1416. Trans. from Deutsche Kraftfahrtforschung, no. 22)

Experimental data on braking coefficients of friction and cornering characteristics for automobile tires are presented. Although the particular types of tires investigated are not of direct interest to the aircraft industry, the data do serve to indicate certain basic aspects of tire behavior and should be of interest to those concerned with the study of tire braking and cornering characteristics. The effects of the following factors are indicated: (a) forward speed, (b) tire loading, (c) tire pressure, (d) form stiffness of tire, (e) tire size, (f) tread pattern, (g) road surface material and condition, and (h) the effects of braking on cornering characteristics.

NACA TM 1419

EFFECTS OF INTERMITTENT VERSUS CONTINUOUS HEATING UPON THE TENSILE PROPERTIES OF 2024-T4, 6061-T6, AND 7075-T6 ALLOYS. G. W. Stickley and H. L. Anderson, Aluminum Company of America. August 1956. 7p. tabs. (NACA TM 1419)

The object of these tests was to determine the effects of intermittent and continuous heating at 300 and 400° F, for total periods of 100 and 200 hours, upon the tensile properties of 2024-T4 and 6061-T6 alloy rolled-and-drawn rod and 7075-T6 alloy extrusions, at room temperature and at the temperature of heating. The effects of intermittent heating were found to be cumulative and the same as for continuous heating.

NACA TN 3709

AERODYNAMIC INVESTIGATION OF A PARABOLIC BODY OF REVOLUTION AT MACH NUMBER OF 1.92 AND SOME EFFECTS OF AN ANNULAR SUPERSONIC JET EXHAUSTING FROM THE BASE. Eugene S. Love. September 1956. 62p. diagrs., photos., tab. (NACA TN 3709. Supersedes RM L9K09)

An aerodynamic investigation of a slender pointed parabolic body of revolution was conducted at a Mach number of 1.92 with and without the effects of an annular supersonic jet exhausting from the base. Measurements with the jet inoperative were made of lift, drag, pitching moment, base pressures, and radial and axial pressures. With the jet in operation, pressure measurements were made over the rear of the body with the primary variables being angle of attack, ratio of jet velocity to stream velocity, and ratio of pressure at jet exit to stream pressure.

*AVAILABLE ON LOAN ONLY.

ADDRESS REQUESTS FOR DOCUMENTS TO NACA, 1512 H ST., NW., WASHINGTON 25, D. C., CITING CODE NUMBER ABOVE EACH TITLE; THE REPORT TITLE AND AUTHOR.

NACA TN 3722

GENERAL THEORY OF WAVE-DRAG REDUCTION FOR COMBINATIONS EMPLOYING QUASI-CYLINDRICAL BODIES WITH AN APPLICATION TO SWEPT-WING AND BODY COMBINATIONS. Jack N. Nielsen and William C. Pitts. September 1956. 79p. diagrs. (NACA TN 3722. Supersedes RM A55B07)

An analysis is made of wave-drag reduction for wing and quasi-cylindrical body combinations produced by changes in cross-sectional shape and in area distribution. The theory, applicable at all supersonic speeds, has been applied to a swept-wing and body combination with sonic leading and trailing edges. A reduction of 22 percent of the wave drag of the winged part of the undistorted combination was achieved by utilizing the optimum axially symmetric indentation, and a further reduction of 42 percent was achieved by distortion of cross-sectional shape. An analytical expression for the optimum axially symmetric indentation is obtained by an alternate method.

NACA TN 3743

AN OPTIMUM SWITCHING CRITERION FOR A THIRD-ORDER CONTACTOR ACCELERATION CONTROL SYSTEM. Anthony L. Passera and Ross G. Willoh, Jr. August 1956. 46p. diagrs., tab. (NACA TN 3743)

A switching criterion for optimum performance of a third-order contactor acceleration control system having complex roots is presented. Analytical and analog-computer methods are utilized to determine this criterion. The resulting optimum transient responses are presented and compared with those of an equivalent linear system.

NACA TN 3745

TRANSITION-FLIGHT TESTS OF A MODEL OF A LOW-WING TRANSPORT VERTICAL-TAKE-OFF AIRPLANE WITH TILTING WING AND PROPELLERS. Powell M. Lovell, Jr., and Lysle P. Parlett. September 1956. 30p. diagrs., photo., tab. (NACA TN 3745)

An investigation of the stability and control of a low-wing four-engine transport vertical-take-off airplane during the transition from hovering to normal forward flight has been conducted with a remotely controlled free-flight model. The model had four propellers distributed along the wing with the thrust axes in the wing-chord plane. The wing could be rotated to 90° incidence so that the propeller thrust axes were vertical for hovering flight.

NACA TN 3751

A STUDY OF THE EFFICIENCY OF HIGH-STRENGTH, STEEL, CELLULAR-CORE SANDWICH PLATES IN COMPRESSION. Aldie E. Johnson, Jr., and Joseph W. Semonian. September 1956. 26p. diagrs., tab. (NACA TN 3751)

Structural efficiency curves are presented for high-strength, stainless-steel, cellular-core sandwich plates of various proportions subjected to compressive end loads for temperatures of 80° F and 600° F. Optimum proportions of sandwich plates for any value of the compressive loading intensity can be determined from the curves. The efficiency of steel sandwich plates of optimum proportions is compared with the efficiency of solid plates of high-strength steel and aluminum and titanium alloys at the two temperatures.

NACA TN 3752

TENSILE PROPERTIES OF AZ31A-0 MAGNESIUM-ALLOY SHEET UNDER RAPID-HEATING AND CONSTANT-TEMPERATURE CONDITIONS. Ivo M. Kurg. August 1956. 21p. diagrs., tabs. (NACA TN 3752)

Specimens of AZ31A-0 magnesium-alloy sheet were heated to rupture at nominal rates of 0.2° F to 100° F per second under constant tensile load conditions. The data are presented and compared with the results of conventional tensile stress-strain tests at elevated temperatures after 1/2-hour exposure. A temperature-rate parameter was used to construct master curves from which stresses and temperatures for yield and rupture can be predicted under rapid-heating conditions. A comparison of the elevated-temperature tensile properties of AZ31A-0 and HK31XA-H24 magnesium-alloy sheet under both constant-temperature and rapid-heating conditions is included.

NACA TN 3821

FLIGHT TECHNIQUES FOR DETERMINING AIRPLANE DRAG AT HIGH MACH NUMBERS. De E. Beeler, Donald R. Bellman, and Edwin J. Saltzman. (Presented to Flight Test Panel of Advisory Group for Aeronautical Research and Development, Brussels, Belgium, August 27-31, 1956). August 1956. 40p. diagrs., photos. (NACA TN 3821)

The accelerometer method has proved to be the most satisfactory method for the flight measurement of total airplane drag during research investigations of high-speed airplanes by the NACA High-Speed Flight Station. The method requires special instrumentation and measuring techniques which are described in detail. Methods for separating the flight-measured overall drag into drag components and for comparing the flight data with wind-tunnel-model data are presented.

NACA TN 3856

FATIGUE-CRACK PROPAGATION IN ALUMINUM-ALLOY BOX BEAMS. Herbert F. Hardrath, Herbert A. Leybold, Charles B. Landers, and Louis W. Hauschild. August 1956. 33p. diagrs., photo. (NACA TN 3856)

Eighteen box-beam specimens constructed according to four designs were subjected to fatigue tests to study fatigue-crack propagation and accompanying stress redistribution. At least two specimens of each design were constructed from each of the aluminum alloys 2024-T3 and 7075-T6.

NACA TN 3859

COMPARISON OF FLIGHT AND WIND-TUNNEL MEASUREMENTS OF HIGH-SPEED-AIRPLANE STABILITY AND CONTROL CHARACTERISTICS. Walter C. Williams, Hubert M. Drake, and Jack Fischel. (The information in this report was also contained in a paper by the same authors which was presented to Wind Tunnel and Model Testing Panel of Advisory Group for Aeronautical Research and Development, Brussels, Belgium, August 27-31, 1956). August 1956. 16p. diagrs. (NACA TN 3859)

Comparisons of some wind-tunnel- and flight-measured values of stability and control characteristics have been made for three swept-wing airplanes to show the agreement in trends and values of the data. In general, agreement of the data was good; however, where differences in the data were shown, generally they could be attributed either to specific geometric discrepancies between model and airplane or to model test techniques. Some suggestions are included for improving correlation of wind-tunnel and flight data and for analysis of the wind-tunnel data.

BRITISH REPORTS

N-44672*

Aeronautical Research Council (Gt. Brit.)
EXPERIMENTS WITH SLOTTED AND PERFORATED WALLS IN A TWO-DIMENSIONAL HIGH-SPEED TUNNEL. D. W. Holder, R. J. North, and A. Chinneck. 1956. 59p. diagrs., photos., tabs. (ARC R & M 2955. Supersedes ARC 14,411, TP 352, FM 1631)

Preliminary tests were made with a 7-1/2 inch by 3 inch two-dimensional induced-flow tunnel fitted with slotted or with perforated walls, and with a closed tunnel and an open jet of the same size. The experiments include observations of the pressures in the empty tunnel, and of the pressure distribution and flow pattern round a 2-inch chord airfoil at angles of attack of 0° and 2°. The reliability of the measurements on the airfoil at high subsonic speeds is estimated by comparison with measurements in the 20- by 8-inch tunnel on an airfoil of the same section and chord.

N-44914*

Royal Aircraft Establishment (Gt. Brit.)
A METHOD FOR CALCULATING THE PRESSURE DISTRIBUTION OVER JET-FLAPPED WINGS. D. Kuchemann. May 1956. 38p. diagrs. (RAE Aero 2573)

The incompressible flow past an airfoil with a thin jet emerging from its lower surface somewhere near the trailing edge is considered. Based on the work of Gates, Maskell, and Spence, a simple method is described for calculating the pressure distribution over wings of nonzero thickness. The effects of finite aspect ratio and of camber are included and the method can be used for design purposes. The possible effects of sweep are briefly discussed. It is pointed out that a saddleback chordwise loading is typical for airfoils with jets and that this is the basic reason for most of the aerodynamic advantages of the jet-flap system.

N-44915*

Royal Aircraft Establishment (Gt. Brit.)
THE LIFT ON A THIN AEROFOIL WITH A BLOWN FLAP. D. A. Spence. May 1956. 17p. diagrs. (RAE Tech. Note Aero 2450)

The method which was previously developed for calculating the lift on a thin jet-flapped airfoil is applied to the case of airfoils with blown flaps. The classical results for attached flow on flapped airfoils without supercirculation are also obtained as a special case. Results show that the effectiveness of the jet flap scheme might be greatly increased by blowing over flaps of the order of 20 or 30 percent of the chord, rather than over the very small shrouds which have hitherto been proposed.

N-44916*

Royal Aircraft Establishment (Gt. Brit.)
A THEORY OF SLENDER DELTA WINGS WITH LEADING EDGE SEPARATION. K. W. Mangler and J. H. B. Smith. April 1956. 21p. diagrs. (RAE Tech. Note Aero 2442)

Flow past a slender delta wing with a highly swept, sharp leading edge, at incidence, usually separates along the edge and a vortex sheet is formed, extending from the wing. This rolls up to form a region of flow with high vorticity, called the "core", joined to the leading edge by a vortex sheet. A potential theory for this type of flow is developed based on the assumptions of slender wing theory and of a conical

velocity field. The three-dimensional problem reduces to a two-dimensional one. The shape of the entire vortex sheet and its strength are determined by the two conditions that the flow must be parallel to the vortex sheet and the pressure continuous across it. The shape and strength of the "core" are found and a graphical method for finding the remainder of the solution is outlined. Some features of the three-dimensional and the corresponding two-dimensional flow pattern are discussed with the aid of diagrams.

N-44918*

Royal Aircraft Establishment (Gt. Brit.)
A PRELIMINARY SURVEY OF SOME EXPERIMENTAL RESULTS OF THE WAVE DRAG OF WINGS AT ZERO LIFT. R. A. Bishop. April 1956. 10p. diagrs., tab. (RAE Tech. Note Aero 2445)

In association with the present work on the theoretical wave drag of wings at zero lift, an examination of experimental data is in progress and a preliminary survey is given here. It appears that because of the existence of interference effects between wings and the bodies on which they are mounted, there is a shortage of experimental results from which the drag of isolated wings can be deduced, but a selection of some results which do seem reliable is made. In one instance a comparison with theoretical estimates is made.

N-44920*

Forest Products Research Lab., Dept. of Scientific and Industrial Research (Gt. Brit.)
COMPOSITE WOOD SECTION. TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. RED SERAYA - SHOREA SMITHIANA - NORTH BORNEO; CONSIGNMENT NO. 840 GIVING TWO BILLETS FROM TWO TREES; WEIGHT - 31 LB./CUBIC FEET AT 15 PER CENT MOISTURE CONTENT. TIMBER PROVISIONALLY CLASSIFIED AS GROUP I. (PROGRESS REPORT THIRTY-FOUR). April 1956. 7p. tabs. (Forest Products Research Lab., DSIR)

N-44947*

Royal Aircraft Establishment (Gt. Brit.)
THE VARIATION OF TENSILE STRENGTH IN LARGE ALUMINIUM ALLOY EXTRUDED BAR TO SPECIFICATIONS D.T.D. 363A, D.T.D. 364B AND D.T.D. 683. A. G. Cole. May 1956. 40p. diagrs., tabs. (RAE Tech. Note Structures 190)

The results of a large number of tensile tests, performed on 4-inch by 4-inch and 8-inch by 4-inch aluminum alloy extruded bar to specifications D.T.D. 363A, D.T.D. 364B, and D.T.D. 683 are recorded and analyzed. Bars supplied by two manufacturers are compared, and curves showing the variation of strength with position in the bar are presented for each material.

N-44948*

Royal Aircraft Establishment (Gt. Brit.)
FLUTTER CALCULATIONS ON A RUDDER WITH TRAILING-EDGE SPOILER. Ll. T. Niblett. May 1956. 14p. diagrs. (RAE Structures 202)

Flutter calculations made on a rudder with trailing-edge spoilers are described. The results obtained agree with the flight experience which has been acquired so far (except for the frequency of the flutter) in spite of the simplicity of the aerodynamic assumptions. It has been found that, as with tab flutter, a form of flutter involving the main surface (fin) occurs with an overmassbalanced spoiler.

N-44949*

Royal Aircraft Establishment (Gt. Brit.)
REDUCTION OF THE EFFECT OF VIBRATIONS IN OPTICAL INVESTIGATIONS: THE BERKSHIRE COPSE LABORATORY AND 210 INCH f/15 COLLIMATOR. J. M. Naish. March 1956. 22p. diagrs., photos. (RAE Tech. Note Ph. 496)

A description is given of the monolithic design and kinematic mounting of a 210-inch collimator. Details are given of precautions taken to insure thermal stability for the collimator and for the associated-optical bench which is carried on the same foundation unit. Photoelectric probe measurements are reported which show the equipment to be suitable for determining the response function of a long-focus camera lens, the angular stability being of the order of 0.1 second of arc.

N-44950*

Royal Aircraft Establishment (Gt. Brit.)
THE SIMULATION OF MECHANICAL THRESHOLD. M. Squires. March 1956. 33p. diagrs. (RAE Tech. Note GW 403)

Three electronic analogs for the threshold behavior found in some mechanisms are described. This behavior is characterized in general by (a) a failure to develop relative motion between rubbing surfaces unless the applied tangential force (or the applied torque in the case of bearings in rotating machinery) exceeds some critical value; (b) the common occurrence of a region of bistable operation, due to reduction in the coefficient of friction with relative velocity; and (c) a range of velocities which cannot be stably maintained.

N-44951*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF WING TORSION ON AILERON-TAB FLUTTER. H. Hall. April 1956. 31p. diagrs., tab. (RAE Structures 203)

Results are presented for a series of calculations on an idealized system having degrees of freedom in wing pitch, rotation of the control surface and rotation of the tab; the pitching degree of freedom is spring restrained and is intended to represent wing torsion. The tab is restrained as a trim tab or pure aerodynamic servo tab, but the results are expected to apply qualitatively to a spring tab. A comparison is made to results by Wittmeyer and Wittmeyer and Templeton where the main surface mode considered was one of vertical translation to represent wing bending. From this previous work criteria were suggested for the prevention of this type of flutter, and in an analogous manner criteria are now proposed for prevention of wing torsion-aileron-tab flutter.

N-44952*

Royal Aircraft Establishment (Gt. Brit.)
TYPICAL TENSILE STRESS-STRAIN RELATIONSHIPS FOR ALUMINIUM ALLOY SHEET TO SPECIFICATIONS D.T.D. 546B, D.T.D. 646B AND D.T.D. 687A. F. Clifton. April 1956. 31p. diagrs., tabs. (RAE Tech. Note Structures 191)

A review is made of a large amount of tensile test data on commonly used types of aircraft structural aluminum alloy sheet, and typical stress-strain and tangent modulus curves are derived.

N-44953*

National Gas Turbine Establishment (Gt. Brit.)
A THEORETICAL ANALYSIS OF REACTION RATE CONTROLLED SYSTEMS. M. V. Herbert. June 1956. 75p. diagrs., tabs. (NGTE R. 196)

Absolute limits of air loading are determined for an adiabatic and homogeneous reaction zone; and a loading parameter is defined, which includes the effect of inlet temperature with or without vitiation. The application to "can" and baffle stabilizing systems is considered, and the influence of pressure drop discussed.

N-44954*

Royal Aircraft Establishment (Gt. Brit.)
SOME TESTS OF INJECTORS FOR ROCKET MOTORS USING LIQUID OXYGEN. J. Humphries and W. H. J. Riedel. February 1956. 25p. diagrs., photos., tabs. (RAE Tech. Note RPD 140)

This note describes some early work during 1950-51 to compare the behavior of three types of injector tested with liquid oxygen as oxidant and 75 percent ethyl alcohol/water and kerosene as fuels. The three injectors were of the V2, peripheral slit, and non-impinging shower or multihole types. With the alcohol fuel, the specific thrusts recorded represented approximately 70 percent, 75 percent, and 90 percent of theoretical respectively. Besides giving a high performance, the multihole injector offered the advantage of stable running with propellant injection pressures as low as 12 lb/sq inch. Only a few tests were carried out with kerosene as fuel, before the work was terminated.

N-44955*

Royal Aircraft Establishment (Gt. Brit.)
EXPERIMENTS ON TWO DIMENSIONAL BASE FLOW AT M = 2.4. L. Fuller and J. Reid. February 1956. 50p. diagrs., photos. (RAE Aero 2569)

This report gives an account of experiments carried out on a family of two-dimensional afterbodies to determine the effect of boattail angle and internal flow on the base pressure, the afterbody pressure, and the velocity distribution in the wake. The afterbodies tested were of constant length with boattail angles of 0°, $2\text{-}1/2^{o}$, 5°, $7\text{-}1/2^{o}$, and 10°, respectively. The results are analyzed and discussed in detail both from the theoretical aspect and also with regard to their practical application.

N-44956*

Ministry of Supply, R.D. Helicopters (Gt. Brit.)
NOTATION FOR ROTORCRAFT WORK.
A. Armitage, compiler. April 1956. 30p. diagrs., tabs. (MOS, R.D. Helicopters RDH Tech. Note 1/56)

A suggested standard notation for rotorcraft work is presented. The notation is the outcome of study of numerous papers of many sources of origin, and of close examination by a working party of the Ministry of Supply Rotating Wing Committee.

MISCELLANEOUS

NACA TN 3362

Errata on "ESTIMATES OF PROBABILITY DISTRIBUTION OF ROOT-MEAN-SQUARE GUST VELOCITY OF ATMOSPHERIC TURBULENCE FROM OPERATIONAL GUST-LOAD DATA BY RANDOM-PROCESS THEORY." Harry Press, May T. Meadows, and Ivan Hadlock. March 1955.

N-45616

WIND-TUNNEL INVESTIGATION OF LOW-SPEED OSCILLATORY DERIVATIVES IN PITCH AND IN ROLL OF AGARD MODEL D. William Letko. (Presented to Wind Tunnel and Model Testing Panel of the Advisory Group for Aeronautical Research and Development, Brussels, Belgium, August 27-31, 1956). 19p. diagrs., photos., tab.

Some results of oscillation-in-pitch and oscillation-in-roll tests of the AGARD wing model D are presented together with a description of the testing and recording technique used for obtaining these results in the Langley stability tunnel of the NACA. The results were obtained at a Mach number of 0.074 and a Reynolds number of about 335,000 based on the wing root chord.

N-45617

TECHNIQUES FOR TESTING MODELS OF VTOL AND STOL AIRPLANES. John P. Campbell. (Presented to Wind Tunnel and Model Testing Panel of the Advisory Group for Aeronautical Research and Development, Brussels, Belgium, August 27-31, 1956). 34p. diagrs., photos.

The purpose of this paper is to describe briefly some of the techniques that have been used by the NACA during the last seven years in conducting research on VTOL and STOL airplanes. These testing techniques may be divided into two general classes: first, conventional wind-tunnel force testing techniques; and, second, the free-flying model techniques including the control-line technique. This paper is primarily concerned with the free-flying model technique; however, a brief description of some of the force-testing techniques is presented.

UNPUBLISHED PAPERS

N-45767*

SOLUTION OF LINEARIZED EQUATIONS OF PLANE, NONSTATIONARY FLOW OF A VISCOUS, INCOMPRESSIBLE FLUID. (O reshenii linearizirovannykh uravnenii ploskogo nestatsionarnogo techniya vyazkoi neszhimaemoi zhidkosti). A. A. Kiselev and O. A. Ladyzhenskaya. 7p. (Trans. from Akademiia Nauk SSSR, Doklady, v.95, no.6, 1954, p.1161-1164)

The subject paper deals with a type of solution of the unsteady Navier-Stokes equations for very low speed flows. The method given presents a mathematical modification of approaches developed in the early 1930's by Scandinavians (starting with Oseen) and Frenchmen.

N-45831*

ON THE STATISTICAL TREATMENT OF RELAXATION PROCESSES. (Zur statistischen Behandlung von Relaxations-prozessen). J. Kubát. 8p. (Trans. from Kolloid-Zeitschrift, v.134, no.2/3, 1953, p.197-201)

The properties of the relaxation model, earlier proposed by the author, are discussed. The non-Maxwellian behavior of relaxations with arbitrarily small initial stresses is explained. A molecular-kinetic interpretation of the relaxation processes corresponding to the statistical assumptions is given.

DECLASSIFIED NACA RESEARCH REPORTS

NONE. See classified version for listing of Reclassified NACA Research Reports.

National Advisory Committee for Aeronautics
Research Abstracts
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Reclassification Notice

NO. 107 **OCTOBER 9, 1956**

CURRENT NACA RESEARCH REPORTS

NACA Rept. 1251

STRESS ANALYSIS OF CIRCULAR SEMIMONOCOQUE CYLINDERS WITH CUTOUTS. Harvey G. McComb, Jr. 1955. ii, 55p. diagrs., tabs. (NACA Rept. 1251. Supersedes TN 3199; TN 3200; TN 3460)

A method is presented for analyzing the stresses about cutouts in circular semimonocoque cylinders with flexible rings. The method involves the use of so-called perturbation stress distributions which are superposed on the stress distribution that would exist in the structure with no cutout in such a way as to give the effects of a cutout. The method can be used for any loading case for which the structure without the cutout can be analyzed and is sufficiently versatile to account for stringer and shear reinforcement about the cutout.

NACA Rept. 1256

AXIALLY SYMMETRIC SHAPES WITH MINIMUM WAVE DRAG. Max. A. Heaslet and Franklyn B. Fuller. 1956. ii, 16p. diagrs. (NACA Rept. 1256. Supersedes TN 3389)

Optimum bodies consisting of a basic cylinder with added peripheral volume are derived and presented in terms of the effective radius-length ratio. Variation of this parameter from 0 to ∞ encompasses the spectrum of results from slender to two-dimensional. A reciprocal theorem leads to simple interpretation of variational problems.

NACA Rept. 1258

A WIND-TUNNEL TEST TECHNIQUE FOR MEASURING THE DYNAMIC ROTARY STABILITY DERIVATIVES AT SUBSONIC AND SUPERSONIC SPEEDS. Benjamin H. Beam. 1956. ii, 14p. diagrs., photos. (NACA Rept. 1258. Supersedes TN 3347)

An experimental technique for measuring dynamic stability derivatives of a model airplane in a wind tunnel is described. A single-degree-of-freedom, feedback-controlled, forced-oscillation system was used to measure the stability derivatives which are important in estimating the lateral and longitudinal oscillatory motions of a rigid airplane. Some representative experimental data are included.

NACA Rept. 1260

STUDIES OF THE SPEED STABILITY OF A TANDEM HELICOPTER IN FORWARD FLIGHT. Robert J. Tapscott and Kenneth B. Amer. 1956. ii, 12p. diagrs., photos., tab. (NACA Rept. 1260. Supersedes RM L53F15a)

Analytical and experimental studies and corresponding pilots' opinions of the speed stability of a tandem helicopter are presented and means for improving the speed stability are discussed. An analytical expression is derived for use in predicting changes in speed stability of a tandem helicopter brought about by changes in the rotor geometry. Constants for use with the analytical expression are presented in chart form.

NACA Rept. 1261

THE NEAR NOISE FIELD OF STATIC JETS AND SOME MODEL STUDIES OF DEVICES FOR NOISE REDUCTION. Leslie W. Lassiter and Harvey H. Hubbard. 1956. i, 12p. diagrs., photos. (NACA Rept. 1261. Supersedes TN 3187)

Experimental studies of the pressure fluctuations near jets were made during unchoked operation of both a full-scale turbojet engine and a 1-inch-diameter high-temperature model jet and during choked operation of model jets of 0.275-inch to 2.00-inch diameter with unheated air. Frequency spectra and spatial distributions of pressure magnitude are given for the full-scale configuration and model data are used to illustrate probable trends at different operating conditions for the unchoked jets. Model tests for choked operation indicate the presence of a discrete-frequency component, and shadowgraph records illustrate that an unusual type of flow formation is associated with this condition. The frequency of this component is shown to be somewhat related to the shock-separation distances and to nozzle diameter. Laboratory methods of reducing the magnitude of pressure fluctuations from choked and unchoked jets are discussed and sample illustrations are given.

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NACA RM A56G17

MEASUREMENTS OF BOUNDARY-LAYER TRANSITION AT LOW SPEED ON TWO BODIES OF REVOLUTION IN A LOW-TURBULENCE WIND TUNNEL. Frederick W. Boltz, George C. Kenyon, and Clyde Q. Allen. September 1956. 14p. diagrs., photos., tabs. (NACA RM A56G17)

An investigation of the location of transition from laminar to turbulent flow in the boundary layer on two bodies of revolution of fineness ratios 7.5 and 9.0 has been made in the Ames 12-foot pressure wind tunnel. Transition measurements were obtained by the use of microphones installed within the bodies. Also presented are the pressure distributions for both bodies of revolution.

NACA TM 1383

FINITE SPAN WINGS IN COMPRESSIBLE FLOW. E. A. Krasilshchikova. September 1956. 130p. diagrs. (NACA TM 1383. From: Scientific Records of the Moscow State University, v.154, Mechanics no.4, 1951, with appendix condensed from a document "Modern Problems of Mechanics," Govt. Pub. House of Tech. Theor. Literature, (Moscow, Leningrad) 1952.)

Equations are developed using the source distribution method for the velocity potential function and pressure on thin wings in steady and unsteady motion. Closed form solutions are given for harmonically oscillating wings of general plan form including the effect of the wing wake. Some useful examples are presented in an appendix for arrow, semielliptical, and hexagonal plan form wings. The paper is essentially a summary of previous work by the author.

NACA TN 3680

INTERACTION OF GRIDS WITH TRAVELING SHOCK WAVES. Darshan Singh Dosanjh, Johns Hopkins University. September 1956. 80p. diagrs., photos. (NACA TN 3680)

Grids were mounted in the path of traveling shock waves in a shock tube. The incident shock wave after its collision with the grid split into transmitted and reflected waves. The emergence, growth, and speeds of these shock fronts were recorded with shadowgraphic and hot-wire techniques. The oscillograms of the hot-wire response of various transient flow regions are examined and some preliminary conclusions regarding the state of the flow downstream of the grid are reached.

NACA TN 3744

SUPERSONIC FLOW PAST NONLIFTING BUMPED AND INDENTED BODIES OF REVOLUTION. F. Edward McLean and Conrad Rennemann, Jr. September 1956. 39p. diagrs. (NACA TN 3744)

Linear-theory values of the supersonic pressure field and wave drag of nonlifting bumped and indented bodies of revolution are presented and compared with the corresponding properties of a smooth body. The comparisons indicate that relatively small surface irregularities cause large pressure disturbances and changes in wave drag. The interference drag produced by bumps and indentations is discussed and a correction for the curvature of the characteristics is applied.

NACA TN 3746

INITIAL RESULTS OF A FLIGHT INVESTIGATION OF THE WING AND TAIL LOADS ON AN AIRPLANE EQUIPPED WITH A VANE-CONTROLLED GUST-ALLEVIATION SYSTEM. T. V. Cooney and Russell L. Schott. September 1956. 31p. diagrs., photos. (NACA TN 3746)

Results are given of an analysis of wing and horizontal-tail spar strains measured on a twin-engine light transport airplane which was modified for the installation of a control system to alleviate airplane motions in turbulent air and thus improve passenger comfort. From a sample of the measurements obtained in flight through clear-air turbulence, normal acceleration at the airplane center of gravity was reduced 43 percent, wing main-spar bending strains were reduced, and wing-spar shear strains were increased. Horizontal-tail shear and bending strains were increased. Measurements of aerodynamic loads obtained in a pull-up with the gust-alleviation system in operation are also presented.

NACA TN 3755

SOME OBSERVATIONS ON THE RELATIONSHIP BETWEEN FATIGUE AND INTERNAL FRICTION. S. R. Valluri, California Institute of Technology. September 1956. 42p. diagrs., photos., tabs. (NACA TN 3755)

Results are presented of an investigation made to determine the internal friction and fatigue strength of commercially pure 1100 aluminum under repeated stressing in torsion at various temperatures and stress levels in an effort to find if there exists any correlation between internal friction and fatigue characteristics.

NACA TN 3761

TURBULENT SHEAR SPECTRA AND LOCAL ISOTROPY IN THE LOW-SPEED BOUNDARY LAYER. Virgil A. Sandborn and Willis H. Braun. September 1956. 34p. diagrs. (NACA TN 3761)

From measurements of turbulent shear spectra together with previously reported longitudinal turbulent energy spectra, the concept of local isotropy in a low-speed boundary layer was examined. Results of these measurements and measurements of the time derivatives of turbulent velocities in the x- and y-directions for various frequency bands showed no evidence of local isotropy in the boundary layer. Several methods (based on isotropy) of evaluating the turbulent dissipation term failed to give consistent answers, further emphasizing a lack of local isotropy.

NACA TN 3762

DRAG COEFFICIENTS FOR DROPLETS AND SOLID SPHERES IN CLOUDS ACCELERATING IN AIR-STREAMS. Robert D. Ingebo. September 1956. 31p. diagrs., photos., tab. (NACA TN 3762)

Linear accelerations for droplets and solid spheres (in clouds) in airstreams were determined from sphere diameter and velocity data obtained with a high-speed camera developed at the NACA Lewis laboratory. An empirical expression $C_D = 27/Re^{0.84}$ correlated drag coefficient C_D with Reynolds number Re for the case of accelerating droplets (iso-octane, water, and trichloroethylene) and solid spheres (magnesium and calcium silicide). This expression was derived for a Reynolds number range of 6 to 400, which included a range of airstream pressure, temperature, and velocity conditions. Trajectory equations for spheres were also derived.

NACA TN 3764

NEAR NOISE FIELD OF A JET-ENGINE EXHAUST. II - CROSS CORRELATION OF SOUND PRESSURES. Edmund E. Callaghan, Walton L. Howes, and Willard D. Coles. Appendix: CORRELATION COMPUTER. Channing C. Conger and Donald F. Berg. September 1956. 53p. diagrs., photos., tab. (NACA TN 3764)

Pressure cross correlations were obtained over a range of jet velocities both longitudinally and laterally for the overall sound pressure and for several frequency bands. The region of positive correlation was found to increase with distance downstream of the nozzle exit and was greater for lateral than for longitudinal correlations. In general, little change in the correlation curves was found as a function of jet velocity or frequency band width. Measurements made with a fixed and a movable microphone in a plate showed correlations similar to the free-field results. The results are interpreted in terms of pressure loads on surfaces.

NACA TN 3765

SOME EFFECTS OF SMALL-SCALE FLOW DISTURBANCE ON NOZZLE-BURNER FLAMES. Edgar L. Wong. September 1956. 19p. diagrs., photos., tabs. (NACA TN 3765)

Laminar-like and brush-like propane-air flames were obtained when wire grids were used as turbulence generators in a 1/2-inch nozzle burner. The laminar-like flames for grid-disturbed flow had a slightly higher burning velocity than "true" laminar flames (no grid used). The brush-like flames were similar to those obtained with pipe turbulent flow. Their burning-velocity dependence on a "flow disturbance" Reynolds number compared favorably with that obtained for pipe turbulent flames. Hot-wire-anemometer equipment was used to measure the flow disturbance intensity in the cold flow with and without the grids in place.

NACA TN 3767

THE USE OF PERFORATED INLETS FOR EFFICIENT SUPERSONIC DIFFUSION. John C. Evvard and John W. Blakey. September 1956. 35p. diagrs., photo. (NACA TN 3767. Supersedes RM E51B10)

The use of wall perforations on supersonic diffusers to avoid the internal contraction-ratio limitation is described. Experimental results at a Mach number of 1.85 on a preliminary model of a perforated diffuser having a geometric internal contraction ratio of 1.49 (the isentropic value) are presented. A theoretical discussion of the flow coefficients as well as the size and the spacing of the perforations is also included. At angles of attack of 0°, 3°, and 5°, total-pressure recoveries of 0.931, 0.920, and 0.906, respectively, were obtained.

NACA TN 3769

FURTHER INVESTIGATION OF THE FEASIBILITY OF THE FREEZE-CASTING METHOD FOR FORMING FULL-SIZE INFILTRATED TITANIUM CARBIDE TURBINE BLADES. E. M. Grala. October 1956. 19p. diagr., photos., tabs. (NACA TN 3769)

A method of casting a full-size cermet turbine blade from titanium carbide was investigated. An extremely thick slip of titanium carbide was prepared with a small amount of binder, cast into a mold by vibration, centrifuged, and frozen to retain the shape of the mold. The casting was then dried in an absorbent sand and sintered by conventional means. The porous casting could then be infiltrated with a nickel- or cobalt-base alloy.

NACA TN 3772

EFFECT OF THREE DESIGN PARAMETERS ON THE OPERATING CHARACTERISTICS OF 75-MILLIMETER-BORE CYLINDRICAL ROLLER BEARINGS AT HIGH SPEEDS. William J. Anderson. October 1956. 37p. diagrs., photo., tabs. (NACA TN 3772)

A total of 30 bearings were run at loads to 368 pounds and DN values to 2.1×10^6. Roller axial clearance ratio had no significant effect on bearing temperature, cage slip, wear, or high-speed operating characteristics except at the lowest clearance ratio (0.0005) where failures occurred. Bearing temperatures were minimum at a cage diametral clearance ratio of about 0.004. Cage land width-diameter ratio had little effect on bearing temperature. At a 368-pound load, cage wear increased with increasing cage land width-diameter ratio.

NACA TN 3773

THE DESIGN OF BRITTLE-MATERIAL BLADE ROOTS BASED ON THEORY AND RUPTURE TESTS OF PLASTIC MODELS. André J. Meyer, Jr., Albert Kaufman, and William C. Caywood. September 1956. 46p. diagrs., photos., tab. (NACA TN 3773. Supersedes RM E53C12)

Theoretical design charts based on Neuber's equations for symmetrically located notches are presented for estimating the approximate rupture strengths of blade roots made from brittle materials. The limit of applicability of the theoretical charts is shown as determined by rupture tests of plastic models. The optimum proportions among overall root width, neck width, notch radius, and notch depth are determined from the design charts. Eighteen different root designs were investigated, their relative strengths were evaluated analytically and experimentally, and the results were compared. A dovetail root having the optimum proportions as established by this investigation was the strongest root evaluated.

NACA TN 3779

TENTATIVE METHOD FOR CALCULATION OF THE SOUND FIELD ABOUT A SOURCE OVER GROUND CONSIDERING DIFFRACTION AND SCATTERING INTO SHADOW ZONES. David C. Pridmore-Brown and Uno Ingard, Massachusetts Institute of Technology. September 1956. 33p. diagrs. (NACA TN 3779)

A semiempirical method is given for the calculation of the sound field about a source over ground considering the effects of vertical temperature and wind gradients as well as scattering of sound by turbulence into shadow zones. The diffracted field in a wind-created shadow zone is analyzed theoretically in the two-dimensional case and is shown to be similar to the results obtained for a temperature-created shadow field as given in NACA TN 3494.

NACA TN 3788

STABILITY DERIVATIVES OF CONES AT SUPERSONIC SPEEDS. Murray Tobak and William R. Wehrend. September 1956. 43p. diagrs. (NACA TN 3788)

The aerodynamic stability derivatives due to pitching velocity and vertical acceleration are derived for circular cones traveling at supersonic speeds. Both first-order and a combination of first- and second-order potential solutions are obtained, and, in calculations for the forces, no approximations are made to the tangency condition or the isentropic pressure relation. In addition, expressions for the forces, moments, and stability derivatives of arbitrary bodies of revolution are derived from Newtonian impact theory.

NACA TN 3789

THE RESULTS OF WIND-TUNNEL TESTS TO A MACH NUMBER OF 0.90 OF A FOUR-ENGINE PROPELLER-DRIVEN AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10. George G. Edwards, Jerald K. Dickson, Fred B. Sutton, and Fred A. Demele. September 1956. 171p. diagrs., photo., tabs. (NACA TN 3789. Supersedes RM A53I28)

The effects of operating propellers on the longitudinal characteristics of the model have been investigated at thrust coefficients up to 0.9 per propeller at Mach numbers from 0.082 to 0.90 and at Reynolds numbers from 1,000,000 to 8,000,000. Variations in the model included different heights and incidences of the horizontal tail, split flaps, several propeller-blade angles, and independent as well as simultaneous operation of the inboard and outboard propellers. Coefficients of lift, longitudinal force, pitching moment, propeller thrust, and propeller power are presented.

NACA TN 3790

ANALYSIS OF WIND-TUNNEL TESTS TO A MACH NUMBER OF 0.90 OF A FOUR-ENGINE PROPELLER-DRIVEN AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10. George G. Edwards, Donald A. Buell, Fred A. Demele, and Fred B. Sutton. September 1956. 170p. diagrs., photos., tabs. (NACA TN 3790. Supersedes RM A54F14)

Experimental data published in NACA TN 3789 are analyzed. The effects of operating propellers on the longitudinal characteristics of the model are separated into various components to illustrate the origin, nature, and intensity of each. The analysis indicates certain configuration changes which would reduce the adverse effects of propellers on the longitudinal stability.

NACA TN 3791

ON A METHOD FOR OPTIMIZATION OF TIME-VARYING LINEAR SYSTEMS WITH NONSTATIONARY INPUTS. Marvin Shinbrot. September 1956. 39p. (NACA TN 3791)

By means of examples, a new method is illustrated for optimizing, over a finite interval of time, time-varying systems with stationary or nonstationary statistical inputs. The method depends on the correlation functions being of a certain type, which, fortunately, is the type found in a large number of practical problems of importance.

NACA TN 3798

A THEORETICAL ESTIMATE OF THE EFFECTS OF COMPRESSIBILITY ON THE PERFORMANCE OF A HELICOPTER ROTOR IN VARIOUS FLIGHT CONDITIONS. Alfred Gessow and Almer D. Crim. October 1956. 33p. diagrs. (NACA TN 3798)

The effects of compressibility arising from high-tip-speed operation on the flapping, thrust, and power of a helicopter rotor in forward speed are investigated for a particular set of airfoil characteristics. Tip-speed ratios ranging from 0.2 to 0.5 were covered at several tip-speed values.

NACA TN 3800

EXPLORATORY INVESTIGATION OF THE EFFECTIVENESS OF BIPLANE WINGS WITH LARGE-CHORD DOUBLE SLOTTED FLAPS IN REDIRECTING A PROPELLER SLIPSTREAM DOWNWARD FOR VERTICAL TAKE-OFF. Robert H. Kirby. October 1956. 22p. diagrs., tab. (NACA TN 3800)

Results are presented from static-force tests on biplane wings with large-chord double slotted flaps which turn the slipstream of a single counterrotating propeller downward for vertical take-off. The investigation provided information on the effect of chord length, flap deflection, propeller position, end plates, fuselage, and ground proximity on the efficiency of the wing system in turning the propeller slipstream.

NACA TN 3801

EXPERIMENTAL INVESTIGATION OF THE STRENGTH OF MULTIWEB BEAMS WITH CORRUGATED WEBS. Allister F. Fraser. October 1956. 17p. diagrs., photos., tabs. (NACA TN 3801)

The results of an experimental investigation of the strength of multiweb beams with corrugated webs are reported. Included in the investigation were two types of connection between the web and the skin. A comparison between the structural efficiency of corrugated-web and channel-web multiweb beams is presented, and it is shown that, for a considerable range of the structural index, corrugated-web beams can be built which are structurally more efficient than channel-web beams.

NACA TN 3803

BAND-PASS SHOCK AND VIBRATION ABSORBERS FOR APPLICATION TO AIRCRAFT LANDING GEAR. Emanuel Schnitzer. October 1956. 27p. diagrs. (NACA TN 3803)

In order to overcome rigidity limitations of conventional shock absorbers over certain frequency ranges or rates of load application, frequency-discriminating band-pass shock absorbers are introduced and the principles of operation are explained. The application of a low-pass shock strut to high-speed aircraft for which conventional oleo struts become rigid links when loads are rapidly applied during landing or taxiing over steep bumps is discussed. Theoretical solutions indicate marked load reductions for the low-pass shock absorbers for steep bumps or water waves and equal actions of both struts for long hills or swells. Possible extension of the principles to double-action band-pass vibration absorbers is discussed.

NACA TN 3805

CALCULATION OF THE FORCES AND MOMENTS ON A SLENDER FUSELAGE AND VERTICAL FIN PENETRATING LATERAL GUSTS. John M. Eggleston. October 1956. 20p. diagrs., tab. (NACA TN 3805)

A theory is presented for calculating the variation with frequency of the lateral-force and yawing-moment coefficients due to sinusoidal side gusts passing over the profile of a simple fuselage—vertical-fin combination. The analysis is based on slender-body theory. The method considers the penetration effect of both fuselage and vertical tail in calculating side force and yawing moment due to side gusts, as opposed to a simple lag concept which considers the flow angle to be uniform over the configuration.

NACA TN 3808

WIND-TUNNEL CALIBRATION OF A COMBINED PITOT-STATIC TUBE AND VANE-TYPE FLOW-ANGULARITY INDICATOR AT MACH NUMBERS OF 1.61 AND 2.01. Archibald R. Sinclair and William D. Mace. October 1956. 11p. diagrs., photo. (NACA TN 3808)

A limited calibration of a combined pitot-static tube and vane-type flow-angularity indicator has been made in the Langley 4- by 4-foot supersonic pressure tunnel at Mach numbers of 1.61 and 2.01. The results indicated that the angle-of-attack indications were affected by upwash about the probe tube and that the angle-of-yaw indications were affected by unsymmetric shock effects at low angles of attack.

NACA TN 3827

EXPERIMENTAL INVESTIGATION OF A LIGHTWEIGHT ROCKET CHAMBER. John E. Dalgleish and Adelbert O. Tischler. October 1956. 11p. photos. (NACA TN 3827. Supersedes RM E52L19a)

Experiments have been conducted with a jacketed rocket combustion chamber that was fabricated by hydraulic forming from sheet metal. Rocket combustion chambers made by this method have been used successfully. Runs with these combustion chambers have been made at overall heat-transfer rates of 2.5 Btu per square inch per second with water cooling and also with ammonia as a regenerative coolant.

BRITISH REPORTS

N-43181*

Royal Aircraft Establishment (Gt. Brit.)
PRECISION PLANNING TECHNIQUES AS APPLIED TO THE MANUFACTURE OF SUPERSONIC WIND TUNNEL MODELS. G. W. Rawlings. (For presentation at the 8th Meeting of the Advisory Group for Aeronautical Research and Development Wind Tunnel Panel, Rome). February 1956. 20p. diagrs., photos. (RAE Tech. Note ADW 2)

The considerable development in recent years in the use of supersonic and transonic wind tunnels has created an increasing demand for scale prototypes or

models and this in turn has given rise to quite a variety of production problems. It is proposed in this paper to discuss these problems and to outline the methods by which, in some measure, they have been met. Since the accuracy or validity of any conclusions reached from wind tunnel testing is so closely related to the accuracy or quality of the models used in the tests, it is essential that the standard of precision of the models shall at least correspond to the standard of precision of the wind tunnels in which they are used and it is from this necessity that the production problems arise. The model types to be discussed fall broadly into three classes, namely, airfoil research models, complete aircraft models, and guided missile models. In the airfoil research class, the models may be either in the form of a single wing arranged for side or base mounting, or in the form of a complete aircraft mounted upon a mandrel adapter or sting.

N-46126*

Royal Aircraft Establishment (Gt. Brit.)
AN INVESTIGATION INTO THE SUITABILITY OF SHOCK TESTING AS A MEANS OF THERMIONIC VALVE SELECTION FOR MISSILE CONTROL SYSTEMS. L. A. J. Lawrence and C. A. Mountford. April 1956. 41p. diagrs., photos., tabs. (RAE Tech. Note GW 411)

A method is described by which VX8122 subminiature valves (vacuum tubes) were initially subjected to controlled shock tests and to controlled vibration tests. The quantities measured were zero drift and microphony. The results are tabulated and an analysis is made to correlate the data from the tests. A description is given of the equipment used for generation and control of both shock and vibration; details of the equipment for measurement and recording are also given.

N-46127*

Royal Aircraft Establishment (Gt. Brit.)
BRIEF DESCRIPTION OF THE R. A. E. INTERMITTENT SUPERSONIC WIND TUNNEL PLANT. K. G. Winter. June 1956. 15p. diagrs., photos. (RAE Tech.Note Aero 2459)

The plant is vacuum-operated on a closed circuit with storage of the air in a flexible container. The useful Mach number range is up to about 4.5. For the largest of the tunnels (15 in. x 16 in.) the maximum running time is of the order of 20 seconds over the whole Mach number range. Runs of 10 to 15 seconds duration can be made every 5 minutes.

N-46128*

Royal Aircraft Establishment (Gt. Brit.)
NOTE ON STRAIN GAUGE RECORDING EQUIPMENT FOR THE R. A. E. INTERMITTENT SUPERSONIC WIND TUNNELS. K. G. Winter and E. J. Petherick. June 1956. 12p. diagrs., photos. (RAE Tech. Note Aero 2461)

A description is given of a simple system for photographing, up to six times per second, revolution counters driven from strain gage balance indicators. A further proposed system using punched cards is also described. Results show that, even with comparatively slow strain gage balance indicators, satisfactory recording of the loads on a model over a wide incidence range can be obtained in a run of 20 seconds duration.

N-46129*

Royal Aircraft Establishment (Gt. Brit.)
THE DETERMINATION OF AILERON EFFECTIVENESS. R. R. Duddy. (Note written for AGARD Flight Test Panel). June 1956. 10p. diagrs., tab. (RAE Tech. Note Aero 2462)

This note describes two alternative methods of measuring aileron effectiveness in flight for comparison with the results of estimates and wind tunnel measurements. Results obtained on four aircraft show that the agreement obtained is not particularly good but the tunnel measurements do indicate the reduction in aileron effectiveness to be expected in flight at high lift coefficients on swept wing aircraft.

N-46130*

Royal Aircraft Establishment (Gt. Brit.)
THE FATIGUE STRENGTH OF ALUMINIUM ALLOY SHEET TO SPECIFICATION D. T. D.546 USING SPECIMENS OF TWO DIFFERENT SIZES. N. J. Wadsworth. April 1956. 12p. diagrs. (RAE Tech. Note Met. 237)

The effect of specimen size on the fatigue strength of specimens cut from 16 gage Alclad D. T. D. 546 sheet was investigated at an endurance of 10^5 cycles. Specimens 1 inch and 0.3 inch wide with and without a central hole (giving an elastic stress concentration factor of 2.44) were tested in a Haigh machine. The strength reduction factor due to the hole was 1.8 in the large specimens and 1.48 on the small. There was little or no difference in the strength of the plain specimens.

N-46131*

Royal Aircraft Establishment (Gt. Brit.)
LOADS ON A MODEL DURING STARTING AND STOPPING OF AN INTERMITTENT SUPERSONIC WIND TUNNEL. K. G. Winter and C. S. Brown. May 1956. 17p. diagrs., photos. (RAE Tech. Note Aero 2453)

Measurements are given of the loads on a model during starting and stopping of an intermittent supersonic wind tunnel at Mach numbers of 2.00 and 2.48. Qualitative agreement is obtained with a simple theory but a need is evident for further measurements at higher Mach numbers. The use of a model loading coefficient in terms of tunnel stagnation pressure is proposed.

N-46132*

Ministry of Supply (Gt. Brit.)
FORMING OF D. T. D. 363 EXTRUSIONS AT ELEVATED TEMPERATURES. WARM BENDING OF DTD 363 EXTRUSIONS. PART I. CONDITIONS FOR FORMING DTD 363 EXTRUSIONS AT ELEVATED TEMPERATURES. K. Kornfeld. HOT BENDING OF DTD 363A EXTRUSIONS. PART II. THE BENDING OPERATION, PROPERTIES OF BENT BARS AND GENERAL CONCLUSIONS. N. W. D. Chrimes. 58p. diagrs., photos., tabs. (MOS S & T Memo.4/56)

N-46133*

Ministry of Supply (Gt. Brit.)
THE FATIGUE PROPERTIES OF TWO ALUMINIUM ALLOYS TESTED UNDER VARIABLE STRESS CONDITIONS. K. Gunn. August 1955. 55p. diagrs., photos., tabs. (MOS S & T Memo.5/56)

Results are given on fatigue properties as affected by periods of standing unstressed at intervals during the progress of the fatigue test, restoration of full fatigue properties after fatigue testing sufficient to cause damage, and a study of the cumulative rule in fatigue testing. The aluminum alloys studied were D. T. D. 364B and D. T. D. 683.

N-46249*

National Gas Turbine Establishment (Gt. Brit.)
THE FOULING OF TURBINE BLADES BY FUEL ASH. PART V. CORROSION TESTS WITH VARIOUS HEAT RESISTING MATERIALS. F. S. E. Whitcher. June 1956. 36p. diagrs., tabs. (NGTE R. 192)

The resistance of selected materials to accelerated oxidation by vanadium bearing fuel oil ash has been assessed by means of a series of rig tests. It is shown that alloys based on nickel or cobalt are more resistant to this type of corrosion than those based on iron. It is also shown that a considerable reduction in corrosion is achieved by the addition of magnesium to the fuel. For iron base alloys at temperatures up to 700° C, and for nickel and cobalt base alloys up to 800° C the oxidation is in many cases reduced to below that found under "ash free" conditions.

N-46250*

Royal Aircraft Establishment (Gt. Brit.)
SOME COMMENTS ON HIGH-LIFT TESTING IN WIND TUNNELS WITH PARTICULAR REFERENCE TO JET-BLOWING MODELS. A. Anscombe and J. Williams. June 1956. 30p. diagrs. (RAE Tech. Note Aero 2460)

This note considers some of the special problems of wind tunnel testing which arise in high-lift work. Discussion is confined to current experience in the R. A. E. and N. P. L. low-speed wind tunnels, and refers mainly to tests on blowing over flaps or jet-flaps. Comments are made on suitable size of model, methods of feeding compressed air into models without affecting balance readings, and general test technique. Methods of model construction are not specifically discussed.

N-46252*

National Gas Turbine Establishment (Gt. Brit.)
A METHOD OF CORRECTION OF COMPRESSOR CHARACTERISTICS FOR CHANGE OF WORKING FLUID SPECIFIC HEAT. S. J. Moyes. July 1956. 13p. diagr. (NGTE Memo. M. 276)

In some applications, the specific heat of the working fluid in the compressor of a gas turbine engine differs considerably from that obtaining in rig tests, due to a difference in temperature levels. It thus becomes necessary to ascertain the effect of changes of specific heat on compressor characteristics. This may be done using stage-by-stage analysis and synthesis, but a more direct and less laborious method is obviously desirable. This memorandum presents such a method for an axial flow compressor, based on aerodynamic relationships, the application of the method being illustrated by an example. The method is limited to cases where Mach number effects in the compressor are not present or are small. It is thought, however, that the method has a useful range of application and also is capable of being extended to deal with changes in working fluid properties other than specific heat.

N-46253*

Royal Aircraft Establishment (Gt. Brit.)
APPLICATION OF SEQUENCE TRANSFORM ANALYSIS TO THE DESIGN OF SAMPLING CONTROL SYSTEMS. A. R. Boothroyd and J. H. Westcott. March 1956. 53p. diagrs. (RAE Tech. Note GW 405)

Analytical methods are described appropriate to linear control systems in which the input is in the form of discrete samples, rather than continuous. The techniques described are applicable to guided weapon systems in which the guidance information is obtained intermittently. The analysis of sampling systems by the sequence transform method is presented, particular reference being made to the important contributions of R. H. Barker in this field. Control systems involving basically the double integrations of a clamped error signal are considered and Barker's method of stabilizing the system in regard to its response sequence at the sampling times is applied.

N-46254*

Royal Aircraft Establishment (Gt. Brit.)
A SATURABLE INDUCTOR MAGNETOMETER. A. Wilson. April 1956. 12p. diagrs., photos. (RAE Tech. Note TD 6)

A saturable inductor type of magnetometer is described which has been developed for measuring the attitude of a missile relative to the earth's magnetic field.

N-46282*

Forest Products Research Lab., Dept. of Scientific and Industrial Research (Gt. Brit.) INVESTIGATIONS INTO GLUES AND GLUING. PROGRESS REPORT NINETY-FIVE - JUNE 1956. THE DURABILITY OF ASSEMBLY GLUES - SECTION A. FINAL REPORT ON THE PLY-CLAD FRAMES AFTER TEN YEAR'S EXPOSURE. R. A. G. Knight, L. S. Doman, and G. E. Soane. 16p. tabs. (Supersedes Progress Reports Forty-Seven, Sixty-Four and Eighty). (Forest Products Research Lab., DSIR)

The durability of animal, casein, urea, phenolic, and resorcinol glues for a particular type of assembly work has been examined over a period of 10 years.

N-46283*

Forest Products Research Lab., Dept. of Scientific and Industrial Research (Gt. Brit.) INVESTIGATIONS INTO GLUES AND GLUING. PROGRESS REPORT NINETY-FOUR - MAY 1956. DURABILITY TESTS ON PLYWOOD ADHESIVES - SERIES II. TENTH YEAR AND FINAL REPORT. R. A. G. Knight, R. J. Newall, and J. E. Grosert. 13p. tabs. (Supersedes Progress Reports Forty-Four, February 1947, Forty-Six, March 1948, Forty-Six Addendum, April 1949, Sixty, March 1951, and Seventy-Six, March 1954). (Forest Products Research Lab., DSIR)

This report analyzes the behavior over a 10 year period of a range of adhesives used in beech plywood exposed to four natural conditions. The adhesives included a number of phenolic and resorcinol resins, one experimental melamine, fortified and normal ureas, (including with the latter some extended with cereal flour), casein and animal glues, and sodium silicate.

N-46284*

Forest Products Research Lab., Dept. of Scientific and Industrial Research (Gt. Brit.) COMPOSITE WOOD SECTION. TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. RED SERAYA - SHOREA PARVIFOLIA - BRITISH NORTH BORNEO. CONSIGNMENT NO. 841 GIVING 2 BILLETS FROM 2 TREES; WEIGHT - 28 LB./CU.FT. AT 15 PER CENT MOISTURE CONTENT. TIMBER PROVISIONALLY CLASSIFIED AS GROUP I. (PROGRESS REPORT THIRTY-NINE). July 1956. 8p. tabs. (Supersedes Progress Report Thirty-One, October 1956) (Forest Products Research Lab., DSIR)

N-46285*

Forest Products Research Lab., Dept. of Scientific and Industrial Research (Gt. Brit.) RADIO FREQUENCY AND OTHER HEATING PROCESSES. THE APPLICATION OF RADIO FREQUENCY HEATING TO A BATTEN TO PLYWOOD GLUED JOINT. PROGRESS REPORT THIRTEEN, MARCH 1956. J. F. S. Carruthers and G. E. Soane. 13p. diagrs., tabs. (Forest Products Research Lab., DSIR)

N-46286*

Forest Products Research Lab., Dept. of Scientific and Industrial Research (Gt. Brit.) COMPOSITE WOOD SECTION. TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. WHITE SERAYA - PARASHOREA PLICATA - NORTH BORNEO. CONSIGNMENT NO. 883 GIVING 2 BILLETS FROM 2 TREES; WEIGHT - APPROX: 35 LB./CU.FT. AT 15 PER CENT MOISTURE CONTENT. TIMBER PROVISIONALLY CLASSIFIED AS GROUP I. (PROGRESS REPORT THIRTY-EIGHT). June 1956. 7p. tabs. (Forest Products Research Lab., DSIR)

N-46287*

Forest Products Research Lab., Dept. of Scientific and Industrial Research (Gt. Brit.) COMPOSITE WOOD SECTION. TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. YELLOW SERAYA - SHOREA (RICHETIA) SP. - NORTH BORNEO. CONSIGNMENT NO. 861 - GIVING TWO BILLETS FROM TWO TREES; WEIGHT - VARIABLE, RANGES FROM 32 TO 55 LB. PER CU. FT. AT 15 PER CENT MOISTURE CONTENT. TIMBER PROVISIONALLY CLASSIFIED AS GROUP I. (PROGRESS REPORT THIRTY-FIVE). April 1956. 8p. tabs. (Forest Products Research Lab., DSIR)

N-46288*

Forest Products Research Lab., Dept. of Scientific and Industrial Research (Gt. Brit.) COMPOSITE WOOD SECTION. TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. KAPUR - DRYOBALANOPS LANCEOLATA - NORTH BORNEO. CONSIGNMENT NO. 842 GIVING TWO BILLETS FROM TWO TREES; WEIGHT - 46 LB./CUBIC FEET AT 15 PER CENT MOISTURE CONTENT. TIMBER PROVISIONALLY CLASSIFIED AS GROUP III. (PROGRESS REPORT THIRTY-SIX). April 1956. 7p. tabs. (Forest Products Research Lab., DSIR)

N-46289*

Forest Products Research Lab., Dept. of Scientific and Industrial Research (Gt. Brit.) COMPOSITE WOOD SECTION. TRIALS OF TIMBERS FOR PLYWOOD MANUFACTURE. KERUING - DIPTEROCARPUS TAWENSIS - NORTH BORNEO. CONSIGNMENT NO. 860 GIVING TWO BILLETS FROM TWO TREES; WEIGHT - VARIABLE, INDIVIDUAL SPECIES VARY BETWEEN 39 AND 59 LB/CU. FT. AT 15 PER CENT MOISTURE CONTENT. TIMBER PROVISIONALLY CLASSIFIED AS GROUP III. (PROGRESS REPORT THIRTY-SEVEN). April 1956. 8p. tabs. (Forest Products Research Lab., DSIR)

MISCELLANEOUS

NACA Rept. 1193

Errata on "THEORETICAL PERFORMANCE CHARACTERISTICS OF SHARP-LIP INLETS AT SUBSONIC SPEEDS." Evan A. Fradenburgh and DeMarquis D. Wyatt. 1954.

N-47258*

Advisory Group for Aeronautical Research and Development. COMPRESSORS FOR HIGH-SPEED WIND TUNNELS. Andrew A. Fejer, University of Toledo and James Clark, Air Research Manufacturing Company of Phoenix. Wilbur C. Nelson, University of Michigan, Editor. January 1956. 216p. diagrs., photos. (AGARDograph 14)

This study is concerned with the compressor drive systems for high-speed wind tunnels of the continuous type. It contains information regarding the aerodynamic characteristics of wind tunnel circuits from which the compressor requirements can be established, presents a method to guide in the selection of the compressor type, and discusses compressor drives utilizing various types of prime movers. It outlines some of the aerodynamic and mechanical considerations underlying the design and operation of wind tunnel drives including a discussion of vibrational problems encountered in systems of this type.

N-47328

Advisory Group for Aeronautical Research and Development. PAPERS PRESENTED AT THE SEVENTH MEETING OF THE WIND TUNNEL AND MODEL TESTING PANEL, OTTAWA, CANADA, JUNE, 1955. 331p. diagrs., photos., tabs. (Advisory Group for Aeronautical Research and Development. AG19/P9)

Contents: THE REPRESENTATION OF ENGINE AIRFLOW IN WIND TUNNEL MODEL TESTING. J. Seddon and L. F. Nicholson, Royal Aircraft Establishment. Appendix I: NOTES ON SOME RECENT WORK ON THE DESIGN OF ANNULAR SUPERSONIC NOZZLES. W. T. Lord. THE INFLUENCE OF TURBOJET AIRFLOW ON THE AERODYNAMIC DESIGN OF AIRPLANES. Harold Luskin and Harold Klein, Douglas Aircraft Co., Inc. THE SIMULATION OF THE EFFECTS OF INTERNAL FLOW IN WIND TUNNEL MODEL TESTS OF TURBOJET POWERED AIRCRAFT. Albert J. Evans, National Advisory Committee for Aeronautics. BOUNDARY LAYERS ON SWEPT WINGS. THEIR EFFECTS AND THEIR MEASUREMENT. D. Küchemann, Royal Aircraft Establishment. THE USE OF PITOT TUBES IN THE MEASUREMENT OF LAMINAR BOUNDARY LAYERS IN SUPERSONIC FLOW. R. J. Monaghan, Royal Aircraft Establishment. METHODE DE CALCUL DE LA COUCHE LIMITE TRIDIMENSIONNELLE APPLICATION A UN CORPS FUSELE INCLINE SUR LE VENT. E. A. Eichelbrenner and A. Oudard, Office National d'Études et de Recherches Aéronautiques. A BRIEF REVIEW OF THREE-DIMENSIONAL BOUNDARY-LAYER FLOWS. W. R. Sears, Cornell University. THE SIMULATION AND MEASUREMENT OF AERODYNAMIC HEATING AT SUPERSONIC AND HYPERSONIC MACH NUMBERS. Jackson R. Stalder and Alvin Seiff, National Advisory Committee for Aeronautics. THE STATUS OF HEAT TRANSFER AND FRICTION INVESTIGATIONS AT SUPERSONIC SPEEDS. H. H. Kurzweg, Naval Ordnance Laboratory. THE N.R.C. ICING WIND TUNNELS AND SOME OF THEIR PROBLEMS. C. K. Rush, National Aeronautical Establishment. WIND TUNNEL SIMULATION OF ATMOSPHERIC ICING CONDITIONS. C. K. Rush and R. L. Wardlaw, National Aeronautical Establishment. THE FLUID FLOW ASSOCIATED WITH THE IMPACT OF LIQUID DROPS WITH SOLID SURFACES. P. Savic and G. T. Boult, National Research Council. THE ICING PROBLEM - CURRENT STATUS OF N.A.C.A. TECHNIQUES AND RESEARCH. Uwe H. von Glahn, National Advisory Committee for Aeronautics.

UNPUBLISHED PAPERS

N-15800*

ON THE ORIGIN OF TURBULENT MOTIONS OF FLUIDS AND ON THE EFFECT OF THESE MOVEMENTS IN THE FLOW THROUGH PIPES. (Über die Entstehung turbulenter Flüssigkeitsbewegungen und über den Einfluss dieser Bewegungen bei der Strömung durch Röhren). Hendrik Antoon Lorentz. July 1956. 35p. (Trans. from Abhandlungen über Theoretische Physik, v.1, ch.3, 1907, p.43-71)

N-16991*

CIRCULATION DISTRIBUTION IN MULTISTAGE AXIAL TURBINES. (Zirkulationsverteilung in Mehrstufigen Axialturbinen). Karl Bammert. 21p. diagrs. (Trans. from Wissenschaftliche Gesellschaft, Braunschweig, Abhandlungen, v. 4, 1952, p. 73-86)

Behind the first stage of multistage axial turbines with untwisted blades, a certain flow pattern occurs which practically is repeated behind each of the succeeding homogeneously constructed stages. Consequently, the blade circulations of both the stator and rotor rows are approximately constant over the entire blade length except for the first stage. With regard to blade circulation there is, therefore, no need to consider the more expensive free-vortex blading with constant circulation over the blade length as being more advantageous compared with the essentially simpler untwisted blading. Untwisted blading is understood to include all blade shapes with a constant outlet angle over the entire blade length.

N-47547*

THE EFFECT OF DEFORMATION ON THE POTENTIALS OF METALS. (Vliyanie deformatsii na potentsialy metallov). E. M. Zaretskii. 18p. diagrs., photo. (Translation from Zhurnal Prikladnoi Khimii, v. 24, no. 6, 1951, p. 614-623)

The effect of deformation on the electrical characteristics of several rolled industrial metals is investigated. The change in the electrode potentials of magnesium, magnesium alloys MA1 and MA3, aluminum, steel, copper, and zinc was studied under the action of deformation. Several tests were conducted on a model voltaic cell of magnesium alloys.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification September 24, 1956.

NACA RM A50I14

WIND-TUNNEL INVESTIGATION AT LOW SPEED OF A WING SWEPT BACK 63° AND TWISTED AND CAMBERED FOR UNIFORM LOAD AT A LIFT COEFFICIENT OF 0.5 AND WITH A THICKENED TIP SECTION. James A. Weiberg and Hubert C. Carel. November 21, 1950. 42p. diagrs., photo., tabs. (NACA RM A50I14)

The results of force and pressure distribution measurements showed that an increase in thickness and a minor change of twist from midsemispan to the tip of a semispan model of a wing with the leading edge swept back 63° did not result in improved longitudinal-stability characteristics of the wing. The modification reduced the nose pressure peaks with no resulting improvement of tip lift characteristics indicating that the early loss of lift of the tip is due more to spanwise flow than local stall. By adding flaps and fences to the wing the adverse effects of spanwise boundary-layer flow and separation on the longitudinal stability of the wing were delayed to higher angles of attack.

NACA RM A50J17

A COMPARISON OF THE EXPERIMENTAL AND THEORETICAL LOADING OVER TRIANGULAR WINGS AT SUPERSONIC SPEEDS. John W. Boyd and E. Ray Phelps. January 3, 1951. 42p. diagrs., photos., tabs. (NACA RM A50J17)

The results of an experimental investigation of the pressure distribution over two triangular wings at Mach numbers from 1.20 to 1.70 are presented and compared with theory. The two wings tested have identical plan form, 45° sweepback of the leading edge, and an aspect ratio of 4.0, but different airfoil sections. One model was composed of round-nose airfoil sections and the other of sharp-nose, biconvex sections, 6 percent thick in streamwise planes.

NACA RM A50K20

LIFT, DRAG, AND PITCHING MOMENT OF LOW-ASPECT-RATIO WINGS AT SUBSONIC AND SUPERSONIC SPEEDS - PLANE TRIANGULAR WING OF ASPECT RATIO 2 WITH NACA 0008-63 SECTION. Donald W. Smith and John C. Heitmeyer. February 1, 1951. 22p. diagrs., photo. (NACA RM A50K20)

This paper contains the results of an investigation to ascertain the lift, drag, and pitching moment of a wing-body combination having a plane triangular wing of aspect ratio 2 and NACA 0008-63 sections in streamwise planes. Results are shown for Mach numbers from 0.24 to 1.70 at a Reynolds number of 3.0 million. The variations of the characteristics with Reynolds number are also shown for several Mach numbers.

NACA RM A53I17

A STUDY OF THE EFFECTS OF BODY SHAPE ON THE VORTEX WAKES OF INCLINED BODIES AT A MACH NUMBER OF 2. Forrest E. Gowen and Edward W. Perkins. December 1953. 25p. diagrs., photos. (NACA RM A53I17)

A study of the wake of a number of bodies of revolution at moderate and large angles of attack was made at a Mach number of 1.98 by use of a visual-flow technique. It was found that the angle of attack at which the crossflow wake became unsteady was increased by reducing the nose fineness ratio, or for a given fineness ratio, by changing the nose shape to a more blunt profile.

NACA RM A53I21

WIND-TUNNEL INVESTIGATION OF A 45° SWEPTBACK WING HAVING A SYMMETRICAL ROOT AND A HIGHLY CAMBERED TIP, INCLUDING THE EFFECTS OF FENCES AND LATERAL CONTROLS. Joseph W. Cleary and Lee E. Boddy. November 1953. 52p. diagrs., photo. (NACA RM A53I21)

A wind-tunnel investigation at subsonic Mach numbers has been made of the aerodynamic characteristics of a 45° sweptback wing-body combination having varying camber along the span. The results show the effects of fences on the longitudinal characteristics and the longitudinal and lateral control characteristics of an aileron and two types of spoilers. The longitudinal characteristics are compared with those of two other wings having the same plan form, one without camber, the other with uniform camber.

NACA RM A53J14

THE EFFECTS OF CIRCULAR END PLATES ON THE LIFT, DRAG, AND PITCHING MOMENT AT SUBSONIC AND SUPERSONIC SPEEDS ON A MODIFIED TRIANGULAR WING HAVING AN ASPECT RATIO OF 2, A TAPER RATIO OF 0.33, AND A 45° SWEPT LEADING EDGE. Robert B. Petersen. March 1954. 16p. diagrs., tab. (NACA RM A53J14)

The effects of circular end plates on the longitudinal aerodynamic characteristics of a modified triangular wing of aspect ratio 2 are presented for subsonic and supersonic Mach numbers at a Reynolds number of approximately 4×10^6. The aerodynamic characteristics investigated are center-of-pressure position, lift-curve slope, maximum lift-drag ratio, minimum drag, and lift coefficient at which the maximum lift-drag ratio occurs.

NACA RM E7I05

THEORETICAL ANALYSIS OF THE PERFORMANCE OF A SUPERSONIC DUCTED ROCKET. Reece V. Hensley. February 13, 1948. 32p. diagrs. (NACA RM E7I05)

Presents theoretical analysis, considering variation of specific heats, of performance of a ducted rocket at supersonic flight velocities. Analysis is based on a gasoline-liquid oxygen rocket. Considerable increases in thrust above the thrust of the rocket alone or the thrust of a ram jet of a size comparable to the ducted rocket could be obtained with a fuel consumption intermediate between those of a rocket and a ram jet operating under similar flight conditions.

NACA RM E7I30

PRELIMINARY ESTIMATE OF PERFORMANCE OF A TURBOJET ENGINE WHEN INLET PRESSURE IS REDUCED BELOW EXHAUST PRESSURE. H. D. Wilsted and W. D. Stemples. February 18, 1948. 42p. diagrs. (NACA RM E7I30)

Investigations of a turbojet engine were conducted with reduced compressor-inlet pressures to simulate operation with inlet-duct losses with two different area jet nozzles. Thrust and air consumption decreased rapidly with decreasing inlet pressure and operating temperatures and specific fuel consumption increased sharply. Small improvements in inlet pressure recovery were shown to appreciably decrease length of take-off run. Data are applicable to use of turbojet engine as a pump for removing boundary-layer air from wing surfaces and to the problem of inlet throttling as a means of thrust control.

NACA RM E8I17a

THEORETICAL PERFORMANCE OF DIBORANE AS A ROCKET FUEL. Vearl N. Huff, Clyde S. Calvert, and Virginia C. Erdmann. January 10, 1949. 31p. diagrs., tabs. (NACA RM E8I17a)

Theoretical performance data including nozzle-exit temperature, specific impulse, and volume specific impulse based on frozen and equilibrium expansion are presented for four rocket propellant combinations at a pressure of 20.4 atmospheres. Composition of reaction products is given. Based on maximum specific impulse, the order of four oxidants reacting with diborane was: liquid fluorine, liquid fluorine oxide, liquid oxygen, and 100-percent hydrogen peroxide. Based on maximum calculated volume specific impulse, order of four oxidants with diborane was: liquid fluorine oxide, liquid fluorine, 100-percent hydrogen peroxide, and liquid oxygen.

NACA RM E50C30

EFFECT OF COMBUSTION-CHAMBER PRESSURE AND NOZZLE EXPANSION RATIO ON THEORETICAL PERFORMANCE OF SEVERAL ROCKET PROPELLANT SYSTEMS. Virginia E. Morrell. May 25, 1950. 15p. diagrs., tabs. (NACA RM E50C30)

Theoretical calculations of specific impulse to determine the separate effects of increasing the combustion-chamber pressure and the nozzle expansion ratio on the performance of the propellants, hydrogen-fluorine, hydrogen-oxygen, ammonia-fluorine and AN-F-58 fuel - white fuming nitric acid (95 percent). The results indicate that an increase in specific impulse obtainable with an increase in combustion-chamber pressure is almost entirely caused by the increased expansion ratio through the nozzle.

NACA RM E50I18

FACTORS IN SELECTING FUELS FOR GAS-TURBINE POWERED AIRCRAFT. Louis C. Gibbons. November 13, 1950. 85p. diagrs., photos., tabs. (NACA RM E50I18)

The problems associated with the selection of fuels for gas-turbine aircraft are briefly discussed. The loss of fuel by high-performance aircraft during climb, and the performance of fuels of varying volatility and composition in gas-turbine engines are considered. The potential availability of fuels at various volatility levels is also considered. Low-volatility fuels would minimize fuels losses during climb and would give good combustion efficiencies and altitude operational limits. Low-volatility fuels would be more difficult to start and would tend to deposit more carbon than volatile fuels.

NACA RM E51C01

THEORETICAL PERFORMANCE OF LITHIUM AND FLUORINE AS A ROCKET PROPELLANT. Sanford Gordon and Vearl N. Huff. May 10, 1951. 22p. diagrs., tabs. (NACA RM E51C01)

Theoretical performance for liquid lithium and liquid fluorine as a rocket propellant was calculated with assumptions both of equilibrium and frozen composition during expansion. Parameters included were specific impulse, combustion-chamber temperature, nozzle-exit temperature, composition, mean molecular weight, characteristic velocity, coefficient of thrust, and ratio of nozzle-exit area to throat area. For chamber pressure of 300 pounds per square inch absolute and expansion to 1 atmosphere, the maximum

equilibrium specific impulse calculated was 335.5 pound-seconds per pound. The effect of ionization on calculated performance was shown to be negligible by comparison of values of various parameters calculated both with and without ionized products of combustion.

NACA RM E51I06

STEADY-STATE ENGINE WINDMILLING AND ENGINE SPEED DECAY CHARACTERISTICS OF AN AXIAL-FLOW TURBOJET ENGINE. A. E. Sobolewski and J. M. Farley. December 1951. 20p. diagrs., photo. (NACA RM E51I06)

A wind-tunnel investigation has been conducted to determine the steady-state windmilling and engine speed decay characteristics of the J34-WE-32 turbojet over a range of altitudes from 5000 to 50,000 feet and simulated flight Mach numbers from 0.19 to 1.06. The effect of an engine accessory load on the speed decay characteristics was also determined. The accessory load was about 7.8 horsepower for engine speeds above 4000 rpm and decreased with decreasing engine speed. An analysis of the speed decay data was made and engine speed decay rates were determined for hypothetical accessory loads up to 40 horsepower.

NACA RM E51I24

PRELIMINARY INVESTIGATION OF A TRANSLATING COWL TECHNIQUE FOR IMPROVING TAKE-OFF PERFORMANCE OF A SHARP-LIP SUPERSONIC DIFFUSER. Edgar M. Cortright, Jr. November 1951. 11p. diagrs., photos. (NACA RM E51I24)

A preliminary investigation was conducted in quiescent air on a translating cowl technique for improving the take-off performance of a sharp-lip supersonic diffuser. The technique consists of cutting the cowling in a plane normal to its axis and then translating the forepart of the cowling in the forward direction. The leading edge of the fixed portion of the cowling is rounded. Appreciably improved inlet performance was obtained with a cowling translation corresponding to a gap of only 1/4 inlet radius.

NACA RM E51L11

THEORETICAL PERFORMANCE OF LIQUID AMMONIA, HYDRAZINE, AND MIXTURE OF LIQUID AMMONIA AND HYDRAZINE AS FUELS WITH LIQUID OXYGEN BIFLUORIDE AS OXIDANT FOR ROCKET ENGINES. I - MIXTURE OF LIQUID AMMONIA AND HYDRAZINE. Vearl N. Huff and Sanford Gordon. February 1952. 24p. diagrs., tabs. (NACA RM E51L11)

Theoretical performance for mixture of 36.3 percent liquid ammonia and 63.7 percent hydrazine with liquid oxygen bifluoride as rocket propellant was calculated on assumption of equilibrium composition during expansion for a wide range of fuel-oxidant and expansion ratios. Parameters included were specific impulse, combustion-chamber temperature, nozzle exit temperature, composition, mean molecular weight, characteristic velocity, coefficient of thrust, and ratio of nozzle-exit area to throat area. For chamber pressure of 300 pounds per square inch absolute and expansion to 1 atmosphere, maximum specific impulse was 295.8 pound-seconds per pound. Five percent by weight of water in the hydrazine lowered specific impulse from about one to three units over a wide range of weight-percent fuel.

NACA RM E52G09

THEORETICAL PERFORMANCE OF LIQUID AMMONIA, HYDRAZINE, AND MIXTURE OF LIQUID AMMONIA AND HYDRAZINE AS FUELS WITH LIQUID OXYGEN BIFLUORIDE AS OXIDANT FOR ROCKET ENGINES. II - HYDRAZINE. Vearl N. Huff and Sanford Gordon. September 1952. 20p. diagrs., tabs. (NACA RM E52G09)

Theoretical performance of hydrazine with liquid oxygen bifluoride as a rocket propellant was calculated for a wide range of fuel-oxidant and expansion ratios on the assumption of equilibrium composition during expansion. Parameters included were specific impulse, combustion-chamber temperature, nozzle exit temperature, equilibrium composition, mean molecular weight, characteristic velocity, coefficient of thrust, and ratio of nozzle-exit area to throat area. For chamber pressure of 300 pounds per square inch absolute and expansion to 1 atmosphere, maximum specific impulse was 298.7 pound-seconds per pound. The presence of 5 percent by weight of water in the hydrazine lowered specific impulse from 2 to 5 units over a wide range of fuel-oxidant and expansion ratios.

NACA RM E52H14

THEOREITCAL PERFORMANCE OF LIQUID AMMONIA, HYDRAZINE, AND MIXTURE OF LIQUID AMMONIA AND HYDRAZINE AS FUELS WITH LIQUID OXYGEN BIFLUORIDE AS OXIDANT FOR ROCKET ENGINES. III - LIQUID AMMONIA. Vearl N. Huff and Sanford Gordon. October 1952. 15p. diagrs., tabs. (NACA RM E52H14)

Theoretical values of performance parameters for liquid ammonia with liquid oxygen bifluoride were calculated on the assumption of equilibrium composition during the expansion process for a wide range of fuel-oxidant and expansion ratios. Parameters included were specific impulse, combustion-chamber temperature, nozzle-exit temperature, equilibrium composition, mean molecular weight, characteristic velocity, coefficient of thrust, and ratio of nozzle-exit area to throat area. The maximum value of specific impulse was 291.6 pound-seconds per pound for a chamber pressure of 300 pounds per square inch absolute (20.41 atm) and an exit pressure of 1 atmosphere.

NACA RM E52L11

THEORETICAL PERFORMANCE OF LIQUID HYDROGEN AND LIQUID FLUORINE AS A ROCKET PROPELLANT. Sanford Gordon and Vearl N. Huff. February 1953. 28p. diagrs., tabs. (NACA RM E52L11)

Theoretical values of performance parameters for liquid hydrogen and liquid fluorine as a rocket propellant were calculated on the assumption of equilibrium composition during the expansion process for a wide range of fuel-oxidant and expansion ratios. The parameters included were specific impulse, combustion-chamber temperature, nozzle-exit temperature, equilibrium composition, mean molecular weight, characteristic velocity, coefficient of thrust, ratio of nozzle-exit area to throat area, specific heat at constant pressure, coefficient of viscosity, and coefficient of thermal conductivity. The maximum value of specific impulse was 364.6 pound-seconds per pound for a chamber pressure of 300 pounds per square inch absolute (20.41 atm) and an exit pressure of 1 atmosphere.

NACA RM E53A26

THEORETICAL PERFORMANCE OF LIQUID AMMONIA AND LIQUID FLUORINE AS A ROCKET PROPELLANT. Sanford Gordon and Vearl N. Huff. March 1953. 25p. diagrs., tabs. (NACA RM E53A26)

Theoretical values of performance parameters for liquid ammonia and liquid fluorine as a rocket propellant were calculated on the assumption of equilibrium composition during the expansion process for a wide range of fuel-oxidant and expansion ratios. The parameters included were specific impulse, combustion chamber temperature, nozzle-exit temperature, equilibrium composition, mean molecular weight, characteristic velocity, coefficient of thrust, ratio of nozzle-exit area to throat area, specific heat at constant pressure, coefficient of viscosity, and coefficient of thermal conductivity. The maximum value of specific impulse was 311.5 pound-seconds per pound for a chamber pressure of 300 pounds per square inch absolute (20.41 atm) and an exit pressure of 1 atmosphere.

NACA RM E53E12

THEORETICAL PERFORMANCE OF LIQUID HYDRAZINE AND LIQUID FLUORINE AS A ROCKET PROPELLANT. Sanford Gordon and Vearl N. Huff. July 1953. 83p. diagrs., tabs. (NACA RM E53E12)

Theoretical values of performance parameters for liquid hydrazine and liquid fluorine as a rocket propellant were calculated on the assumption of equilibrium composition during the expansion process for four chamber pressures and a wide range of fuel-oxidant and expansion ratios. The parameters included were specific impulse, combustion-chamber temperature, nozzle-exit temperature, equilibrium composition, mean molecular weight, characteristic velocity, coefficient of thrust, ratio of nozzle-exit area to throat area, specific heat at constant pressure, coefficient of viscosity, and coefficient of thermal conductivity. A correlation is presented for the effect of chamber pressure on several of the parameters. The maximum value of specific impulse was 315.3 pound-seconds per pound for a chamber pressure of 300 pounds per square inch absolute (20.41 atm) and an exit pressure of 1 atmosphere.

NACA RM E53F08

THEORETICAL PERFORMANCE OF MIXTURES OF LIQUID AMMONIA AND HYDRAZINE AS FUEL WITH LIQUID FLUORINE AS OXIDANT FOR ROCKET ENGINES. Sanford Gordon and Vearl N. Huff. July 1953. 43p. diagrs., tabs. (NACA RM E53F08)

Theoretical values of rocket performance parameters for two mixtures of liquid ammonia and hydrazine as fuels with liquid fluorine as oxidant were calculated on the assumption of equilibrium composition during the expansion process for a wide range of fuel-oxidant and expansion ratios. The parameters included were specific impulse, combustion-chamber temperature, nozzle-exit temperature, equilibrium composition, mean molecular weight, characteristic velocity, coefficient of thrust, ratio of nozzle-exit area to throat area, specific heat at constant pressure, coefficient of viscosity, and coefficient of thermal conductivity. Exponents were calculated that permit determination of specific impulse over a range of chamber pressures. The maximum value of specific impulse at sea level for a chamber pressure of 300 pounds per square inch absolute (20.41 atm) was 313.6 pound-seconds per pound for the fuel mixture containing 36.3 percent ammonia by weight and 311.9 pound-seconds per pound for the fuel mixture containing 87 percent ammonia by weight.

NACA RM E53I15

ANALYSIS OF PART-SPEED OPERATION FOR HIGH-PRESSURE-RATIO MULTISTAGE AXIAL-FLOW COMPRESSORS. William A. Benser. December 1953. 41p. diagrs., tab. (NACA RM E53I15)

A multistage axial-flow compressor stage-stacking analysis has indicated that either discontinuities in the performance of inlet stages or stage interactions could result in multiple-valued performance curves at intermediate speeds. The dips exhibited in the surge limits of high-pressure-ratio multistage axial-flow compressors are probably a transition from operation with the inlet stage stalled to operation with the inlet stage unstalled. In addition, the performance curve obtained at a given speed depends on the manner in which speed and throttling are varied in setting that particular operating point. Thus, intermediate-speed surge limits obtained during engine operation of a compressor may be different from those obtained in component testing, and the surge limit obtained during engine acceleration may differ from that obtained during slow decelerations. Severe inlet stage-stall characteristics or stage interactions result in extremely low part-speed efficiencies. Stages with continuous performance characteristics at their stall points, when operated in a multistage compressor, are desirable from the standpoint of good part-speed efficiency and surge-limit characteristics.

NACA RM E54H09

THEORETICAL MAXIMUM PERFORMANCE OF LIQUID FLUORINE - LIQUID OXYGEN MIXTURES WITH JP-4 FUEL AS ROCKET PROPELLANTS. Sanford Gordon and Roger L. Wilkins. October 1954. 18p. diagrs., tabs. (NACA RM E54H09)

Theoretical values of rocket performance parameters were calculated for JP-4 fuel and various mixtures of liquid fluorine and liquid oxygen, assuming both equilibrium and frozen composition during expansion. Data were calculated at several equivalence ratios for each fluorine-oxygen mixture. Parameters included were specific impulse, combustion-chamber temperature, nozzle-exit temperature, equilibrium composition, mean molecular weight, characteristic velocity, coefficient of thrust, and ratio of nozzle-exit area to throat area. Maximum value of specific impulse for chamber pressure of 300 lb/sq in. abs and exit pressure of 1 atm is 299.4 lb-sec/lb for equilibrium composition and 278.9 lb-sec/lb for frozen composition.

NACA RM L50I18

NOTE ON SOME OBSERVED EFFECTS OF ROCKET-MOTOR OPERATION ON THE BASE PRESSURES OF BODIES IN FREE FLIGHT. Paul E. Purser, Joseph G. Thibodaux, and H. Herbert Jackson. November 16, 1950. 28p. diagrs., tabs. (NACA RM L50I18)

Some measurements of the effects of rocket-motor operation on base pressure were obtained incidental to other research on some bodies in free flight. These data are presented and qualitatively analyzed. The analysis indicates that jet effects on drag are of sufficient importance to deserve consideration in the design of jet-motor nozzles, especially for aircraft and missiles where the thrust and drag are of the same order of magnitude. The base-pressure changes induced by the jet should be considered in the structural design of the outer body skin on the aft portion of fuselages containing jets.

NACA RM L50I22

COMPARISON OF LARGE-SCALE FLIGHT MEASUREMENTS OF ZERO-LIFT DRAG AT MACH NUMBERS FROM 0.9 TO 1.7 OF TWO WING-BODY COMBINATIONS HAVING SIMILAR 60° TRIANGULAR WINGS WITH NACA 65A003 SECTIONS. Eugene D. Schult. October 25, 1950. 15p. diagrs., photo., tab. (NACA RM L50I22)

An investigation of zero-lift drag of a fin-stabilized wing-body combination was made at high-subsonic and supersonic speeds in the Reynolds number range of 13×10^6 to 41×10^6. The ratio of body frontal area to wing area was 0.0612. These data are presented with those of a wingless body and similar winged body described in NACA RM L50D26 in which the ratio of body frontal area to wing area was 0.0306. The bodies of both configurations were the same as the wingless body and had parabolic profiles and fineness ratios of 10. The wings were triangular in plan form with a leading-edge sweep of 60° and NACA 65A003 airfoil sections.

#NACA RM L50I26

NACA RM L51I14

FREE-FLIGHT INVESTIGATION TO DETERMINE FORCE AND HINGE-MOMENT CHARACTERISTICS AT ZERO ANGLE OF ATTACK OF A 60° SWEPTBACK HALF-DELTA TIP CONTROL ON A 60° SWEPTBACK DELTA WING AT MACH NUMBERS BETWEEN 0.68 AND 1.44. C. William Martz, James D. Church, and John W. Goslee. December 1951. 36p. diagrs., photos. (NACA RM L51I14)

Control hinge-moment coefficients, normal-force coefficients and chordwise center-of-pressure locations were obtained at zero angle of attack from free-flight tests of two rocket-powered models equipped with 60° sweptback half-delta wing-tip controls mounted on a 60° sweptback delta wing. The data were obtained for deflections up to ±10° over a Mach number range of 0.675 to 1.435 and used to calculate hinge-moment coefficients at various hinge-line locations. Comparisons are made with linearized theory and other rocket-test results.

NACA RM L51I26

EFFECTS ON CONTROL EFFECTIVENESS OF SYSTEMATICALLY VARYING THE SIZE AND LOCATION OF TRAILING-EDGE FLAPS ON A 45° SWEPTBACK WING AT A MACH NUMBER OF 1.9. Carl R. Jacobsen. December 1951. 34p. diagrs., photo., tab. (NACA RM L51I26)

Plain trailing-edge flaps were tested on a 45° sweptback semispan wing in the Langley 9- by 12-inch supersonic blowdown tunnel. The tests were made through an angle-of-attack range of ±6° at a Mach number of 1.9 and a Reynolds number of 2.1×10^6. Flaps having chords and spans which were systematically varied were tested at several spanwise locations. The results were compared with similar results obtained from a related unswept wing. The wing model had an aspect ratio of 2.5, a taper ratio of 0.625, and 6-percent-chord-thick modified hexagonal airfoil sections. Experimental effectiveness parameters are compared with effectiveness parameters calculated by linearized theory.

NACA RM L53I08

AERODYNAMIC CHARACTERISTICS OF A 68.4° DELTA WING AT MACH NUMBERS OF 1.6 AND 1.9 OVER A WIDE REYNOLDS NUMBER RANGE. John E. Hatch, Jr., and James J. Gallagher. November 1953. 44p. diagrs., photos., tabs. (NACA RM L53I08)

The effect of Reynolds number on the aerodynamic characteristics of a 68.4° delta wing is presented. At Mach number 1.62 pressure data are shown for a Reynolds number range of 2.2×10^6 to 7.4×10^6. Force data are presented at a Mach number 1.9 for a Reynolds number range of 7.4×10^6 to 18.4×10^6, and pressure data are given for a range of 2.2×10^6 to 18.4×10^6. Basic studies of the flow in the wing boundary layer and of the flow just outside of the boundary layer are also presented.

NACA RM L53I10

FLIGHT TEST RESULTS OF ROCKET-PROPELLED BUFFET-RESEARCH MODELS HAVING 45° SWEPTBACK WINGS AND 45° SWEPTBACK TAILS LOCATED IN THE WING CHORD PLANE. Homer P. Mason. October 1953. 26p. diagrs., photos., tab. (NACA RM L53I10)

Results of flight tests of two rocket-propelled buffet-research models having 45° sweptback tails located in the chord plane of 45° sweptback wings and of one similar model with no horizontal-tail surfaces are presented as incremental accelerations due to buffeting, trim angles of attack and force coefficients, wing-tip helix angles, static-directional-stability derivatives, and drag coefficients plotted against Mach number.

#NACA RM L53I22c

NACA RM L53I25

SOME EFFECTS OF LEADING-EDGE ROUGHNESS ON THE AILERON EFFECTIVENESS AND DRAG OF A THIN RECTANGULAR WING EMPLOYING A FULL-SPAN PLAIN AILERON AT MACH NUMBERS FROM 0.6 TO 1.5. Roland D. English. November 1953. 16p. diagrs., photos. (NACA RM L53I25)

An investigation has been made of some effects of leading-edge roughness on the rolling effectiveness and drag of an unswept, untapered, 6-percent-thick, circular-arc-airfoil wing. The results indicate that the addition of roughness reduces the rolling effectiveness at subsonic speeds, but has little effect in the supersonic range. Adding roughness increased the drag coefficient over the entire Mach number range from 0.6 to 1.5.

NACA RM L53I28

A FLIGHT INVESTIGATION OF THE EFFECTS OF INCLINATION OF THE PRINCIPAL AXIS OF INERTIA ON THE DYNAMIC LATERAL STABILITY OF THE REPUBLIC XF-91 AIRPLANE. Thomas W. Finch. July 1954. 19p. diagrs., photos., tab. (NACA RM L53I28)

A flight investigation has been conducted to determine the effect of variable wing incidence angle on the dynamic lateral stability of the Republic XF-91 airplane. The tests were conducted over a Mach number range of 0.3 to 0.9 at altitudes of 10,000, 20.000, 30,000, and 37,500 feet at wing incidence angles of -2°, 2°, 4°, and 5.65°.

NACA RM L53I28a

AERODYNAMIC CHARACTERISTICS OF A CANARD-BALANCED, FREE-FLOATING, ALL-MOVABLE STABILIZER AS OBTAINED FROM ROCKET-POWERED-MODEL FLIGHT TESTS AND LOW-SPEED WIND-TUNNEL TESTS. William N. Gardner. December 1953. 65p. diagrs., photos., tabs. (NACA RM L53I28a)

Low-speed wind-tunnel tests and flight tests of two rocket-powered models were conducted on a tail-alone configuration incorporating a canard-balanced free-floating all-movable delta-surface horizontal tail mounted on the tip of a swept vertical tail. The canard-type servoplane is used to change the trim deflection of the free-floating tail, and a linked trailing-edge flap is used to allow the tail to provide a static-stability contribution to a configuration on which it is employed. Data were obtained on the servoplane effectiveness as well as the floating characteristics, dynamic stability, hinge moments, lift, and trim of the all-movable tail over a Mach number range from 0.6 to 1.46 corresponding to Reynolds numbers of 4×10^6 to 10×10^6.

NACA RM L53I29

RESULTS OF A ROCKET-MODEL INVESTIGATION OF CONTROL-SURFACE BUZZ AND FLUTTER ON A 4-PERCENT-THICK UNSWEPT WING AND ON 6-, 9-, AND 12-PERCENT-THICK SWEPT WINGS AT TRANSONIC SPEEDS. Allen B. Henning. November 1953. 33p. diagrs., photos., tabs. (NACA RM L53I29)

The results of an investigation of control-surface buzz and flutter on four rocket-powered models having a 4-percent-thick unswept wing and 6-, 9-, and 12-percent-thick 35° swept wings with free floating and statically mass-balanced control surfaces are presented. All control surfaces buzzed. Buzz was related to presence of shock wave. Amplitude and frequency of the control-surface motion and wing drag were measured.

NACA RM L54I08

INVESTIGATION AT HIGH SUBSONIC SPEEDS OF THE PRESSURE DISTRIBUTIONS ON A 45° SWEPTBACK VERTICAL TAIL IN SIDESLIP WITH A 45° SWEPTBACK HORIZONTAL TAIL MOUNTED AT 50-PERCENT AND 100-PERCENT VERTICAL-TAIL SPAN. Harleth G. Wiley and William C. Moseley, Jr. November 1954. 89p. diagrs., photos., tabs. (NACA RM L54I08)

This paper presents the results of an investigation in the Langley 7- by 10-foot tunnel to determine the aerodynamic loadings at high subsonic speeds on a 45° sweptback, untapered vertical tail in sideslip. The vertical tail was tested in the presence of a cylindrical body with a 45° sweptback untapered horizontal tail located either at the midspan or tip of the vertical tail. The vertical and horizontal tails had NACA 65A010 airfoil sections perpendicular to the leading edge and aspect ratios of 2.0 and 4.0, respectively. The tests were made at angles of attack of 0°, 4°, and 12° through an angle of sideslip range of -2° to 23° and a Mach number range of 0.60 to 0.95.

NACA RM L54I09

EFFECT OF A WING LEADING-EDGE FLAP AND CHORD-EXTENSION ON THE HIGH SUBSONIC CONTROL CHARACTERISTICS OF A SPOILER-SLOT-DEFLECTOR CONTROL LOCATED AT TWO SPANWISE POSITIONS. Robert F. Thompson and Robert T. Taylor. November 1954. 73p. diagrs., photo., tabs. (NACA RM L54I09)

Incremental force and moment coefficients due to control projection are presented for a wind-tunnel investigation at high subsonic speeds and angles of attack up to 24° to determine the effects of a wing leading-edge modification on the control characteristics of a spoiler-slot-deflector-type control located at two spanwise positions. A few comparative tests were made with the spoiler part of the control used as a plain, flap-type spoiler. The wing was modified by a leading-edge chord-extension over the outboard 35 percent of the semispan in combination with a full-span leading-edge flap deflected 6°. The wing-fuselage model tested had a wing of aspect ratio 4, taper ratio 0.3, 45° sweepback, and NACA 65A006 airfoil sections.

NACA RM L54I13

COMPARISON OF LOW-SPEED ROTOR AND CASCADE PERFORMANCE FOR MEDIUM-CAMBER NACA 65-(C_{l_o} A_{10})10 COMPRESSOR-BLADE SECTIONS OVER A WIDE RANGE OF ROTOR BLADE-SETTING ANGLES AT SOLIDITIES OF 1.0 AND 0.5. George C. Ashby, Jr. December 1954. 40p. diagrs., photo. (NACA RM L54I13)

A medium-camber compressor rotor having NACA 65-($C_{l_o}A_{10}$)10 blades was tested in a low-speed 28-inch test blower. The tests were made at solidities of 1.0 and 0.5 without guide vanes or stators over a wide range of blade-setting angles and quantity flow rates. The measured overall and blade-element performance was compared with the performance estimated from cascade data to extend the correlation of cascade and compressor-rotor data over a broad range of blade-setting angles.

#NACA RM SL9E13
#NACA RM SL50E01
#NACA RM SL51E23
#NACA RM SL53G24
#NACA RM SL53G27
#NACA RM SL54G26

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1263

INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS OF A MODEL WING-PROPELLER COMBINATION AND OF THE WING AND PROPELLER SEPARATELY AT ANGLES OF ATTACK UP TO 90°. Richard E. Kuhn and John W. Draper. 1956. ii, 40p. diagrs., photos., tab. (NACA Rept. 1263. Supersedes TN 3304)

Results are presented of a wind-tunnel investigation of the effects of slipstream for two large-diameter propellers on the aerodynamic characteristics of a wing model. The investigation covered angles of attack from -10° to 90° and thrust coefficients representing free-stream velocities from zero to the normal range of cruising flight. An appreciable increase in the angle of attack for maximum lift with increasing power is indicated. A modification of the method of Smelt and Davies for estimating the effects of slipstreams on the lift-curve slope is presented. Performance calculations for an assumed vertical take-off airplane are also included. Forces and moments on the wing-propeller combination and on the wing and propellers separately are included. A large nose-up pitching moment on the propeller itself was found at high angles of attack.

NACA TN 3576

FURTHER MEASUREMENTS OF INTENSITY, SCALE, AND SPECTRA OF TURBULENCE IN A SUBSONIC JET. James C. Laurence and Truman M. Stickney. October 1956. 24p. diagrs. (NACA TN 3576)

As an extension to the data reported in Technical Note 3561, hot-wire anemometer measurements of the intensity, scale, and spectra of turbulence in a 3.5-in.-diameter free subsonic jet were made for downstream distances from 8 to 20 jet diameters. Eddy size increased with distance from the jet nozzle until a maximum was reached. The position of this maximum depended upon the distance from the jet centerline. After reaching the maximum, the eddy decreased uniformly in size with distance from the nozzle. The nondimensional mean-velocity profiles were nearly similar in a region from 12 to 20 jet diameters from the nozzle. Corresponding similarity in intensity of turbulence profiles, however, was not observed as far as 20 jet diameters downstream of the nozzle.

NACA TN 3683

MECHANISM OF GENERATION OF PRESSURE WAVES AT FLAME FRONTS. Boa-Teh Chu, Johns Hopkins University. October 1956. 20p. diagrs. (NACA TN 3683)

A study has been made of the pressure waves generated at a flame front. An analysis is included of the performance of a flame front and an equivalent heater in producing the pressure waves.

NACA TN 3684

LARGE DEFLECTION OF CURVED PLATES. H. G. Lew, J. A. Fox, and T. T. Loo, Pennsylvania State University. October 1956. 38p. diagrs., tabs. (NACA TN 3684)

Several problems on large deflections of curved plates with compound curvature are treated. Large-deflection equations of plates and cylinders are used. Initial curvature of a plate under axial compression increases its deflection considerably upon application of load. The average shear strain for a plate under shear loading is not much affected by the initial curvature, at least for the initial deflection function used. In addition, for the circular cylindrical plate with small initial curvature under axial compression, the deflections of the plate are affected more by changes in the radius R_0 than by changes in the initial curvature. It is shown that the effective width of the curved plates in longitudinal compression is reduced by the presence of an initial deflection function.

NACA TN 3741

AN INVESTIGATION OF THE LOADS ON THE VERTICAL TAIL OF A JET-BOMBER AIRPLANE RESULTING FROM FLIGHT THROUGH ROUGH AIR. Jack Funk and Richard H. Rhyne. October 1956. 36p. diagrs., tabs. (NACA TN 3741)

Vertical-tail loads were measured in turbulent air on a four-engine jet bomber. Results showed large load oscillations which were lightly damped. Comparison of experimental results with discrete-load calculations indicated that discrete-gust calculations underestimated the loads by 30 to 40 percent and gave

no indication of the low damping. Power spectral analysis, on the other hand, indicated the general frequency characteristics and gave a somewhat better estimate of the peak-load distributions. The present results strongly suggest that discrete-gust calculations for gust loads on vertical tails may seriously underestimate the gust loads for airplanes having lightly damped lateral oscillations.

NACA TN 3747

EQUATIONS AND PROCEDURES FOR NUMERICALLY CALCULATING THE AERODYNAMIC CHARACTERISTICS OF LIFTING ROTORS. Alfred Gessow. October 1956. 21p. diagr., tab. (NACA TN 3747)

Equations and procedures are presented for numerically determining the aerodynamic characteristics of lifting rotors. The equations are general and can account for stall and compressibility effects, as well as variations in hub and blade configurations, that are normally omitted from conventional analytical rotor treatments. The application of the method to solution by automatic computing machines is discussed.

NACA TN 3748

CALCULATION AND COMPILATION OF THE UNSTEADY-LIFT FUNCTIONS FOR A RIGID WING SUBJECTED TO SINUSOIDAL GUSTS AND TO SINUSOIDAL SINKING OSCILLATIONS. Joseph A. Drischler. October 1956. 59p. diagrs., tab. (NACA TN 3748)

The total lift responses to sinusoidal sinking oscillations and to sinusoidal gusts have been calculated, largely from existing information, for wings of various plan forms in subsonic and supersonic flow. For most of the cases considered, closed-form expressions are given and the final results are presented in the form of plots of the square of the modulus of the lift coefficient for wings in a sinusoidally oscillating gust field and in the form of the real and imaginary parts of the lift coefficient for wings undergoing sinusoidal sinking oscillations.

NACA TN 3749

TORSIONAL STIFFNESS OF THIN-WALLED SHELLS HAVING REINFORCING CORES AND RECTANGULAR, TRIANGULAR, OR DIAMOND CROSS SECTION. Harvey G. McComb, Jr. October 1956. 35p. diagrs. (NACA TN 3749)

A theoretical investigation is presented of the torsional stiffness of thin-walled aerodynamic surfaces filled with cores which stabilize the skins. Rectangular, slender triangular, and slender diamond cross sections are considered. Results for the torsional stiffness constants are shown graphically.

NACA TN 3750

AN ANALYSIS OF AIRSPEED, ALTITUDE, AND ACCELERATION DATA OBTAINED FROM A TWIN-ENGINE TRANSPORT AIRPLANE OPERATED OVER A FEEDER-LINE ROUTE IN THE ROCKY MOUNTAINS. Martin R. Copp and Mary W. Fetner. October 1956. 23p. diagrs., tabs. (NACA TN 3750)

Time-history data of airspeed, altitude, and acceleration obtained with the NACA VGH recorder from a twin-engine airplane operated by a regional feeder airline in the Rocky Mountains are evaluated to determine the magnitude and frequency of occurrence of gusts and gust accelerations and the operating airspeeds and altitudes. The results obtained are compared with the results previously obtained from a representative short-haul and long-haul operation.

NACA TN 3754

A SIMPLE METHOD FOR CALCULATING THE CHARACTERISTICS OF THE DUTCH ROLL MOTION OF AN AIRPLANE. Bernard B. Klawans. October 1956. 16p. diagrs., tabs. (NACA TN 3754)

A simple method for calculating the characteristics of the Dutch roll motion of an airplane is obtained by arranging the lateral equations of motion in such form and order that an iterative process is quickly convergent.

NACA TN 3758

INTERACTION OF BEARING AND TENSILE LOADS ON CREEP PROPERTIES OF JOINTS. E. G. Bodine, R. L. Carlson, and G. K. Manning. Battelle Memorial Institute. October 1956. 23p. diagrs., photo. (NACA TN 3758)

The interaction of bearing and tensile loads on the creep behavior of joints was studied. A specimen was designed for this study which possessed some of the general features of pin and rivet joint connections and an apparatus was constructed to apply both bearing and tensile loads to the joint model. Deformation measurements were made by use of a photogrid printed on the joint model.

NACA TN 3763

NEAR NOISE FIELD OF A JET-ENGINE EXHAUST. I - SOUND PRESSURES. Walton L. Howes and Harold R. Mull. October 1956. 51p. diagrs., photos. (NACA TN 3763)

Experimental data without afterburning from a 10,000-pound-thrust turbojet engine are presented in a series of contour maps of overall and 1/3-octave-band sound-pressure levels. Some data on sound-pressure levels were also obtained as a function of jet velocity, at the surface of a stiff plate, and with afterburning. On a dimensionless basis, the apparent locations of acoustical sources as a function of frequency were found to be similar to those indicated by turbulence measurements in a small cold-air jet.

NACA TN 3766

RADIATION AND RECOVERY CORRECTIONS AND TIME CONSTANTS OF SEVERAL CHROMEL-ALUMEL THERMOCOUPLE PROBES IN HIGH-TEMPERATURE, HIGH-VELOCITY GAS STREAMS. George E. Glawe, Frederick S. Simmons, and Truman M. Stickney. October 1956. 25p. diagrs., photo., tabs. (NACA TN 3766)

Radiation and recovery corrections and time constants were experimentally determined for several designs of shielded and unshielded thermocouple probes using chromel-alumel wire. Radiation and time constant data were obtained for Mach numbers from 0.3 to 0.9, static pressure from $\frac{2}{3}$ to $1\frac{1}{3}$ atmospheres, and temperatures from 1500° to 2500° R. Recovery data were obtained for Mach numbers from 0.2 to 0.9 and total pressures from $\frac{1}{7}$ to $1\frac{2}{3}$ atmospheres, at room total temperature. A review of the theory of gas temperature measurements and an analysis of the data show that simple empirical formulas may be used to correlate corrections for various gas-stream conditions.

NACA TN 3768

ON POSSIBLE SIMILARITY SOLUTIONS FOR THREE-DIMENSIONAL INCOMPRESSIBLE LAMINAR BOUNDARY LAYERS. I - SIMILARITY WITH RESPECT TO STATIONARY RECTANGULAR COORDINATES. Arthur G. Hansen and Howard Z. Herzig. October 1956. 30p. tab. (NACA TN 3768)

Solutions of mainstream flow patterns for all possible incompressible laminar-boundary-layer flows having classical similarity with respect to rectangular-coordinate systems are derived. These solutions, which apply to a wide range of flows, are summarized in table form.

NACA TN 3770

IMPINGEMENT OF DROPLETS IN 60° ELBOWS WITH POTENTIAL FLOW. Paul T. Hacker, Paul G. Saper, and Charles F. Kadow. October 1956. 54p. diagrs., tabs. (NACA TN 3770)

Theoretical trajectories were determined for droplets in air flowing through 60° elbows. The elbows were established by selecting as walls of each elbow two streamlines of a two-dimensional flow field produced by a complex potential function. These elbows are suitable for use in aircraft air-inlet ducts. Droplet impingement data are presented in terms of dimensionless parameters along with empirical equations so that the results can be applied over a wide range of conditions and elbow sizes. A comparison of the 60° elbow with previous calculations for a comparable 90° elbow indicated that the impingement characteristics of the two elbows are very similar.

NACA TN 3771

LOW-SPEED WAKE CHARACTERISTICS OF TWO-DIMENSIONAL CASCADE AND ISOLATED AIRFOIL SECTIONS. Seymour Lieblein and William H. Roudebush. October 1956. 49p. diagrs., tabs. (NACA TN 3771)

Available low-speed wake data of two-dimensional cascade and isolated airfoil sections are analyzed to determine empirical and theoretical variations with downstream distance of such wake properties as minimum velocity, form factor, momentum thickness, full thickness, total-pressure loss, and ratio of mass-averaged to area-averaged loss. The reenergizing of the wake downstream of the blade is shown to occur very rapidly, with most of the mixing loss and changes in wake characteristics taking place within $\frac{1}{4}$ to $\frac{1}{2}$ chord length behind the blade. Except for the variation of momentum thickness, the developments of the wake behind the cascade airfoil and the isolated airfoil are generally similar.

NACA TN 3776

HEAT-TRANSFER MEASUREMENTS ON TWO BODIES OF REVOLUTION AT A MACH NUMBER OF 3.12. John R. Jack and N. S. Diaconis. October 1956. 36p. diagrs., photos., tabs. (NACA TN 3776)

Heat-transfer rates were measured on a cone cylinder and a parabolic-nosed cylinder at Reynolds numbers up to 12×10^6 based on model length for heated and cooled surfaces. The experimental data were obtained with an axial temperature distribution and then corrected to the isothermal case. The laminar data agreed closely with theory at all temperature levels.

NACA TN 3777

SEAT DESIGN FOR CRASH WORTHINESS. I. Irving Pinkel and Edmund G. Rosenberg. October 1956. 42p. diagrs., photos., tab. (NACA TN 3777)

On the basis of deceleration data obtained in full-scale crashes, a description of crash deceleration pulses is presented which is suitable for seat design. Charts are presented for obtaining the maximum deceleration loads experienced by the seat and passenger in response to their crash deceleration pulses. Finally, a method is presented for determining the seat strength, spring stiffness, and deformation beyond the elastic limit required to serve in a crash deceleration pulse of given description. Measurement of passenger decelerations in full-scale laboratory and crash studies shows that the general principles presented in the report apply.

NACA TN 3787

HEAT-CAPACITY MEASUREMENTS OF TITANIUM AND OF A HYDRIDE OF TITANIUM FOR TEMPERATURES FROM 4° TO 15° K INCLUDING A DETAILED DESCRIPTION OF A SPECIAL ADIABATIC SPECIFIC-HEAT CALORIMETER. M. H. Aven, R. S. Craig, and W. E. Wallace, University of Pittsburgh. October 1956. 30p. diagrs., tabs. (NACA TN 3787)

Results of heat-capacity measurements on samples of pure titanium and of a hydride of titanium are presented and compared with calculated results. The measurements were made using a special adiabatic specific-heat calorimeter which is described in detail.

NACA TN 3792

A THEORETICAL ANALYSIS OF HEAT TRANSFER IN REGIONS OF SEPARATED FLOW. Dean R. Chapman. October 1956. 47p. diagrs., tabs. (NACA TN 3792)

An analysis is made of the rate of heat transfer to regions of separated flow in compressible streams. The physical mechanism postulated applies in principle to both laminar and turbulent flow, and to conditions where gas is injected into a separated region. Under the special condition of zero boundary-layer thickness at the separation point, the analysis yields relatively simple equations. Detailed calculations are presented for laminar separations in compressible flow with Prandtl numbers between 0.1 and 10.0.

NACA TN 3793

EXPLORATORY INVESTIGATION OF THE USE OF AREA SUCTION TO ELIMINATE AIR-FLOW SEPARATION IN DIFFUSERS HAVING LARGE EXPANSION ANGLES. Curt A. Holzhauser and Leo P. Hall. October 1956. 18p. diagrs. (NACA TN 3793)

Tests were made at a mean inlet Mach number of 0.2 with area suction applied to conical diffusers with expansion angles of 30° and 50° and exit to inlet area ratios of 2. Air-flow separation was eliminated with suction mass flows of 3 and 4 percent of the inlet mass flows for the 30° and 50° diffusers, respectively.

NACA TN 3799

AN AIR-FLOW-DIRECTION PICKUP SUITABLE FOR TELEMETERING USE ON PILOTLESS AIRCRAFT. Wallace L. Ikard. October 1956. 25p. diagrs., photos. (NACA TN 3799. Supersedes RM L53K16)

A vane-type air-flow-direction pickup is described which is suitable for telemetering angle-of-attack and angle-of-sideslip data from rocket-propelled pilotless aircraft models. Test results which are presented show that the device performs well under high accelerations and is stable throughout a Mach number range from subsonic to above a Mach number of 2.5.

NACA TN 3802

INVESTIGATION OF A RELATED SERIES OF TURBINE-BLADE PROFILES IN CASCADE. James C. Dunavant and John R. Erwin. October 1956. 100p. diagrs. (NACA TN 3802. Supersedes RM L53G15)

Series of directly related turbine blade shapes uniformly variable in camber are designed to satisfy the usual turbine-blade operating requirements of inlet air angle and turning angle. Low-speed cascade test results of five blade sections and sample high-speed cascade tests for two blade sections of these series are presented. A method of properly cambering turbine blade shapes based on low-speed test results is given.

NACA TN 3804

A FACTOR AFFECTING TRANSONIC LEADING-EDGE FLOW SEPARATION. George P. Wood and Paul B. Gooderum. October 1956. 43p. diagrs., photos. (NACA TN 3804)

A change in flow pattern that was observed as the free-stream Mach number was increased in the vicinity of 0.8 was described in NACA Technical Note 1211 by Lindsey, Daley, and Humphreys. The flow on the upper surface behind the leading edge of an airfoil at an angle of attack changed abruptly from detached flow with an extensive region of separation to attached supersonic flow terminated by a shock wave. In the present paper, the consequences of shock-wave—boundary-layer interaction are proposed as a factor that may be important in determining the conditions under which the change in flow pattern occurs. Some experimental evidence in support of the importance of this factor is presented.

NACA TN 3807

CONVERSION OF INVISCID NORMAL-FORCE COEFFICIENTS IN HELIUM TO EQUIVALENT COEFFICIENTS IN AIR FOR SIMPLE SHAPES AT HYPERSONIC SPEEDS. James N. Mueller. October 1956. 31p. diagrs. (NACA TN 3807)

A correlation factor applicable for converting inviscid aerodynamic normal-force coefficients of simple shapes in helium to equivalent coefficients in air is found by using calculations based on the shock-expansion method at Mach numbers of 12, 16, and 20.

NACA TN 3810

CHARTS FOR ESTIMATING THE HOVERING ENDURANCE OF A HELICOPTER. Robert A. Makofski. October 1956. 15p. diagrs. (NACA TN 3810)

As a means of comparing the performance capabilities of various helicopter propulsion systems, charts have been presented for estimating the hovering endurance of a helicopter in the form of a hovering-endurance parameter as a function of the ratio of total fuel load to helicopter initial weight for a range of initial thrust coefficients from 0.002 to 0.012 and for values of rotor mean lift coefficient from 0.24 to 0.72. The charts were presented for a helicopter

having rotor blades with ideal twist. However, corrections may be applied to the hovering endurance to account for other combinations of twist and taper. The effects of stall and compressibility have been neglected.

NACA TN 3811

CHARTS ADAPTED FROM VAN DRIEST'S TURBULENT FLAT-PLATE THEORY FOR DETERMINING VALUES OF TURBULENT AERODYNAMIC FRICTION AND HEAT-TRANSFER COEFFICIENTS. Dorothy B. Lee and Maxime A. Faget. October 1956. 16p. diagrs., tab. (NACA TN 3811)

A modified method of Van Driest's flat-plate theory for turbulent boundary layer has been found to simplify the calculation of local skin-friction coefficients which, in turn, have made it possible to obtain through Reynolds analogy theoretical turbulent heat-transfer coefficients in the form of Stanton number. A general formula is given and charts are presented from which the modified method can be solved for Mach numbers 1.0 to 12.0, temperature ratios 0.2 to 6.0, and Reynolds numbers 0.2×10^6 to 200×10^6.

NACA TN 3812

FLIGHT INVESTIGATION OF THE STABILITY AND CONTROL CHARACTERISTICS OF A VERTICALLY RISING AIRPLANE RESEARCH MODEL WITH SWEPT OR UNSWEPT WINGS AND ×- OR +-TAILS. Robert H. Kirby. October 1956. 30p. diagrs., photos. (NACA TN 3812)

The take-off, landing, hovering, and transition flight characteristics of a propeller-driven, fighter-type, vertically rising airplane model were obtained from time histories of the flights and from the pilots' opinions of the flight characteristics. In general, there were no major differences in the behavior of any of the configurations, all of which performed satisfactorily.

NACA TN 3816

STATIC STRENGTH OF ALUMINUM-ALLOY SPECIMENS CONTAINING FATIGUE CRACKS. Arthur J. McEvily, Jr., Walter Illg, and Herbert F. Hardrath. October 1956. 54p. diagrs., photos., tabs. (NACA TN 3816. Supersedes RM L55D15a)

Seven configurations of specimens made of 2024 and 7075 aluminum-alloys in both rolled and extruded form were subjected to repeated axial loads until fatigue cracks of various lengths were formed. The specimens were then subjected to static tests to determine the residual static strength. Small cracks resulted in disproportionately large reductions of static strength, the reduction being greater for 7075 than for 2024 aluminum alloy. A simple method of analysis which predicts the observed results was developed and described.

NACA TN 3829

EFFECT OF PRESSURE ON THE SPONTANEOUS IGNITION TEMPERATURE OF LIQUID FUELS. Cleveland O'Neal, Jr. October 1956. 21p. diagrs., tabs. (NACA TN 3829)

Spontaneous ignition temperatures were measured in air for n-heptane, isooctane, benzene, and JP-4 and JP-5 aviation fuels in the pressure range of 1 to 9 atmospheres. A solid stream (no spray) of fuel was injected into a 125-cc Erlenmeyer flask enclosed in a bomb. Fuel charges were varied so that the lowest temperature at which spontaneous ignition occurs was obtained. The spontaneous ignition temperature of all the fuels decreased with increasing pressure. Most of the decrease occurred in the range of 1 to 3 or 4 atmospheres. Time lags before ignition were measured.

NACA TN 3831

TABULATION OF MASS-FLOW PARAMETERS FOR USE IN DESIGN OF TURBOMACHINE BLADE ROWS FOR RATIOS OF SPECIFIC HEATS OF 1.3 AND 1.4. Warren J. Whitney. October 1956. 111p. diagrs., tabs. (NACA TN 3831)

Mass-flow tables are presented that enable a quick and accurate determination of the integrated average specific mass flow across a region where the end-point velocities are known, commensurate with the assumptions that the total state is constant and the static pressure varies linearly between the two velocities. The tables include specific-mass-flow parameter and ratio of static to total pressure.

NACA TN 3843

EXPERIMENTAL STEADY-STATE YAWING DERIVATIVES OF A 60° DELTA-WING MODEL AS AFFECTED BY CHANGES IN VERTICAL POSITION OF THE WING AND IN RATIO OF FUSELAGE DIAMETER TO WING SPAN. Byron M. Jaquet and Herman S. Fletcher. October 1956. 20p. diagrs., tab. (NACA TN 3843)

Results are presented of an investigation conducted in the Langley stability tunnel to determine the effects of vertical position of the wing and the effects of the ratio of the fuselage diameter to wing span on the steady-state yawing derivatives of a 60° delta-wing model. The test Mach number was 0.13 and the test Reynolds number was 1.65×10^6.

NACA TN 3858

A LOW-SPEED EXPERIMENTAL INVESTIGATION OF THE EFFECT OF A SANDPAPER TYPE OF ROUGHNESS ON BOUNDARY-LAYER TRANSITION. Albert E. von Doenhoff and Elmer A. Horton. October 1956. 43p. diagrs., photos. (NACA TN 3858)

An investigation conducted in the Langley low-turbulence pressure tunnel at low speeds showed that for sandpaper-type roughness the occurrence of transition could be correlated on the basis of a local roughness Reynolds number based on the size of the roughness and the velocity at the top of the

roughness. The extent of the roughened area does not appear to have an important effect on the critical value of the roughness Reynolds number.

BRITISH REPORTS

N-46412*

Royal Aircraft Establishment (Gt. Brit.)
SOME MEASUREMENTS OF THE VOLATILITY OF SYNTHETIC LUBRICANTS. D. J. Barke and G. Kinner. June 1956. 14p. diagr., tabs. (RAE Tech. Note Chem. 1282)

Measurements of the volatility of synthetic lubricants are described using three separate methods of test, but only that using the A. S. T. M. evaporation cell is considered to have satisfactory precision. Rate of evaporation from the A. S. T. M. cell is found to be a function of sample size and to be a complex function of rate of transpiration when the latter is less than approximately 2 l./min. Above this figure, the rate of evaporation of various organic liquids is directly proportional to rate of transpiration and to the vapor pressure of the liquid examined. Use of nitrogen, instead of air, reduces the rate of loss in weight by eliminating tendency to oxidation at elevated temperatures. A qualitative explanation of behavior in the A. S. T. M. cell is offered.

N-46413*

Royal Aircraft Establishment (Gt. Brit.)
SOME CREEP PROPERTIES OF AN 18/8 STAINLESS STEEL AT ROOM TEMPERATURE, 250° C, 400° C, AND 550° C. L. W. Larke and R. A. Whittaker. March 1956. 14p. diagrs., tabs. (RAE Tech. Note Met. 240)

Constant load tensile creep tests have been made on resoftened 18/8 type stainless steel to B. S. S. S. 110 at room temperature (22° C), 250° C, 400° C, and 550° C. Stresses, approximating to the 0.05 percent P. S., 0.10 percent P. S., or 0.20 percent P. S., were determined on and applied to individual creep test pieces at each temperature. Two additional tests, demonstrating the effect of 0.1 percent and 1.0 percent prior straining at room temperature, are included in the series creep tested at 250° C. In all cases the creep curves indicate a rapid increase in strain followed by a relatively small creep rate. This behavior is typical of a material which strain hardens under applied stress. The effect of prior strain at room temperature is to reduce markedly the amount of strain on loading. The shapes of the creep curves preclude the more usual types of assessment of properties but, for comparative purposes, Table II, showing variation of strain with time, is included.

N-46414*

Royal Aircraft Establishment (Gt. Brit.)
CALCULATION OF THE SHAPE OF A THIN SLENDER WING FOR A GIVEN LOAD DISTRIBUTION AND PLANFORM. J. H. B. Smith. January 1956. 22p. diagrs. (RAE Tech. Note Aero 2410)

The problem considered in this note is that of finding the camber and twist for a swept wing of specified slender plan form which will produce the same chordwise lift distribution at each spanwise station as in two-dimensional flow past a flat plate, in conjunction with a uniform distribution of chord loading. Linearized inviscid potential flow theory is used and the results are valid only if $A^2|1 - M^2| \ll 1$. The slope of the wing is obtained in closed form as a function of two rectangular coordinates for wings with straight-swept leading and trailing edges and streamwise tips. Numerical results are given for the chordwise and spanwise variations of the slope of the wing surface measured in the chordwise (that is, the streamwise) direction, at several stations; and chordwise wing sections are drawn, for two particular plan forms. These sections are found to have continuous tangents and not more than three discontinuities of curvature. Spanwise distributions of camber and local incidence are given for the two wings.

N-46415*

Royal Aircraft Establishment (Gt. Brit.)
FATIGUE LOADINGS IN FLIGHT: LOADS IN THE WING OF A VARSITY. Anne Burns. May 1956. 23p. diagrs., tabs. (RAE Tech. Note Structures 192)

Data are presented on the number of load cycles of various magnitudes occurring in the wing of a Varsity in normal ground and flight conditions. The conditions include taxiing, take-off, landing, and flight in turbulence. The relative importance of the loads in the different conditions is illustrated by reference to the loads in a typical flight. A relationship is determined between wing loads and accelerations in turbulence so that the test results can, if required, be related to gust data obtained operationally by means of the counting accelerometer.

N-46416*

Royal Aircraft Establishment (Gt. Brit.)
EXPERIMENTAL INVESTIGATION OF THE PRESSURE DISTRIBUTION AT THE CENTRE-SECTION OF A SWEPTBACK WING AT HIGH SUBSONIC SPEEDS. T. E. B. Bateman and A. J. Lawrence. August 1955. 35p. diagrs., photos., tabs. (RAE Aero 2556)

The uncertainty of the validity of theoretical estimates and the absence of experimental data for the pressure distribution at the center section of a sweptback wing at high subsonic speeds led to the present tests. The measurements have been made on a 40° sweptback wing over the Mach number range 0.50 to 0.94, at zero incidence. Given pressures are reached further aft at the center section than on a section of the infinite-sheared wing. In particular the supersonic region, when formed, occurs much farther aft and the shock wave moves quickly to a position close behind the trailing edge. The isobars lose their sweep in the neighborhood of the center

section and this reduces the critical Mach number from 0.88 for the sheared wing to 0.81 for the center section. The maximum local Mach number at the center section tends to a steady value of about 1.15 at high subsonic speeds. Theoretical estimates of the pressure distributions on the sheared wing at zero incidence are shown to agree well with the measured values for speeds at which no shock waves form but estimates for the center section agree well only at very low speeds. At higher speeds (even at $M = 0.5$) the theory predicts too low a pressure over the forward half of the chord and too low a suction over the rear half, that is, it underestimates the "center effect."

N-46417*

Royal Aircraft Establishment (Gt. Brit.)
NOTES ON THE PRACTICAL APPLICATION OF THE METHOD OF R. A. E. REPORT NO. STRUCTURES 168. D. Williams. May 1956. 49p. diagrs. (RAE Structures 209)

In report No. Structures 168, a method for deriving the influence coefficients of any type of wing, and hence of deriving the deflection and stresses was described in outline. The practical application of the method, however, raises a number of minor problems - mostly concerned with boundary values - which have all to be overcome if the method is to become popular among stressmen. Some of the more important of these problems are treated in this report.

N-46418*

Royal Aircraft Establishment (Gt. Brit.)
LOW SPEED STATIC AND FLUCTUATING PRESSURE DISTRIBUTIONS ON A CYLINDRICAL BODY WITH A SQUARE FLAT PLATE AIRBRAKE. T. B. Owen. January 1956. 18p. diagrs., tab. (RAE Tech. Note Aero 2396)

There is a very rapid increase both in the rms amplitude of the pressure fluctuations and in the area of the body affected, if the brake angle is increased beyond 50°. At the lower frequencies there is a large increase in amplitude between 40° and 50° which is associated with the appearance of a regular shedding of turbulent eddies. On the model used, with an average of about 27 percent of the length of the side of the brake, the shedding frequencies are in close agreement with those measured on an isolated plate at the smaller brake angles and slightly higher than on an isolated plate at the higher brake angles. The fluctuating pressures due to the brake are little affected by the distance of the brake from the tail of the body.

N-46471*

Aeronautical Research Council (Gt. Brit.)
WIND TUNNEL TESTS ON ANTISYMMETRIC FLUTTER OF A DELTA WING WITH ROLLING BODY FREEDOM. D. R. Gaukroger and D. Nixon. 1956. 9p. diagrs. (ARC CP 259)

Wind-tunnel tests on a half-span model to determine the antisymmetric flutter characteristics of a delta wing are described. The model had a leading-edge sweepback of 45° and a tip chord 1/16th of the root chord. The effect of fuselage rolling moment of inertia on critical flutter speed and frequency was investigated. The results show that body freedom flutter is obtained under conditions of fuselage rolling moment of inertia that are representative of full scale, and that the flutter speeds are considerably higher and the frequencies lower than with the root fixed. With large values of fuselage rolling moment of inertia disturbed root flutter occurs, the speeds again being higher than with the root fixed.

N-46472*

Aeronautical Research Council (Gt. Brit.)
ADDITIONAL DATA ON SURFACE SLOPES OF THE RAE 100-104 AEROFOIL SECTIONS. Edna M. Love and J. Williams. 1956. 10p. tabs. (ARC CP 252)

To supplement earlier data, the surface slopes of the RAE 100, 101, and 103 sections are tabulated, and for the RAE 102 and 104 sections additional values are quoted closer to the leading edge than before. An elementary but flexible method of specifying the minimum number of tangent planes needed for airfoil manufacture is also given.

N-46473*

Aeronautical Research Council (Gt. Brit.)
MODELS FOR AERO-ELASTIC INVESTIGATIONS. H. Templeton. (Presented at International Congress on Models in Engineering, Venice, October 1-5, 1955, sponsored by Accademia Nazionale dei Lincei and Società Adriatica di Elettricità). 1956. 22p. diagrs., photos. (ARC CP 255)

An account is given of several types of aeroelastic model used for flutter investigations. The various purposes for which they are used are outlined, and the scale relationships for prediction models are derived. Different types of model construction are described and their main applications are defined. The construction types include flexible skin, segmented airfoil, stressed skin, solid, and semirigid models.

N-46474*

Aeronautical Research Council (Gt. Brit.)
FATIGUE LOADINGS IN FLIGHT: LOADS IN THE TAILPLANE AND FIN OF A VARSITY. Anne Burns. 1956. 20p. diagrs., tabs. (ARC CP 256)

Data are presented on the number of load cycles of various sizes occurring in the tailplane and fin of a Varsity in normal ground and flight conditions. The conditions include flight in turbulence, take-off, landing, taxiing, and ground running of the engines. The relative importance of the loads in the different conditions is illustrated by reference to the loads in a typical flight.

N-46475*

Aeronautical Research Council (Gt. Brit.)
SOME FATIGUE CHARACTERISTICS OF A TWO SPAR LIGHT ALLOY STRUCTURE (METEOR 4 TAILPLANE). K. D. Raithby and Jennifer Longson. 1956. 32p. diagrs., photos., tabs. (ARC CP 258)

Results are given for fatigue tests on 61 Meteor tail planes, treated as representative small-scale wing systems and tested under a variety of loading conditions. The object of the investigation was to study the fatigue characteristics of a typical aircraft structure, in particular the effects of mean load and alternating load on the endurance. The effects of preloading, periodic overloading, and low temperatures were also investigated. Endurance curves are given for different mean loads; the results indicate that, for a given alternating load, the endurance is roughly inversely proportional to mean load. Substantial improvements in endurance may be obtained by preloading and by periodic overloading. The endurance at low temperature is higher than at room temperature.

N-46476*

Aeronautical Research Council (Gt. Brit.)
REPORT OF THE SECOND YEAR'S FLYING ON THE DEVELOPMENT OF FLIGHT TESTING TECHNIQUES FOR FINDING AND MEASURING NATURAL ICING CONDITIONS. G. C. Abel. 1956. 39p. diagrs., photos., tabs. (ARC CP 222)

Icing conditions extending over 100 miles have been found in strato-cumulus clouds over areas from East Anglia to the English Channel. Average liquid-water contents were 0.4-0.5 gms/cubic meter but an exceptional value of 1.4 gms/cubic meter is reported. This advance in sampling technique is being extended to try to measure liquid-water content and total-water content by timing the exposures. The RAE thermal ice detectors have not yet reached their final form but have been improved considerably. The Smiths ice detector has been calibrated to give liquid-water content and together with the rotating disk has continued to be very valuable. Meteorological Office forecasts of icing conditions have continued to be reliable.

N-46478*

Aeronautical Research Council (Gt. Brit.)
THE STRENGTH OF TUBES UNDER UNIFORM EXTERNAL PRESSURE. P. C. Cleaver. 1956. 203p. diagrs., photos., tabs. (ARC CP 253)

This report traces the development of theoretical solutions to the problem of determining the strength of tubes subjected to uniform external pressure, and describes an extensive series of tests to check the accuracy of the Sturm solution to this problem and the effects of material properties on collapse pressure. A total of 530 tests were made covering ranges of length:diameter from 0.0098 to 0.056. The mean collapse pressure of the tests designed to check the accuracy of the Sturm solution corrected for eccentricity effects exceeded the mean theoretical collapse pressure by 2.2 percent, the standard deviation was 7.0 percent, and the distribution approximately Gaussian. It is concluded that this theory may confidently be used to predict the strength of tubes under uniform external pressure applied to the sides only.

N-46479*

Aeronautical Research Council (Gt. Brit.)
AN UNCONVENTIONAL TYPE OF FATIGUE-TESTING MACHINE. F. Aughtie and H. L. Cox. 1955. 12p. diagrs. (ARC R & M 2833; ARC 1880)

The general principles governing the design of fatigue-testing machines are considered, and the operation of a machine in which the range of load is generated by resonant oscillation of a mass on the end of a spring is examined. The advantages attendant upon operation at the resonant speed are demonstrated, and a driving mechanism which insures stable operation at the resonant frequency is described. The construction and operation of a direct-stress fatigue-testing machine embodying the principles of resonant oscillation are described and skeleton designs for a torsional fatigue-testing machine suitable for testing specimens 3 inches in diameter and for a direct-stress-fatigue testing machine to give a range of 50 tons are appended.

N-46480*

Aeronautical Research Council (Gt. Brit.)
A SIMPLIFIED TREATMENT OF A FIXED-ROOT SWEPT WING BUILT ON HILL'S ISOCLINIC PRINCIPLE. D. Williams. 1956. 15p. diagrs., tab. (ARC R & M 2870; ARC 13,945. Supersedes RAE Structures 101)

This note shows how the Hill Aero-isoclinic principle works out in practice for a swept wing, fixed at the root and having straight flexural and inertia axes. The conditions assumed are readily represented in a wind-tunnel model and experiments by Lambourne show good agreement with theory. The further aft the flexural axis from the quarter-chord position, the smaller is the sacrifice of wing torsional stiffness entailed in making a swept wing isoclinic, and previous work has on that account taken a far-aft position as a reasonable basic assumption. It is shown that by sacrifice to torsional stiffness the gap between the two axes may be reduced and one aspect of the constructional problem is simplified.

N-46481*

Aeronautical Research Council (Gt. Brit.)
V-G RECORDS FROM VAMPIRE AIRCRAFT. (MARCH 1951-OCTOBER 1951). E. Marjorie Owen and J. R. Heath-Smith. 1956. 17p. diagrs., photos., tabs. (ARC R & M 2963; ARC 15,143. Supersedes RAE Tech. Note Structures 88)

Four hundred sixty-one V-g records covering 923 flying hours were taken from Vampire aircraft operating in England and Germany during the period March to October 1951. V-g boundaries expected to be exceeded once in 30, 100, and 300 hours are estimated, special consideration being given to aircraft engaged on ground-attack duties. The results confirm the general belief that more severe accelerations and higher speeds may be expected when aircraft are on ground-attack duties than when they are on other duties.

N-46482*

Aeronautical Research Council (Gt. Brit.)
THE FULL-SCALE HYDRODYNAMIC PERFORMANCE OF A LARGE FOUR-ENGINED FLYING BOAT AT OVERLOAD IN CALM WATER AND SWELL. J. A. Hamilton and R. V. Gigg. 1956. 38p. diagrs., photos., tabs. (ARC R & M 2898; ARC 15,197. Supersedes: MAEE F/Res/225)

Sheltered water characteristics were investigated over a range of weights between 72,000 and 84,000 pounds. The performance in swell covered weights up to 82,000 pounds and swell heights up to 5 feet. The latter tests were made at Gibraltar in Feb. 1951. Conclusions which may be applied generally to hulls similar to the Solent are included.

N-46483*

Aeronautical Research Council (Gt. Brit.)
A DETAILED EXPERIMENTAL COMPARISON OF AXIAL COMPRESSOR BLADES DESIGNED FOR FREE VORTEX FLOW AND EQUIVALENT UNTWISTED AND TWISTED CONSTANT SECTION BLADES. S. J. Andrews and H. Ogden. 1956. 20p. diagrs. (ARC R & M 2928; ARC 16,141. Supersedes: NGTE R. 141)

As a contribution to the knowledge of the performance of potentially cheap compressor blades, six stages of both twisted and untwisted constant section or "strip" blades were tested at a low speed in the 106 compressor. The performance is compared with that of six stages of equivalent free vortex blades, and interstage flow traverses provide the more detailed flow information.

N-46484*

Aeronautical Research Council (Gt. Brit.)
AN EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF DEFORMATION ON THE AERODYNAMIC CHARACTERISTICS OF A SWEPT-BACK WING. Joseph Black. 1956. 34p. diagrs., photos., tabs. (ARC R & M 2938. Supersedes: ARC 16,172; Perf. 1145; S & C 2806)

A wind-tunnel investigation of the effects of structural deformation on the pressure distributions round a tapered wing has been carried out over a range of deformations at a RN of 0.6×10^6. A technique for constructing a model and deforming it into any desired deformation has been successfully developed and described. The cycle can be repeated any number of times with the same model, to cover a range of deformations. From the modes investigated the appropriate deformations required to produce an almost elliptic span loading at a selected moderate overall lift, or to delay tip stalling at high incidence, were established.

N-46485*

Aeronautical Research Council (Gt. Brit.)
EFFECTS OF REYNOLDS NUMBER ON THE FLOW OF AIR THROUGH A CASCADE OF COMPRESSOR BLADES. H. G. Rhoden. 1956. 34p. diagrs., photos. (ARC R & M 2919; ARC 15,259)

The experimental work consisted of the separate testing of three cascades of axial-flow compressor blades of camber angles 20°, 30°, and 40°, respectively. Measurements were made of the distribution of static pressure over the central cross section of the middle blade of each cascade, together with traverses of static pressure, total head, and angle of flow at inlet and outlet to each cascade in the plane of the central cross section. The tests covered a range of actual Reynolds number from 3×10^4 to 5×10^5, based on the inlet air velocity and the blade chord, and also a range of inlet air angle α_1, from 35° to 60°.

N-46486*

Aeronautical Research Council (Gt. Brit.)
THE BUCKLING SHEAR STRESS OF SIMPLY-SUPPORTED, INFINITELY-LONG PLATES WITH TRANSVERSE STIFFENERS. P. W. Kleeman. 1956. 18p. diagrs., tab. (ARC R & M 2971; ARC 15,828. Supersedes RAE Structures 140)

This report is an extension of previous theoretical investigations of the elastic buckling in shear of flat plates reinforced by transverse stiffeners. The plates are treated as infinitely long and simply supported along the long sides. Stiffeners are spaced at regular intervals, dividing the plate into a number of panels of uniform size. The effect of bending and torsional stiffnesses of the stiffeners upon the buckling shear stress is calculated for the complete range of stiffnesses, for panels with ratios of width to stiffener spacing of 1, 2, and 5. The results are presented in tabular and graphical form.

N-46487*

Aeronautical Research Council (Gt. Brit.)
A WIND-TUNNEL TECHNIQUE FOR FLUTTER INVESTIGATIONS ON SWEPT WINGS WITH BODY FREEDOMS. P. F. Jordan and F. Smith. 1955. 11p. diagrs., photos. (ARC R & M 2893; ARC 13,729. Supersedes RAE Structures 73)

The practice of ignoring the body freedoms of aircraft in making wing-flutter investigations is no longer justified for modern designs with swept wings and especially for tailless aircraft. A technique is described which has been developed for wind-tunnel tests on wing-flutter models with the body freedoms. A half-span wing model is used, attached to a rigid body; longitudinal stability is insured, and the body-mass parameters are reduced to small values, by an appropriate arrangement of supporting springs. The ease of parameter variations makes the wind-tunnel rig suitable for systematic investigation.

N-46488*

Aeronautical Research Council (Gt. Brit.)
THE SUBSONIC FLOW PAST SWEPT WINGS AT ZERO LIFT WITHOUT AND WITH BODY.
D. Küchemann and J. Weber. 1956. 65p. diagrs., tabs. (ARC R & M 2908)

A review is given of the effects associated with the subsonic inviscid flow past swept wings at zero lift with the aim of providing the information needed for an understanding of the flow phenomena. Methods of obtaining the full benefit of sweep are described. Detailed solutions for incompressible flow are given for three basic cases: (a) the sheared wing of infinite span, (b) the center section of a swept wing of infinite span, and (c) the flow in the curved intersection line between wing and body. These solutions are used to find approximate solutions for any given wing of finite aspect ratio. The Prandtl-Glauert procedure is extended and applied to derive approximations for the compressible flow in the subcritical region. The special cases treated in detail are: the flow in the tip regions of wings; tapered wings; wing-fuselage interference for symmetrical arrangements; and modifications to the wing or to the body shape, for instance to restore sheared-wing conditions.

N-46489*

Aeronautical Research Council (Gt. Brit.)
PRESSURE AND BOUNDARY-LAYER MEASUREMENTS ON A TWO-DIMENSIONAL WING AT LOW SPEED. G. G. Brebner and J. A. Bagley. 1956. 47p. diagrs., tabs. (ARC R & M 2886; ARC 15,083. Supersedes RAE Aero 2455)

Results are given of pressure measurements and boundary-layer traverses on a two-dimensional wing with 10 percent RAE 101 section at RN of 1.6×10^6 and 3.2×10^6. The results, which have been integrated to give lift, drag, and aerodynamic-center characteristics, are used to check some calculation methods for the growth of the turbulent boundary layer and for the effect of a known boundary layer on the pressure distribution. The calculation of the boundary layer still needs a little refinement before it is accurate enough to predict viscosity effects on pressure distribution, lift, drag, and aerodynamic center; but these effects can be calculated if the actual boundary-layer characteristics are known.

N-46490*

Aeronautical Research Council (Gt. Brit.)
SOME FLUTTER TESTS ON SWEPT-BACK WINGS USING GROUND-LAUNCHED ROCKETS. W. G. Molyneux and F. Ruddlesden. 1956. 16p. diagrs., tabs. (ARC R & M 2949; ARC 16,551. Supersedes RAE Structures 155)

This report gives the results of tests on flutter models of untapered wings with 20°, 40°, and 60° sweepback. Tests have been made up to a M = 1.4. A comparison is made between the measured flutter speeds and the speeds estimated using a flutter speed formula. Modifications to the formula are proposed which include a compressibility correction. A comparison is made between measured flutter speeds and those calculated using two-dimensional incompressible flow theory. This shows that the calculated speeds are lower than the measured speeds except in the transonic region, where they are in some cases slightly higher. The calculated flutter frequencies are on the average some 20 percent higher than the measured values.

N-46491*

Aeronautical Research Council (Gt. Brit.)
ANALYSIS OF SHORT-PERIOD LONGITUDINAL OSCILLATIONS OF AN AIRCRAFT--INTERPRETATION OF FLIGHT TESTS. S. Neumark. 1956. 55p. diagrs., tabs. (ARC R & M 2940; ARC 15,600. Supersedes RAE Aero 2479)

A method is presented of analyzing experimental curves obtained in flight when an aircraft is disturbed longitudinally by a suitable elevator input and performs mainly short-period oscillations. Determination of frequency, damping factor, amplitude ratios, and phase angles of various oscillatory curves leads to formulas for evaluating stability derivatives. Cases of elevator fixed or oscillating, for tailed and tailless aircraft, are considered and illustrated by numerical examples. The main results of the investigation are given.

N-46492*

Aeronautical Research Council (Gt. Brit.)
WIND-TUNNEL OBSERVATIONS OF BOUNDARY-LAYER TRANSITION ON A WING AT VARIOUS ANGLES OF SWEEPBACK. A. Anscombe and L. N. Illingworth. 1956. 9p. diagrs., photos., tabs. (ARC R & M 2968; ARC 15,019. Supersedes RAE Tech. Note Aero 2170)

Visual observations have been made of boundary-layer transition on a wind-tunnel model of constant chord at zero to 50°. At each angle above 25° a critical speed could be found within the speed range of the tunnel (400 ft/sec) at which striations appeared within the laminar boundary layer, while the transition line itself lay at 50 percent to 60 percent chord. As the speed was further increased transition started to move forward, finally occurring close to the leading edge. The wind speed at which the striations appeared and the forward movement of transitions started, decreased with increasing angle of sweepback.

N-46493*

Aeronautical Research Council (Gt. Brit.)
CONTROL TESTING IN WIND TUNNELS. L. W. Bryant and H. C. Garner. 1956. 56p. diagrs., tabs. (ARC R & M 2881. Supersedes ARC 13,465, S & C 2441 & ARC 13,718, S & C 2441a)

Contents: Construction of the model; observation and control of transition in the boundary layer - size of transition wires; corrections for tunnel-wall interference - blockage correction, two-dimensional interference correction, interference corrections in open-jet tunnels, uniform incidence or full-span control, deflected partial-span control, accurate determination of tunnel interference for a large model; free-stream calculations - lifting line theory, practical correlation; effect of Reynolds number - scale effect on incidence derivatives, scale effect at high lifts, scale effects at small lifts, scale effect on derivatives of

flap angle; summary of procedure - collected formulas for correcting two-dimensional tests, collected approximate formulas for correcting three-dimensional tests in a closed tunnel; calculated examples. Appendices: Validity of elliptic spanwise loading; methods of computing δ_0 and δ_1 in rectangular, circular, and octagonal tunnels.

N-46520*

Forest Products Research Lab., Dept. of Scientific and Industrial Research (Gt. Brit.) RADIO FREQUENCY AND OTHER HEATING PROCESSES. THE APPLICATION OF RADIO FREQUENCY HEATING TO PLYWOOD MANUFACTURE PRELIMINARY EXPERIMENT. PROGRESS REPORT FOURTEEN, MARCH 1956. J. F. S. Carruthers and G. E. Soane. 3p. diagr. (Forest Products Research Lab., DSIR)

The object of this preliminary experiment was to examine the application of radio frequency heating to the manufacture of plywood of various thicknesses and to indicate profitable lines for research. For convenience only flat plywood was considered, but the results are, of course, applicable to curved shapes.

UNPUBLISHED PAPERS

N-47593*

TRENDS IN TECHNICAL DEVELOPMENT OF AIRCRAFT. (Puti tekhnicheskogo razvitiya samoleta). L. S. Kamenomostskii. 34p diagrs., photos., tabs. (Translation from Vsesoyuznoe Obshchestvo Po Rasprostraneniyu Politicheskikh i Nauchnykh Znanie, Seriya IV, No. 37, Izdatel'stvo 'Znanie', Moscow 1954)

Trends in Russian aeronautical developments are reviewed. The transition from biplanes to monoplanes, evolution of the wing, increase in the load per unit of wing area, landing gear, and engines are discussed.

N-47700*

University of Oklahoma Research Institute. FLAME STABILIZATION IN GASES FLOWING CYCLONICALLY: FLOW CHARACTERISTICS, TEMPERATURE, GAS ANALYSES. Lyle F. Albright and Lloyd G. Alexander. (Final rept. for period September 1954 to September 1955). viii, 104p. diagrs., photos., tabs. (Oklahoma U. Research Inst.)

Flow measurements were made in this investigation of a stable flame in an emergent cyclonic free jet. Flames were stabilized in 2-inch I. D. ducts over a wide range of flow conditions. Flow characteristics, temperatures, and gas analyses were determined for several typical flames in a duct. The flow characteristics of cyclonic air in a duct were established. Stability limits were measured for a cyclonic flame in a diverging section. The rates of energy release were calculated for several cyclonic flames, and they were found to be high as compared to other types of flames.

N-47712*

Guggenheim Aeronautical Laboratory, California Institute of Technology. A DESIGN OF TURBULENT PIPE FLOW APPARATUS FOR ACOUSTIC MEASUREMENT. Paul F. R. Weyers. March 1956. ii, 11p. diagrs., photos. (Guggenheim Aeronautical Lab., Calif. Inst. of Tech.)

A system, of simple design, for obtaining fully developed turbulent pipe flow is discussed. It is intended primarily for use in the investigation of acoustic fields resulting from turbulent pipe flows. The performance of the equipment indicates that a satisfactory solution to the design problems has been obtained and that a start can be made on the investigation of the acoustics of such flow.

N-47713*

Acoustics Laboratory, Massachusetts Institute of Technology. INSTRUMENTATION FOR FIELD MEASUREMENTS OF NOISE PROPAGATION OVER GROUND. Stanley K. Oleson. April 30, 1956. 90p. diagrs., photos. (Acoustics Lab., Mass. Inst. of Tech.)

The procedure described attempts to improve on previous methods by recording meteorological and acoustic data almost simultaneously. The measuring system comprises a high level noise source, a number of microphones to pick up the noise signal at various fixed distances from the source, thermistor anemometers and thermometers to measure wind velocity and temperature at different elevations and associated electronic apparatus to amplify, measure, and record the signals from the microphones, anemometers, and thermometers. All functions are controlled from a central point, to which all signals are transmitted for recording and measurement.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification October 18, 1956.

NACA RM A52J21

THE EFFECTS OF TIP-MOUNTED JET NACELLES ON THE TRANSONIC CHARACTERISTICS OF LOW-ASPECT-RATIO WINGS. Charles F. Coe. December 1952. 81p. diagrs., photos., tabs. (NACA RM A52J21)

An investigation has been conducted to determine the effects of tip-mounted jet-engine nacelles on the aerodynamic characteristics of low-aspect-ratio rectangular wings of varying aspect ratio, camber, and thickness. Nacelles were mounted in three positions in a vertical plane at the tip. Data are also presented for a tapered wing with and without a nacelle mounted symmetrically at the tip. The test Mach number was varied from 0.60 to 1.12 which corresponded to a test Reynolds number range of 1.6 million to 2.1 million for the rectangular wings and 2.3 million to 3.1 million for the tapered wing.

NACA RM A53J26

THE USE OF A LEADING-EDGE AREA-SUCTION FLAP TO DELAY SEPARATION OF AIR FLOW FROM THE LEADING EDGE OF A 35° SWEPTBACK WING. Curt A. Holzhauser and Robert K. Martin. December 1953. 42p. diagrs., photos., tabs. (NACA RM A53J26)

The aerodynamic characteristics and suction requirements for a 35° swept-wing model having a 40° leading edge area-suction flap were compared with those obtained on the same model having leading edge area suction (NACA RM A53E06). The measurements also included pressure distributions over the wing. The free-stream velocity range of the test was from 112 to 166 feet per second. It was found that comparable delays in air-flow separation from the forward portion of the wing were obtained by the two methods of boundary-layer control. However, the power required for the 40° leading edge area-suction flap was about one-tenth of that required for leading edge area suction at the same angle of attack.

NACA RM A54A25

THE USE OF AREA SUCTION TO INCREASE THE EFFECTIVENESS OF A TRAILING-EDGE FLAP ON A TRIANGULAR WING OF ASPECT RATIO 2. Mark W. Kelly and William H. Tolhurst, Jr. April 1954. 44p. diagrs., photos. (NACA RM A54A25)

An investigation was conducted to determine the effectiveness of area suction applied to the leading edge of a partial-span trailing-edge flap on a triangular wing of aspect ratio 2. The investigation covered a Reynolds number range from 9.8 to 18.2 x 10^6. The results indicated that high lift at relatively low attitudes can be obtained from this configuration with low suction flow requirements. Measurements of lift, drag, pitching moment, pressure distribution on the wing and flap, and suction requirements are presented.

NACA RM A54J22

THE PRESSURE-RECOVERY AND PROPELLER-FORCE CHARACTERISTICS OF A PROPELLER-SPINNER-COWLING COMBINATION EMPLOYING NACA 4-(5)(05)-037 SIX- AND EIGHT-BLADE DUAL-ROTATION PROPELLERS WITH AN NACA 1-SERIES D-TYPE COWL. Robert I. Sammonds and Robert M. Reynolds. January 1955. 98p. diagrs., photos., tabs. (NACA RM A54J22)

The pressure recovery and propeller force characteristics of six- and eight-blade dual-rotation propeller-spinner-cowling combinations are presented for various propeller blade angles, inlet velocity ratios, and advance ratios at Mach numbers up to 0.84. All tests were made at a Reynolds number of 1.3 million, based on the maximum cowl diameter.

NACA RM A55I09

FULL-SCALE WIND-TUNNEL TESTS OF A 35° SWEPTBACK WING AIRPLANE WITH HIGH-VELOCITY BLOWING OVER THE TRAILING-EDGE FLAPS. Mark W. Kelly and William H. Tolhurst, Jr. November 1955. 49p. diagrs., photos., tab. (NACA RM A55I09)

A wind-tunnel investigation was conducted to determine the effects of blowing high-velocity air over the trailing-edge flaps of an airplane having a 35° swept-back wing. It was found that blowing over the flaps produced large increases in flap effectiveness for deflections from 45° to 85°. Measurements of lift, drag, pitching moment, and blowing-air requirements are presented for Reynolds numbers from 5.8 to 10.1 x 10^6.

#NACA RM E8J27

NACA RM E50J09

EXPERIMENTAL PRESSURE DISTRIBUTIONS OVER TWO WING-BODY COMBINATIONS AT MACH NUMBER 1.9. Barry Moskowitz and Stephen H. Maslen. February 5, 1951. 31p. diagrs., photos. (NACA RM E50J09)

Pressure distributions on two wing-body combinations were obtained at Mach number of 1.9 to investigate wing-body interference. A rectangular wing, a triangular wing, and a cylindrical body having an ogive nose were investigated alone and in combination. Pressure distributions over the wing-body combination compared favorably with theoretical calculations based primarily on a generalization of the method of Nielsen and Matteson, except at the root section of wings where boundary layer of body modified the flow.

NACA RM E51J08

PRELIMINARY INVESTIGATION OF USE OF CONICAL FLOW SEPARATION FOR EFFICIENT SUPERSONIC DIFFUSION. W. E. Moeckel and P. J. Evans, Jr. December 1951. 15p. photos., diagrs. (NACA RM E51J08)

Use of flow separation on a rod projecting upstream of a blunt body to decelerate the supersonic stream ahead of an annular nose inlet was investigated at Mach numbers of 1.76, 1.93, and 2.10. Maximum pressure recoveries were obtained with rod tip projections about 1.5 times the radius of the spherical nose and were higher than those obtained with single-shock solid cones. Subcritical operation was similar to that observed with solid-cone inlets, but the effect of angle of attack on maximum pressure recovery was more severe.

NACA RM E51J22

EXPERIMENTAL INVESTIGATION OF EFFECT OF JET EXIT CONFIGURATION ON THRUST AND DRAG. Edmund E. Callaghan and Willard D. Coles. December 1951. 18p. diagrs., photos. (NACA RM E51J22)

Performance losses occurring when airplanes equipped with afterburner and cooling-air ejector installations were flown with the afterburner inoperative were investigated. These losses were found to have two sources: either excessive ejector pumping or overexpansion of the propulsive jet. The effect of a partial shroud on performance appeared negligible at pressure ratios as high as 4.0.

NACA RM E52I11

PHOTOGRAPHIC STUDIES OF PREIGNITION ENVIRONMENT AND FLAME INITIATION IN TURBOJET-ENGINE COMBUSTORS. David M. Straight and J. Dean Gernon. February 1953. 40p. photos., diagrs. (NACA RM E52I11)

Preignition environment and flame initiation in turbojet combustors were studied in transparent combustors by photographic techniques. The concept of reverse air flow in a combustor primary zone was substantiated. Fuel atomization was improved by air turbulence in the combustor and by change in fuel-nozzle design. The initial flame spreading from the ignition source followed the preignition air-flow patterns. Better understanding of the effect of spark-electrode position and other design variables on starting performance may be obtained from this type of photographic study.

NACA RM E52J21

EFFECT OF FUEL VOLATILITY CHARACTERISTICS ON IGNITION-ENERGY REQUIREMENTS IN A TURBOJET COMBUSTOR. Hampton H. Foster and David M. Straight. January 1953. 32p. diagrs., tab. (NACA RM E52J21)

The effect of fuel-volatility characteristics on the ignition-energy requirements in a turbojet combustor was investigated. Data were obtained at simulated static sea-level engine starting conditions for a wide range of combustor-inlet air and fuel temperatures and also for a range of altitude inlet-air pressures and two air flows. In order to determine the relative ignition characteristics of the fuels at various combustor-inlet pressures and two air flows, a relation between the minimum ignition-energy requirements and an empirical function of combustor inlet-air pressure and velocity ($V/\sqrt{P}$) was developed. The data obtained at both sea-level and altitude conditions showed that the A. S. T. M. 15-percent evaporated temperatures of the fuels were generally indicative of their ignition characteristics; whereas, the Reid vapor pressures of the fuels were not.

NACA RM L8G29

FLIGHT INVESTIGATION TO DETERMINE THE AERODYNAMIC CHARACTERISTICS OF ROCKET-POWERED MODELS REPRESENTATIVE OF A FIGHTER-TYPE AIRPLANE CONFIGURATION INCORPORATING AN INVERSE-TAPER WING AND A VEE TAIL. Sidney R. Alexander. November 2, 1948. 29p. diagrs., photos., tab. (NACA RM L8G29)

Two rocket-powered models representative of a fighter-type airplane configuration having an inverse-taper wing and a vee tail were investigated in flight at Mach numbers up to 1.01 and 1.07 by the Langley Pilotless Aircraft Research Division at its testing station at Wallops Island, Va. These models incorporated a tail length of 1.56 mean aerodynamic chords and were flown with controls undeflected and wing and stabilizers set at 0° incidence. Values of lateral acceleration, normal acceleration, velocity, and drag were obtained by use of a telemeter and a Doppler velocimeter radar unit.

NACA RM L9J26

COMPARATIVE TESTS OF THE ROLLING EFFECTIVENESS OF CONSTANT-CHORD, FULL-DELTA, AND HALF-DELTA AILERONS ON DELTA WINGS AT TRANSONIC AND SUPERSONIC SPEEDS. Carl A. Sandahl and H. Kurt Strass. December 12, 1949. 26p. diagrs., photos., tab. (NACA RM L9J26)

Comparative tests of the rolling power of plain constant-chord, full-delta, and half-delta ailerons on

delta wings having 45° and 60° leading-edge sweepback have been made utilizing rocket-propelled test vehicles in free flight. The results are compared with theory.

NACA RM L51J22a

WIND-TUNNEL INVESTIGATION AT TRANSONIC SPEEDS OF A LEADING-EDGE SLAT ON A MODIFIED-DOUBLE-WEDGE WING. Richard G. MacLeod. December 1951. 12p. diagrs. (NACA RM L51J22a)

Contains results at a Reynolds number of about 1×10^6 and at Mach numbers from 0.6 to 1.10 of a preliminary investigation on a leading-edge slat on a modified-double-wedge wing. Results indicated that the gain obtained in maximum lift at low Mach numbers by deflecting the slat was not maintained through the Mach number range. Below the stall a drag increase and a diving moment resulted through the Mach number range when the slat was deflected.

NACA RM L51J29

JET EFFECTS ON PRESSURES AND DRAGS OF BODIES. Warren Gillespie, Jr. November 1951. 12p. diagrs. (NACA RM L51J29)

Experimental results of recent investigations by the Lewis and Langley laboratories of the jet effect on body end pressures and drag at zero lift indicate that a decrease in base drag can be obtained by a small amount of jet flow to the base. A large base annulus may contribute as much or greater base drag during power-on conditions than the whole base area during power-off flight. The jet effect on body side pressures at supersonic Mach numbers decreases rapidly with increasing Mach number and distance forward of the base. More extensive measurements are required to clarify the jet effect on total drag.

NACA RM L52D02

EXPERIMENTAL INVESTIGATION OF BOUNDARY-LAYER SUCTION THROUGH SLOTS TO OBTAIN EXTENSIVE LAMINAR BOUNDARY LAYERS ON A 15-PERCENT-THICK AIRFOIL SECTION AT HIGH REYNOLDS NUMBERS. Laurence K. Loftin, Jr., and Elmer A. Horton. June 1952. 38p. diagrs., photos., tabs. (NACA RM L52D02)

The results presented indicate that essentially full-chord laminar flow with large net drag savings can be obtained through the use of multiple suction slots for Reynolds numbers as high as 16.0×10^6 to 17.0×10^6. These results, however, could be obtained only after a very high degree of surface excellence had been achieved on the model.

NACA RM L52J01

TRANSONIC WIND-TUNNEL INVESTIGATION OF THE INTERFERENCE BETWEEN A 45° SWEPTBACK WING AND A SYSTEMATIC SERIES OF FOUR BODIES. Donald L. Loving and Dewey E. Wornom. November 1952. 42p. diagrs., photos., tabs. (NACA RM L52J01)

The interference between a 45° sweptback wing and a systematic series of four bodies is presented for subsonic and transonic speeds. Measurements were made at nonlifting and lifting conditions for the various wing-body configurations and the bodies alone at Mach numbers from 0.60 to 1.13. Analysis showed that the principal effects of the various body shapes on the wing-body interference occurred in the transonic range, with the drag characteristics being most significantly affected. The changes to the original body shape decreased the zero-lift drag rise of the wing with interference and increased the lift-drag ratio at transonic speeds. The modifications had significant effects on the drag characteristics of the bodies alone at transonic speeds and the pitching-moment characteristics throughout the speed range tested.

NACA RM L52J07

A STUDY OF THE USE OF FREON-12 AS A WIND-TUNNEL TESTING MEDIUM AT LOW SUPERSONIC MACH NUMBERS. Milton A. Schwartzberg. November 1952. 24p. diagrs., photo. (NACA RM L52J07)

Pressure distributions measured on a 45° sweptback wing in Freon-12 at a low supersonic Mach number are compared with similar measurements made in air. Small differences between the data obtained in the two gases are resolved by application of conversion factors derived from the concept of geometrical similarity of the flow pattern in the two gases.

NACA RM L52J22

A SMALL-SCALE INVESTIGATION OF THE EFFECT OF SPANWISE AND CHORDWISE POSITIONING OF AN OGIVE-CYLINDER UNDERWING NACELLE ON THE HIGH-SPEED AERODYNAMIC CHARACTERISTICS OF A 45° SWEPTBACK TAPERED-IN-THICKNESS WING OF ASPECT RATIO 6. H. Norman Silvers and Thomas J. King, Jr. December 1952. 57p. diagrs., tab. (NACA RM L52J22)

An investigation of a nacelle in several spanwise and chordwise locations was made at Mach numbers from 0.7 to 1.08 on a semispan wing with 45° sweepback, an aspect ratio of 6, and a taper ratio of 0.6 with an NACA 65A-series section tapering from root in thickness ratio from 9 percent to 3 percent. The nacelle, a solid body of revolution of fineness ratio 9.34, was composed of a cylinder with ogival nose and tail.

NACA RM L52J28

CONTROL CHARACTERISTICS OF TRAILING-EDGE SPOILERS ON UNTAPERED BLUNT TRAILING-EDGE WINGS OF ASPECT RATIO 2.7 WITH 0° AND 45° SWEEPBACK AT MACH NUMBERS OF 1.41 AND 1.96. Carl R. Jacobsen. December 1952. 35p. diagrs., photo. (NACA RM L52J28)

An investigation has been made in the Langley 9- by 12-inch supersonic blowdown tunnel to determine the control characteristics of full-span trailing-edge spoilers on several blunt trailing-edge wings of aspect ratio 2.7 at Mach numbers of 1.41 and 1.96. The tests were made at spoiler projections up to 6 percent of the wing chord and at angles of attack up to 25°. The Reynolds numbers for the tests ranged from 1.3×10^6 to 2.3×10^6. Full-span spoilers were tested at the 70-percent-chord line and at the trailing edge of both the unswept and 45° sweptback wings. A trailing-edge spoiler, which pivoted about the 85-percent-chord line of the wing, was also tested on an unswept wing with the trailing-edge thickness equal to one-third of the maximum thickness.

NACA RM L52J29

LOW-SPEED WIND-TUNNEL INVESTIGATION OF A THIN 60° DELTA WING WITH DOUBLE SLOTTED, SINGLE SLOTTED, PLAIN, AND SPLIT FLAPS. John M. Riebe and Richard G. MacLeod. January 1953. 57p. diagrs., photo., tabs. (NACA RM L52J29)

Results are presented of a wind-tunnel investigation at low speeds of a thin delta wing equipped with double slotted, single slotted, plain, and split flaps. Results of the double-slotted-flap configuration indicated an increase in the lift-drag ratio from a lift coefficient of 0.8 up to the stall. The double-slotted-flap configuration tested resulted in an increment of lift coefficient of about 0.96 at zero angle of attack and an increase in maximum lift coefficient of 0.36.

NACA RM L53J05

INVESTIGATION AT TRANSONIC SPEEDS OF THE LATERAL-CONTROL AND HINGE-MOMENT CHARACTERISTICS OF A FLAP-TYPE SPOILER AILERON ON A 60° DELTA WING. Harleth G. Wiley and Robert T. Taylor. January 1954. 22p. diagrs. (NACA RM L53J05)

This paper presents results of an investigation of the lateral-control and hinge-moment characteristics of a 0.67 semispan flap-type spoiler aileron on a semispan thin 60° delta wing at transonic speeds by the reflection-plane technique. The spoiler-aileron had a constant chord of 10.29 percent mean aerodynamic chord and was hinged at the 81.9-percent-wing-root-chord station. Tests were made with the spoiler aileron slot open, partially closed, and closed. Incremental rolling-moment, incremental yawing-moment, and hinge-moment coefficients were obtained through a Mach number range of 0.62 to 1.08. Results indicated reasonably linear variations of rolling-moment and hinge-moment coefficients with spoiler projection except at spoiler projections of less than -2 percent mean aerodynamic chord and angles of attack greater than 12° with results generally independent of slot geometry.

NACA RM L53J05a

WIND-TUNNEL INVESTIGATION AT HIGH SUBSONIC SPEEDS OF THE EFFECT OF SPOILER PROFILE ON THE LATERAL CONTROL CHARACTERISTICS OF A WING-FUSELAGE COMBINATION WITH QUARTER-CHORD LINE SWEPT BACK 32.6° AND NACA 65A006 AIRFOIL SECTION. Harold S. Johnson. November 1953. 15p. diagrs. (NACA RM L53J05a)

This paper contains the results of a wind-tunnel investigation made through a Mach number range of 0.39 to 0.89 to determine the effect of spoiler profile on the lateral control characteristics of a wing-fuselage model. Included are rolling- and yawing-moment data through an angle-of-attack range from 0° to about 8° for each of four 49.7-percent-semispan inboard spoilers located on the 70-percent-chord line of the aspect-ratio-4, taper-ratio-0.6 wing which had a quarter-chord sweepback of 32.6° and an NACA 65A006 airfoil section. The spoiler profiles investigated were a right-angle spoiler, forward- and rearward-hinged flap-type spoilers, and a spoiler obtained by joining the forward- and rearward-hinged flap-type spoilers at the line of maximum projection. Also included are lift, drag, and pitching-moment data for the wing-fuselage combination without spoilers.

NACA RM L53J09b

APPLICATION OF TRANSONIC AREA RULE TO A SHARP-LIPPED DUCTED NACELLE. Richard E. Walters. January 1954. 11p. diagrs., tab. (NACA RM L53J09b)

The transonic area rule concept has been applied to normal-shock, sharp-lipped inlet configurations by replacing them with bodies of equivalent area distributions. The drag results from the equivalent bodies confirm the application of the rule in these cases.

NACA RM L53J12a

LONGITUDINAL STABILITY AND TRIM OF TWO ROCKET-PROPELLED AIRPLANE MODELS HAVING 45° SWEPTBACK WINGS AND TAILS WITH THE HORIZONTAL TAIL MOUNTED IN TWO POSITIONS. James H. Parks and Alan B. Kehlet. December 1953. 26p. diagrs., photos. (NACA RM L53J12a)

The longitudinal stability and trim characteristics of two rocket-propelled airplane models with swept wings and fixed horizontal tails of the same geometry but located at different positions were investigated in free flight at Mach numbers from about 0.6 to 1.4. Static- and dynamic-longitudinal stability parameters, values of trim lift coefficient and angle of attack, and vibration characteristics of the horizontal tails are presented. The results are presented with some observations but without analysis.

NACA RM L53J15

THE INFLUENCE OF THE CONTROL-SURFACE-SERVO NATURAL FREQUENCY UPON THE TRANSIENT CHARACTERISTICS OF A FLIGHT-PATH-ANGLE CONTROL SYSTEM INCORPORATING A SUPERSONIC MISSILE. Anthony L. Passera and Thomas F. Bridgland, Jr. December 1953. 22p. diagrs., photo., tabs. (NACA RM L53J15)

A theoretical investigation has been made to determine the effect of the natural frequency of a second-order control-surface servo upon the transient characteristics of a supersonic canard missile configuration in a flight-path-angle control system for several flight conditions and static margins. These effects are presented as plots of response time, attitude accuracy, peak rate and total volume of oil flow through the servo, and maximum normal acceleration of the airframe against control-surface-servo natural frequency in response to a unit step command input.

NACA RM L53J21

WIND-TUNNEL INVESTIGATION AT TRANSONIC SPEEDS OF A SPOILER-SLOT-DEFLECTOR COMBINATION ON AN UNSWEPT NACA 65A006 WING. Raymond D. Vogler. December 1953. 27p. diagrs., 3 tabs. (NACA RM L53J21)

Results are presented of a wind-tunnel investigation at transonic speeds and angles of attack up to 24° to determine the lateral control characteristics of a spoiler, a spoiler-gap-lip combination, and a spoiler-slot-deflector combination. The spoiler-slot-deflector combination showed good rolling effectiveness throughout the angle-of-attack and Mach number range investigated.

NACA RM L53J22

EFFECTS OF EXTERNAL STORE MOUNTING ON THE BUFFET, TRIM, AND DRAG CHARACTERISTICS OF ROCKET-POWERED FUSELAGE AND STORE COMBINATIONS BETWEEN MACH NUMBERS OF 0.7 AND 1.4. Homer P. Mason. December 1953. 27p. diagrs., photos., tab. (NACA RM L53J22)

An investigation has been made of the effects of store mounting on the buffet, trim, and drag characteristics of fuselage-mounted external stores between Mach numbers of 0.7 and 1.4 using the rocket propelled model technique. Four models have been tested which consisted of wingless parabolic fuselages with finless models of a 10,000-pound large-diameter bomb located at the same longitudinal stations with various store mounting arrangements. The mounting arrangements tested were a semisubmerged store, a store mounted tangent to the fuselage, a store mounted on a 10-percent-thick pylon, and a store mounted on a 4-percent-thick pylon. In conjunction with these tests, a model has been flown by the helium-gun technique to obtain the drag of the isolated store. Data from these tests show that strong interference effects about fuselage-mounted external stores may produce severe buffeting and large drag increments.

NACA RM L53J26

LOW-SPEED INVESTIGATION OF THE EFFECTS OF LOCATION OF A DELTA AND A STRAIGHT TAIL ON THE LONGITUDINAL STABILITY AND CONTROL OF A THIN DELTA WING WITH EXTENDED DOUBLE SLOTTED FLAPS. John M. Riebe and Jean C. Graven, Jr. January 1954. 49p. diagrs., tabs. (NACA RM L53J26)

Results are presented of a wind-tunnel investigation at low speeds of the effect of horizontal-tail location and plan form on the longitudinal stability and control characteristics of a thin delta wing with extended double slotted flaps including the effects of a retractable canard horizontal surface. An investigation was also made of a Fowler type flap. Satisfactory locations of horizontal tail with flaps deflected were indicated to be lower and farther to the rear than for the flap-retracted condition. With regard to stability and control, a delta-plan-form tail was generally found to be superior to a moderately swept tail. Use of the canard with the extended double slotted flap and a delta tail generally resulted in a longitudinally stable high-lift configuration with a trim lift coefficient of 0.82 at an angle of attack of 0° and a maximum trim lift coefficient of 2.30.

NACA RM L54C05

EFFECT ON THE LOW-SPEED AERODYNAMIC CHARACTERISTICS OF A 49° SWEPTBACK WING HAVING AN ASPECT RATIO OF 3.78 OF BLOWING AIR OVER THE TRAILING-EDGE FLAP AND AILERON. Edward F. Whittle, Jr., and Stanley Lipson. April 1954. 51p. diagrs., photo., tab. (NACA RM L54C05)

An investigation was made in the Langley full-scale tunnel to determine the effect on aerodynamic characteristics of a semispan 49.1° sweptback wing of blowing a high-energy stream of air over a trailing-edge flap and an aileron with and without a slat and fences. The wing had an aspect ratio of 3.78, a taper ratio of 0.59, and NACA 65A006 airfoil sections parallel to the plane of symmetry. Rolling moments produced by a flap-type aileron were measured and flap pressures were obtained at one spanwise station. The data were obtained at Reynolds numbers of 2.9×10^6, 4.4×10^6, and 6.1×10^6 corresponding to Mach numbers of 0.05, 0.07, and 0.10, respectively.

NACA RM L54G09

GROUND TESTS OF THE ELEVATOR POWER CONTROL SYSTEM AND FEEL DEVICE IN A BOEING B-47A AIRPLANE. B. Porter Brown. October 1954. 34p. diagrs. (NACA RM L54G09)

Ground tests were made on the elevator power control system and feel device of a Boeing B-47A airplane. Frequency-response measurements were made by oscillating the control stick sinusoidally while recording the stick force, stick angle, and elevator angle. Tests were also made involving a simulator which affords the pilot a visual indication of the airplane response to control motions. All tests were made at various equivalent airspeeds which were simulated by applying the appropriate air pressure to the feel device Q-spring.

NACA RM L54J22

A LIMITED ANALYSIS OF BUFFETING EXPERIENCE IN FLIGHT BY A NORTH AMERICAN F-86A-1 AIRPLANE WITH AND WITHOUT LARGE EXTERNAL FUEL TANKS. Jim Rogers Thompson, Thomas C. O'Bryan, and Max C. Kurbjun. September 1955. 40p. diagrs., photo. (NACA RM L54J22)

A limited analysis of buffeting experienced by a North American F-86A-1 airplane with and without large external fuel tanks installed (extending to severe buffeting at maximum Mach numbers of 0.88 with tanks and 1.0 without tanks) has been performed in order to explore the buffeting characteristics of such configurations. The analysis consists of two parts: The effect of the tanks on the general buffeting characteristics throughout the investigated range, and detail study by frequency analysis methods of one run in the low-lift high Mach number buffeting region.

NACA RM L54J28a

WIND-TUNNEL INVESTIGATION AT TRANSONIC SPEEDS OF THE LIFT AND HINGE-MOMENT CHARACTERISTICS OF A FLAP WITH ATTACHED BALANCING TAB ON A 45° SWEPTBACK WING. Raymond D. Vogler. December 1954. 63p. diagrs. (NACA RM L54J28a)

Lift and hinge moments of a low-aspect-ratio sweptback wing with a flap and a balancing tab attached to the inboard trailing edge of the flap were obtained for a Mach range from 0.75 to 1.20. Data were obtained for a range of tab deflection between 10° unbalancing and 30° balancing, flap deflections between ±20°, and angles of attack from -2° to 16°. For flap balance, a tab-flap deflection ratio of approximately 1 subsonically and 1.5 supersonically was indicated. The lift effectiveness of the balanced flap was 67 to 80 percent of that of the unbalanced flap.

NACA RM L55D29a

A CORRELATION OF TWO-DIMENSIONAL DATA ON LIFT COEFFICIENT AVAILABLE WITH BLOWING-, SUCTION-, SLOTTED-, AND PLAIN-FLAP HIGH-LIFT DEVICES. John M. Riebe. October 1955. 32p. diagrs. (NACA RM L55D29a)

This paper contains results of a correlation of the available two-dimensional data on flap-type high-lift devices including plain, single slotted, and double slotted flaps and suction and blowing flaps which utilized boundary-layer control by suction and by jet flow, respectively. The flap-chord ratios ranged from 20 to 40 percent wing chord. The correlation indicated that the largest lift increments were obtained for the blowing flaps. Flap-chord ratio had a large effect on the momentum coefficient required to obtain a given lift coefficient with minimum momentum coefficient required in the flap-chord ratio range greater than 0.30 and less than 0.40.

NACA RM L55E11a

RECENT STABILITY AND AERODYNAMIC PROBLEMS AND THEIR IMPLICATIONS AS TO LOAD ESTIMATION. Charles H. Zimmerman. June 1955. 12p. diagrs. (NACA RM L55E11a)

Modern fighter airplanes tend to suffer from stability deficiencies which can give rise to inadvertent high structural loads. These deficiencies are briefly described and discussed.

NACA RM L55F02

AERODYNAMIC CHARACTERISTICS AND PRESSURE DISTRIBUTIONS OF A 6-PERCENT-THICK 49° SWEPTBACK WING WITH BLOWING OVER HALF-SPAN AND FULL-SPAN FLAPS. Edward F. Whittle, Jr., and H. Clyde McLemore. September 1955. 71p. diagrs., photo., tabs. (NACA RM L55F02)

An investigation was made in the Langley full-scale tunnel to determine the effect on aerodynamic characteristics and chordwise and spanwise loadings of a semispan 49.1° sweptback wing of blowing a high-energy stream of air over half-span and full-span trailing-edge flaps with and without a slat and a fence installed. The wing had an aspect ratio of 3.22, a taper ratio of 0.64, and NACA 65A006 airfoil sections parallel to the plane of symmetry. The data were obtained in a Reynolds number range from 3.0×10^6 to 7.5×10^6 corresponding to a Mach number range from 0.05 to 0.12. The momentum-coefficient range investigated was from 0.08 to 0.38.

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NO. 109 **NOVEMBER 29, 1956**

CURRENT NACA RESEARCH REPORTS

NACA Rept. 1257

ON THE KERNEL FUNCTION OF THE INTEGRAL EQUATION RELATING LIFT AND DOWNWASH DISTRIBUTIONS OF OSCILLATING WINGS IN SUPERSONIC FLOW. Charles E. Watkins and Julian H. Berman. 1956. ii, 18p. diagrs. (NACA Rept. 1257. Supersedes TN 3438)

A suitable form of doublet potential that serves as a basis for deriving the kernel function for supersonic flow, corresponding to the kernel function for subsonic flow presented in NACA Report 1234, is derived by using a cutoff or unit function. A treatment similar to that made for the subsonic kernel is made for the kernel function for supersonic flow. The singularities are isolated and discussed, and the kernel function is shown to lead to correct results for two-dimensional flow, and to reduce properly to the sonic case.

NACA RM E56G17

METHODS FOR MEASURING TEMPERATURES OF THIN-WALLED GAS-TURBINE BLADES. Francis S. Stepka and Robert O. Hickel. November 1956. 25p. diagrs., photos., tab. (NACA RM E56G17)

The accuracy and durability of two means for measuring the metal temperature of gas-turbine blades were investigated experimentally in a turbojet engine. Cemented thermocouples that could be placed in walls as thin as 0.010 inch and commercial temperature-indicating paints were evaluated at turbine-inlet temperatures up to about 1650° F and for centrifugal forces equivalent to about 42,000 times gravity. The cemented thermocouples operated satisfactorily. The temperature-indicating paints were neither as accurate nor as durable as the cemented thermocouples.

NACA TM 1402

AEROELASTIC PROBLEMS OF AIRPLANE DESIGN. (Aeroelastische Probleme des Flugzeugbaus). H. G. Küssner. November 1956. 51p. tabs. (NACA TM 1402. Translation from Zeitschrift für Flugwissenschaften, v.3, no.1, January 1955, p.1-18)

A review, based on a bibliographical selection of some 65 papers and on the author's experience, is given of some recent progress in the field of wing flutter and related matters. The review touches on phases of unsteady aerodynamics and flutter theory, model and flight testing, and on design requirements.

NACA TN 3753

AERODYNAMIC CHARACTERISTICS AND FLYING QUALITIES OF A TAILLESS TRIANGULAR-WING AIRPLANE CONFIGURATION AS OBTAINED FROM FLIGHTS OF ROCKET-PROPELLED MODELS AT TRANSONIC AND LOW SUPERSONIC SPEEDS. Grady L. Mitcham, Joseph E. Stevens, and Harry P. Norris. November 1956. 57p. diagrs., photos., tabs. (NACA TN 3753. Supersedes RM L9L07)

A flight investigation of rocket-powered models of a tailless triangular-wing airplane configuration was made through the transonic and low supersonic speed range at the Langley Pilotless Aircraft Research Station at Wallops Island, Va. An analysis of the aerodynamic coefficients, stability derivatives, and flying qualities based on the results obtained from the successful flight tests of three models is presented.

NACA TN 3775

CRASH INJURY. Gerard J. Pesman and A. Martin Eiband. November 1956. 36p. diagrs., photos. (NACA TN 3775)

Data from full-scale experimental airplane crashes were studied to determine how impact injuries occur and how the chance of such injuries may be reduced. The following hazards were considered: (1) being crushed, (2) being struck by missiles, (3) striking objects by tearing loose or flailing about, and (4) being injured by the crash decelerations. Transport, cargo, fighter, and light airplane crashes were studied.

NACA TN 3778

ANALYSIS OF ELASTIC THERMAL STRESSES IN THIN PLATE WITH SPANWISE AND CHORDWISE VARIATIONS OF TEMPERATURE AND THICKNESS. Alexander Mendelson and Marvin Hirschberg. November 1956. 41p. diagrs. (NACA TN 3778)

An approximate method for calculating thermal stresses in a thin plate with variable thickness and temperature distributions in both the spanwise and chordwise directions is presented. Several examples are worked out and plotted.

NACA TN 3809

A METHOD FOR CALCULATION OF FREE-SPACE SOUND PRESSURES NEAR A PROPELLER IN FLIGHT INCLUDING CONSIDERATIONS OF THE CHORDWISE BLADE LOADING. Charles E. Watkins and Barbara J. Durling. November 1956. 68p. diagrs., tabs. (NACA TN 3809)

This report presents tabulated values of certain definite integrals that are involved in the calculation of near-field propeller noise when the chordwise forces are assumed to be either uniform or of a Dirac delta type. The tabulations are over a wide range of operating conditions and are useful for estimating propeller noise when either the concept of an effective radius or radial distributions of forces are considered. Use of the tabulations is illustrated by several examples of calculated results for some specific propellers.

NACA TN 3813

COMPARISON OF THEORETICAL STRESSES AND DEFLECTIONS OF MULTICELL WINGS WITH EXPERIMENTAL RESULTS OBTAINED FROM PLASTIC MODELS. George W. Zender. November 1956. 32p. diagrs., photos. (NACA TN 3813)

The experimental deflections and stresses of six plastic multicell-wing models of unswept, delta, and swept plan form are presented and compared with previously published theoretical results obtained by the electrical analog method. The comparisons indicate that the theory is reliable except for the evaluation of stresses in the vicinity of the leading edge of delta wings and the leading and trailing edges of swept wings. The stresses in these regions are questionable, apparently because of simplifications employed in idealizing the actual structure for theoretical purposes and because of local effects of concentrated loads.

NACA TN 3815

ON SLENDER-BODY THEORY AND THE AREA RULE AT TRANSONIC SPEEDS. Keith C. Harder and E. B. Klunker. November 1956. 14p. (NACA TN 3815. Supersedes RM L54A29a)

The basic ideas of the slender-body approximation have been applied to the nonlinear transonic-flow equation for the velocity potential in order to obtain some of the essential features of slender-body theory at transonic speeds. The results of the investigation are presented from a unified point of view which demonstrates the similarity of slender-body solutions in the various Mach number ranges. The transonic area rule and some conditions concerning its validity follow from the analysis.

NACA TN 3818

WIND-TUNNEL INVESTIGATION TO DETERMINE THE HORIZONTAL- AND VERTICAL-TAIL CONTRIBUTIONS TO THE STATIC LATERAL STABILITY CHARACTERISTICS OF A COMPLETE-MODEL SWEPT-WING CONFIGURATION AT HIGH SUBSONIC SPEEDS. James W. Wiggins, Richard E. Kuhn, and Paul G. Fournier. November 1956. 34p. diagrs., photo. (NACA TN 3818. Supersedes RM L53E19)

Results are presented of an investigation made in the Langley high-speed 7- by 10-foot tunnel to determine the horizontal- and vertical-tail contributions to the static lateral stability of a complete-model configuration. The general research model was tested through a Mach number range from 0.40 to 0.95 and an angle-of-attack range from -3° to 25° at angles of sideslip of $\pm 4^{\circ}$.

NACA TN 3820

SOME OBSERVATIONS ON MAXIMUM PRESSURE RISE ACROSS SHOCKS WITHOUT BOUNDARY-LAYER SEPARATION ON AIRFOILS AT TRANSONIC SPEEDS. Walter F. Lindsey and Patrick J. Johnston. November 1956. 27p. diagrs., photos. (NACA TN 3820)

An investigation of the flow along flat plates having rounded leading edges has provided additional information on shock-induced separation. The results are compared with data from two-dimensional airfoil investigations and indicate that laminar boundary layers can sustain theoretical pressure rises for normal shocks without separating. The permissible pressure rise increases with increase in angle of attack and proximity of shock to the leading edge of the flat plate or the airfoil.

NACA TN 3830

GROWTH OF DISTURBANCES IN A FLAME-GENERATED SHEAR REGION. Perry L. Blackshear, Jr. November 1956. iv, 148p. diagrs., photos., tabs. (NACA TN 3830)

This paper contains a stability analysis of the flow field that arises when a flame is anchored in a duct and an experimental examination of the growth of disturbances imposed on an anchored V-flame in a duct. The stability analysis shows that the flow is stable to all symmetric disturbances, and unstable to antisymmetric disturbances having wavelengths greater than the critical wavelength. This critical value is 2-1/2 times the local flame width for flames filling a small fraction of the duct and becomes infinite when the flame fills the duct. Roughly similar results obtain for the V-flame. The rate of heat release in a flame in a duct can be increased by introducing disturbances that the flame zone can amplify.

NACA TN 3832

ON POSSIBLE SIMILARITY SOLUTIONS FOR THREE-DIMENSIONAL INCOMPRESSIBLE LAMINAR BOUNDARY LAYERS. II - SIMILARITY WITH RESPECT TO STATIONARY POLAR COORDINATES. Howard Z. Herzig and Arthur G. Hansen. November 1956. 16p. tab. (NACA TN 3832)

Solutions of mainstream flow patterns for three-dimensional, laminar, incompressible thin-boundary-layer flows (over flat or slightly curved surfaces) having similarity with respect to stationary polar coordinates in the plane of the surface are derived. The solutions are summarized in a table.

NACA TN 3833

STABILITY LIMITS AND BURNING VELOCITIES OF LAMINAR HYDROGEN-AIR FLAMES AT REDUCED PRESSURE. Burton Fine. November 1956. 29p. diagrs., tab. (NACA TN 3833)

Laminar burning velocity was measured at pressures of 1 atm and below and critical boundary velocity gradient for flashback below 1 atm over a range of compositions for hydrogen-air burner flames. Both quantities were correlated with pressure, the pressure dependence being independent of composition between equivalence ratios of about 1 and 2. A more general correlation involving quenching distance conformed to a simple quenching model. From this correlation and thermal equations for flame propagation, a reaction order was calculated. The general laminar stability loop was discussed in terms of quenching regions, normal laminar regions, and regions of laminar-turbulent transition.

NACA TN 3837

INVESTIGATION OF HEAT TRANSFER FROM A STATIONARY AND ROTATING ELLIPSOIDAL FOREBODY OF FINENESS RATIO 3. James P. Lewis and Robert S. Ruggeri. November 1956. 46p. diagrs., photo., tabs. (NACA TN 3837)

Experimental convective heat transfer was obtained for a 20-inch-diameter forebody for airspeeds up to 240 knots, rotational speeds up to 1200 rpm, angles of attack of 0°, 3°, and 6°, and both uniform surface temperature and uniform input heat density. The results agree well with theoretical predictions. Effects of rotation were insignificant, and effects of angle of attack only minor. Transition from laminar to turbulent heat transfer varied over a Reynolds number range of 0.8×10^6 to 5×10^6. Limited transient heating data indicated that the change of surface temperature with time followed an exponential relation.

NACA TN 3838

PERFORMANCE CHARACTERISTICS OF RING-CASCADE-TYPE THRUST REVERSERS. Jack G. McArdle. November 1956. 53p. diagrs., photos., tab. (NACA TN 3838)

Model thrust reversers consisting of a cascade of turning rings plus a mechanical deflector positioned aft of a 4-inch exhaust nozzle with a 7° external fairing were tested in quiescent air at exhaust-nozzle pressure ratios up to 2.5. Reverse-thrust ratios up to 68 percent were obtained. The effects of several geometric design variables on performance and reversed-flow fields were measured. The modulation characteristics of a typical shrouded ring-cascade reverser were found to be satisfactory.

NACA TN 3840

ANALYSIS OF PARTICLE MOTIONS FOR A CLASS OF THREE-DIMENSIONAL INCOMPRESSIBLE LAMINAR BOUNDARY LAYERS. Arthur G. Hansen and Howard Z. Herzig. November 1956. 22p. diagrs., tabs. (NACA TN 3840)

An analysis is presented for the positions of particles at various time intervals in a three-dimensional incompressible laminar boundary layer on a flat surface for main flows consisting of streamline translates having constant axial velocity. Boundary-layer particles initially arrayed on a line normal to the surface trace out twisted surfaces as they progress downstream. For viscous-flow problems where it is important to know the length of time a particle remains near a bounding surface, tables are presented to facilitate rapid computation of the residence times of boundary-layer particles for a given flow configuration.

NACA TN 3848

A STUDY OF SEVERAL FACTORS AFFECTING THE STABILITY CONTRIBUTED BY A HORIZONTAL TAIL AT VARIOUS VERTICAL POSITIONS ON A SWEPTBACK-WING AIRPLANE MODEL. Gerald V. Foster and Roland F. Griner. November 1956. 28p. diagrs., tab. (NACA TN 3848. Supersedes RM L9H19)

Results are presented of a study made in the Langley 19-foot pressure tunnel at a Reynolds number of 6.8×10^6 to determine the effects of fuselage afterbody shape, split flaps, and a reduction in the span of 0.575-span leading-edge flaps on the stability contributed by a horizontal tail at various heights to a 42° sweptback wing-fuselage combination. Results are also presented of air-flow surveys in the vicinity of the tail with the wing flaps deflected.

NACA TN 3853

COMPRESSIVE STRESS-STRAIN PROPERTIES OF 2024-T3 ALUMINUM-ALLOY SHEET AT ELEVATED TEMPERATURES. Eldon E. Mathauser. November 1956. 66p. diagrs., photo., tab. (NACA TN 3853)

Compressive stress-strain test results for 2024-T3 aluminum-alloy sheet are presented for temperatures up to 700° F and exposure times from 0.1 to 100 hours. All specimens were loaded parallel to the rolling direction of the sheet and tested at a strain rate of 0.002 per minute. Significant design data obtained from the stress-strain curves (yield stress, Young's modulus, secant and tangent moduli, and two stresses useful for determining the maximum compressive strength of plates) are presented in graphical and tabular form. A rate-process relationship is used to determine exposure time which produces a maximum yield stress for a given temperature, and a time-temperature parameter is used to present the yield stresses as a single master curve.

NACA TN 3854

COMPRESSIVE STRESS-STRAIN PROPERTIES OF 7075-T6 ALUMINUM-ALLOY SHEET AT ELEVATED TEMPERATURES. Eldon E. Mathauser. November 1956. 54p. diagrs., photo., tab. (NACA TN 3854)

Compressive stress-strain test results for 7075-T6 aluminum-alloy sheet are presented for temperatures up to 700° F and exposure times from 0.1 to 100 hours. All specimens were loaded parallel to the rolling direction of the sheet and tested at a nominal strain rate of 0.002 per minute. Significant design data obtained from the stress-strain curves (yield stress, Young's modulus, secant and tangent moduli, and two stresses useful for determining the maximum compressive strength of plates) are presented in graphical and tabular form. A time-temperature parameter derived from rate-process theory is used to present the compressive yield stresses as a single master curve.

NACA TN 3857

EXPERIMENTAL INVESTIGATION AT LOW SPEED OF THE EFFECTS OF WING POSITION ON THE STATIC STABILITY OF MODELS HAVING FUSELAGES OF VARIOUS CROSS SECTION AND UNSWEPT AND 45° SWEPTBACK SURFACES. William Letko. November 1956. 77p. diagrs., photo., tabs. (NACA TN 3857)

An experimental investigation was made to determine the effects of wing position on the low-speed static longitudinal and static lateral stability derivatives of airplane models having fuselages of square and rectangular cross sections and unswept and 45° sweptback surfaces. The results indicate that in general the effects of wing position on the static longitudinal and static lateral stability characteristics of the models with the square and rectangular fuselages are similar to those obtained with models having fuselages with circular cross sections.

NACA TN 3868

PARTICULAR SOLUTIONS FOR FLOWS AT MACH NUMBER 1. Max. A. Heaslet and Franklyn B. Fuller. November 1956. 32p. diagrs. (NACA TN 3868)

Two families of exact solutions, representing either pure subsonic or supersonic flow, are found for the small-disturbance potential equation at unit stream Mach number. Solutions are given for both two-dimensional and rotationally symmetric cases. The plane supersonic solution is closely related to Prandtl-Meyer expansion. In either case it is possible to join the supersonic solution to the subsonic; the transition is made through the mechanism of a shock wave.

NACA TN 3870

MEASUREMENT OF THE LONGITUDINAL MOMENT OF INERTIA OF A FLEXIBLE AIRPLANE. Henry A. Cole, Jr., and Frances L. Bennion. November 1956. 30p. diagrs., photos., tabs. (NACA TN 3870. Supersedes RM A55J21)

A method for measuring the longitudinal moment of inertia of a flexible airplane by ground oscillation tests is presented. The effects of flexibility on the fundamental frequency for various combinations of springs and knife edges are shown, and a method which minimizes flexibility effects is developed. A description and results of tests which were conducted by this method are presented.

NACA TN 3882

A RELATION BETWEEN BURNING VELOCITY AND QUENCHING DISTANCE. A. E. Potter, Jr., and A. L. Berlad. November 1956. 19p. diagrs., tabs. (NACA TN 3882)

The product of burning velocity and quenching distance is proportional to a term which has the character of a thermal diffusivity and a term which increases with the activation energy of the flame reaction. The quotient of burning velocity and quenching distance is proportional to the average flame reaction rate and to terms which are mildly dependent on the flame reaction activation energy and the transport properties.

BRITISH REPORTS

N-32837*

Royal Aircraft Establishment (Gt. Brit.)
LIST OF R. A. E. TRANSLATIONS ISSUED UP TO 31st MAY, 1956. A. O'Donnell, Compiler. June 1956. 53p. (RAE Library Bibliog. 166. Supersedes RAE Library Bibliog. 117)

This list supersedes the previous list (Library Bibliography No. 117). A number of the earlier translations in this list were subsequently issued as R. T. P. Translations, and have only been included for completeness.

N-46477*

Aeronautical Research Council (Gt. Brit.)
SAUNDERS-ROE PRINCESS FLYING BOAT G-ALUN AIR AND WATER HANDLING TESTS. 1956. 50p. diagrs., photos. (ARC CP 257)

The basic aerodynamic and hydrodynamic handling characteristics of the aircraft are satisfactory over the range of all operating conditions tested.

N-46517*

Royal Aircraft Establishment (Gt. Brit.)
ILL-CONDITIONED FLUTTER EQUATIONS AND THEIR IMPROVEMENT FOR SIMULATOR USE. E. G. Broadbent. June 1956. 23p. diagrs., tab. (RAE Tech.Note Structures 195)

If simple arbitrary modes are used as coordinates in a wing flutter calculation, the equations are ill-conditioned and cannot be solved satisfactorily on a simulator. This ill-conditioning can be avoided by transforming the flutter matrix so as to reduce the inertia couplings between like modes to zero. This transformation is described with numerical examples, and some observations are made on the general problem of choice of coordinates in a flutter calculation.

N-46518*

Royal Aircraft Establishment (Gt. Brit.)
TABLES OF CHARACTERISTICS SLOPES FOR USE IN THE DESIGN OF NOZZLES FOR SUPERSONIC WIND TUNNELS. K. G. Winter. May 1956. 11p. diagr., tabs. (RAE Tech.Note Aero 2444)

Tables are given which are of use in the calculation of characteristic networks appropriate to two-dimensional nozzles for Mach numbers up to 4.5. The tabulated characteristics slopes enable the coordinates of a characteristics intersection each to be evaluated in one operation on a desk calculating machine.

N-46519*

Royal Aircraft Establishment (Gt. Brit.)
LONGITUDINAL RESPONSE OF AIRCRAFT TO OSCILLATORY VERTICAL GUSTS (FREQUENCY ANALYSIS INCLUDING THE EFFECT OF UNSTEADY AERODYNAMICS). J. K. Zbrozek. November 1955. 55p. diagrs. (RAE Aero 2559)

This work is a first step towards a full analysis of aircraft response to turbulent air. The theory tries to give a clearer picture of aircraft response to a gust and includes a study of the effect of unsteady flow on aircraft dynamics.

N-46611*

Royal Aircraft Establishment (Gt. Brit.)
THE SAMPLING ERRORS OF TURBULENCE MEASUREMENTS. N. I. Bullen. May 1956. 18p. diagrs., tabs. (RAE Structures 208)

Estimates of atmospheric turbulence from counting accelerometer records show a large scatter. The simple assumption of a random distribution of gusts is inconsistent with this scatter. A formula which takes account of the variations in gust density is given and the calculated sampling errors for 10 ft/sec gusts are found to be about four times those calculated on the basis of a random distribution.

N-46612*

Royal Aircraft Establishment (Gt. Brit.)
THERMAL DEGRADATION OF VARIOUS POLYMERS OVER THE RANGE 300°-600° C. D. Sheehan. May 1956. 19p. diagrs., tabs. (RAE Tech. Note Chem. 1280)

Residues of high-carbon content have been obtained by heating certain polymers in air and in nitrogen. Oxidation of these residues occurred at 500° C in air, but phenolic resins showed relatively low weight losses at 600° C in nitrogen. Other materials studied included chlorinated linear polymers, melamine-formaldehyde resins, polybenzyl and its naphthalene analog, and polyphenylenes prepared by Wurtz syntheses from di- and trichlorobenzenes. Full descriptions of these syntheses are given.

N-46613*

Royal Aircraft Establishment (Gt. Brit.)
A STUDY OF THE CONSTITUTION OF SOME TITANIUM-OXYGEN-VANADIUM ALLOYS. D. A. Sutcliffe. March 1956. 19p. diagrs., photos., tab. (RAE Tech. Note Met. 233)

Alloys containing up to 5 percent oxygen and 95 percent vanadium by weight have been prepared by arc melting. The constitution of selected alloys has been determined by quenching from 750° C and 1000° C and metallographic or X-ray examination of the quenched alloy. All the alloys examined exhibited only α and/or β titanium, no intermediate phases being detected.

N-46614*

Royal Aircraft Establishment (Gt. Brit.)
PHOTOGRAPHING HIGH FREQUENCY CATHODE RAY TUBE TRACES. E. S. Mallett and H. W. P. Knapp. February 1956. 12p. diagrs., photos. (RAE Tech. Note TD 5)

A method is described for increasing the effective film velocity by movement of the cathode ray tube trace. The clarity and resolution of the trace are improved by brilliance modulation.

N-46615*

Royal Aircraft Establishment (Gt. Brit.)
THE USE OF AN ARALDIT COATED IRON CASTING AS A LINER FOR A SUPERSONIC WIND TUNNEL. C. S. Brown and K. G. Winter. May 1956. 9p. diagrs. (RAE Tech. Note Aero 2443)

The use of cast iron and araldite appears to overcome the disadvantages of wooden liners. The surface finishing is no more difficult than with wood and the overall manufacturing time is comparable. The use of a pair of male templets to define the profile is recommended. Considerable care should be taken in the manufacture of the templets, and use should be made of a curvature gage during manufacture.

N-46616*

Royal Aircraft Establishment (Gt. Brit.)
FATIGUE LOADINGS IN FLIGHT LOADS IN THE FUSELAGE AND NOSE UNDERCARRIAGE OF A VARSITY. E. W. Wells. May 1956. 19p. diagrs., tabs. (RAE Tech. Note Structures 193)

Flight tests have been made on a Varsity to obtain data on the fatigue loads in the fuselage and the nose undercarriage. The data are tabulated in terms of the number of load ranges of a given magnitude occurring during various ground and flight conditions. An estimate is made of the loads in a typical operational training flight to show the relative importance of the various conditions. A relationship is established between the fuselage loads and the accelerations at the aircraft c. g. when flying in turbulence; this enables the results from the flight tests to be linked to operational data obtained on gusts.

N-46618*

Royal Aircraft Establishment (Gt. Brit.)
THE RELATIVE REACTIVITIES OF BIFUNCTIONAL MONOMERS. PART IV. THE PREPARATION OF SOME OLEFINIC ALCOHOLS AND THEIR METHACRYLATE ESTERS. G. M. Bristow. May 1956. 9p. (RAE Tech. Note Chem. 1278)

The preparation of several allylic alcohols is described. The alcohols have been converted into their methacrylate esters either by ester interchange with methyl methacrylate or by interaction of the allylic chloride with silver methacrylate. The following methacrylates have been prepared: α-methallyl, β-methallyl, γ-methallyl, α, α-dimethallyl, α, β-dimethallyl, α, γ-dimethallyl, γ, γ-dimethallyl, allyl carbinyl, and β-chlorallyl.

N-46647*

Aeronautical Research Council (Gt. Brit.)
TESTS ON A SINGLE-STAGE TURBINE COMPARING THE PERFORMANCE OF TWISTED WITH UNTWISTED ROTOR BLADES. I. H. Johnston and L. R. Knight. 1956. 11p. diagrs. (ARC R & M 2927; ARC 15,999. Supersedes NGTE Memo. M. 174)

An experimental single-stage turbine designed for the testing of a variety of blade forms with cold air is described together with the instrumentation provided for test measurements. Performance results obtained on this unit from two rotor blade designs are presented and it is shown that for the incidence range covered by the tests an untwisted constant-section blade of about 10 percent reaction possesses characteristics of pressure loss and deflection nearly identical to those of a conventional rotor blade twisted along its length to conform to the requirements of radial equilibrium, the mean diameter sections of the two blade designs being identical.

N-46648*

Aeronautical Research Council (Gt. Brit.)
THE INFLUENCE OF ROPE STRETCH ON TENSION VARIATIONS IN ARRESTING GEARS. N. I. Bullen. 1956. 38p. diagrs., tabs. (ARC R & M 2964; ARC 14,401. Supersedes RAE Tech. Note NA 229)

It is usual, when considering the performance of an arresting gear as a whole, to assume an inextensible rope which automatically excludes the possibility of developing oscillations in the predicted tension. A method of calculation is given which removes this limitation of inextensibility and produces results which can be related to the tension oscillations occurring in practice. The calculations are made for a constant-pressure type arresting gear and the tension oscillations are shown to be interrelated with the action of the constant-pressure valve and the general hydraulic system. The results are compared with actual values obtained from such a gear.

N-46649*

Aeronautical Research Council (Gt. Brit.)
THEORY OF AEROFOIL SPOILERS. L. C. Woods. 1956. 21p. diagrs., tabs. (ARC R & M 2969. Supersedes ARC 15,870, FM 1895, S & C 2774)

A mathematical theory of airfoil spoilers in two-dimensional subsonic flow is presented. Equations are given for load distribution, lift, drag, moments, and hinge moments produced by spoiler-flap combinations. The theory is developed for a spoiler in a general position but the trailing-edge spoiler receives special attention. For this important case the theory gives good agreement with experiment, but in the more general case, because of uncertainty about the pressure distribution on the airfoil to the rear of the spoiler, the agreement is not as good.

N-46673*

Aeronautical Research Council (Gt. Brit.)
MEASUREMENT OF LIFT, PITCHING MOMENT AND HINGE MOMENT ON A TWO-DIMENSIONAL RAE 102 AEROFOIL. A. S. Batson. 1955. 30p. diagrs., tabs. (ARC CP 191)

The charts of R. & M. 2730 for estimating two-dimensional control derivatives were based mainly on data for airfoils of 15 percent thickness. Supplementary tests have been carried out on a two-dimensional 10-percent-thick RAE 102 airfoil with 20 percent and 40 percent plain round-nosed control surfaces. Lift, pitching moment, and hinge moment were determined from balance measurements and from integrated pressure distributions on one section. In most cases, consistent coefficients were obtained by the two methods. Particular care was taken in observing or fixing with wires the positions of boundary-layer transition on both surfaces of the airfoil. The experimental derivatives varied smoothly with position of transition and were in fair agreement with the general charts of R. & M. 2730.

MISCELLANEOUS

N-39013

Advisory Group for Aeronautical Research and Development. AIRCRAFT STRUCTURES RESEARCH AT ELEVATED TEMPERATURES. John E. Duberg, NACA. (Presented at the Second Meeting of AGARD Structures and Materials Panel, London, September 5-9, 1955). September 1955. vi, 22p. diagrs., photos. (AGARD Report 3)

A review is made of the tests techniques that have been developed and used by the NACA for experimental research in aircraft structures at elevated temperatures. Some experimental results are presented. Remarks are included on the problem of model scaling for testing of structures at high temperatures.

N-42673

Advisory Group for Aeronautical Research and Development. THE QUANTITATIVE EVALUATION OF AN AIRCRAFT CONTROL SYSTEM. R. R. Duddy, Royal Aircraft Establishment. (Presented at the Eighth Meeting of the Flight Test Panel, Rome, Italy, February 20-25, 1956). February 1956. III, 4p. (AGARD Report 29)

This note is an introduction to the problem of making a quantitative assessment of the ability of an aircraft-pilot system to perform a given task. Two examples are given to illustrate the inadequacy of simple measurements of the accuracy with which a task can be performed.

N-43188

Advisory Group for Aeronautical Research and Development. WIND TUNNEL MODELS. R. P. Davie, North American Aviation, Inc. (Presented at the Eighth Meeting of the Wind Tunnel and Model Testing Panel, Rome, Italy, February 20-25, 1956). August 1956. iv, 56p. diagrs., photos. (AGARD Report 19)

This paper will deal with wind-tunnel models, their design, and construction. It is based on experience gained by the Model Design Group of North American

Aviation, Inc., Los Angeles Division, as observed by the author and his associates. Only unclassified material is included. An attempt will be made to avoid giving data already published. It is hoped that this paper will be of value to those concerned with wind-tunnel models, particularly to those connected with model design and construction.

N-47980*

Advisory Group for Aeronautical Research and Development. CONDENSATION EFFECTS AND AIR DRYING SYSTEMS FOR SUPERSONIC WIND TUNNELS. J. J. Smolderen, Centre National d'Etudes et de Recherches Aeronautiques. Wilbur C. Nelson, editor, University of Michigan. July 1956. (ix), 79p. diagrs., tab. (AGARDograph 17)

Part one is devoted to a study of condensation effects and a criterion is presented for the complete removal of these effects. Conditions under which disturbances are sufficiently small are also indicated. The second part studies drying processes in use and the third part surveys measuring devices for the determination of humidity.

N-47981

Advisory Group for Aeronautical Research and Development. THERMAL PROBLEMS IN AIRCRAFT STRUCTURES. N. J. Hoff, Polytechnic Institute of Brooklyn. (Presented at the First Meeting of the Structures and Materials Panel, Ottawa, Canada, June 13-17, 1955). June 1956. v, 27p. photos. (AGARD Report 2)

A survey is given of the problems that develop in the structural design and analysis of aircraft when high supersonic speeds cause elevated temperatures in the structure. Experimental methods and equipment that are now being used by various research organizations in the United States are described.

N-47982

Advisory Group for Aeronautical Research and Development. THE LAYOUT OF TECHNICAL REPORTS. A. H. Holloway, editor, Ministry of Supply. Appendix III: CATALOGUING NOTES. R. A. Kennedy, National Research Council, Canada. (Presented at the Seventh Meeting of the Documentation Committee, Brussels, August 1956). August 1956. ii, 24p. (AGARD Specification 1)

Recommendations by Documentation Committee for size, markings on cover and title page, contents list, pagination, notation, abstract, list of references, tables, illustrations, appendices, and index cards in technical reports. Notes are included on the application of the recommendations to bound books and to periodicals. Appendices give proposals to I. S. O. for minimum biographical references, examples of abbreviations of titles of periodicals, and cataloger's notes.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification November 14, 1956

#NACA RM 52D11

NACA RM A51K14

EXPERIMENTAL INVESTIGATION OF THE EFFECT OF FOREBODY BLUNTNESS ON THE PRESSURE RECOVERY AND DRAG OF A TWIN-SCOOP INLET-BODY COMBINATION AT MACH NUMBERS OF 1.4 AND 1.7. John F. Stroud. February 1952. 20p. diagrs., photos. (NACA RM A51K14)

The pressure recovery, mass flow, and drag of a twin-scoop inlet-body combination were measured at Mach numbers of 1.4 and 1.7 at zero angle of attack. Tests were made of the combination with an ogival forebody and with three different forebody shapes obtained by shortening the body and increasing the nose bluntness. Pressure surveys were made just ahead of the inlets and drag values were obtained for three forebodies without inlets. Increasing the forebody bluntness caused losses in pressure recovery and maximum mass-flow ratio, and large increases in total external drag of the inlet-body combination.

NACA RM A53E06

THE USE OF AREA SUCTION FOR THE PURPOSE OF IMPROVING TRAILING-EDGE FLAP EFFECTIVENESS ON A 35° SWEPTBACK WING. Woodrow L. Cook, Curt A. Holzhauser, and Mark W. Kelly. July 1953. 77p. diagrs., photos., tabs. (NACA RM A53E06)

An investigation was conducted to determine the effectiveness of area suction applied to the leading edge of a trailing-edge flap on a 35° sweptback wing. The results indicated that with area suction the linear variation of flap increment with flap angle was retained up to at least 55° of deflection. A flap increment of lift of 0.78 was obtained with 55° deflection of the partial-span flap and a flow coefficient of 0.0005. An increment of lift of 0.87 was obtained with 70° deflection of a partial-span flap and a flow coefficient of 0.0009.

NACA RM A53K24

BUFFETING FORCES ON TWO-DIMENSIONAL AIRFOILS AS AFFECTED BY THICKNESS AND THICKNESS DISTRIBUTION. Charles F. Coe and Jack A. Mellenthin. February 1954. 26p. diagrs., photo. (NACA RM A53K24)

Seven symmetrical airfoils were tested over a Mach number range from about 0.4 to 0.9 in the two-dimensional channel in the Ames 16-foot high-speed

wind tunnel to determine the effects of thickness and of the thickness distribution on the fluctuations of normal-force and pitching-moment coefficients. The corresponding Reynolds number range was from about 4.6 million to 8 million. Thickness was varied from 12 percent to 2 percent on 65A-series airfoils, while for 8-percent-thick airfoils the thickness distribution was varied to give positions of maximum thickness from about 0.16 chord to about 0.63 chord. A 4-percent-thick circular-arc airfoil was also tested. No one of the seven airfoils tested had the lowest normal-force fluctuations over the entire range of Mach numbers and normal-force coefficients investigated.

NACA RM A54K16a

AN INVESTIGATION OF STING-SUPPORT INTERFERENCE ON BASE PRESSURE AND FOREBODY CHORD FORCE AT MACH NUMBERS FROM 0.60 TO 1.30. Phillips J. Tunnell. January 1955. 19p. diagrs. (NACA RM A54K16a)

Various configurations of rear sting supports were tested on one wing-body model with a turbulent boundary layer over the aft portion of the fuselage to determine the interference effects on the base pressure and foredrag characteristics. The tests were made at a Reynolds number of 5.4×10^6 based on fuselage length and over a Mach number range of 0.60 to 1.30.

NACA RM E50D26

EFFECT OF MACH NUMBER ON OVER-ALL PERFORMANCE OF SINGLE-STAGE AXIAL-FLOW COMPRESSOR DESIGNED FOR HIGH PRESSURE RATIO. Charles H. Voit, Donald C. Guentert, and James F. Dugan. July 10, 1950. 19p. diagrs., tab. (NACA RM E50D26)

A complete stage of an axial-flow compressor designed to produce a high pressure ratio was investigated at speeds from 110 to 130 percent of design speed (836 ft/sec). The data obtained and the results of a previous investigation of the same compressor at speeds from 50 to 100 percent of design speed were used to determine the effect of Mach number on overall performance. The peak total-pressure ratio increased from 1.095 to 1.515 and the peak adiabatic efficiency decreased from 0.93 to 0.89 as the relative inlet Mach number increased from 0.34 to 0.77. At a relative inlet Mach number of 0.91, a total-pressure ratio of 1.635 was obtained at an adiabatic efficiency of 0.74.

#NACA RM E51J23, by Wallner and Welna

NACA RM E51K05

INFLUENCE OF FUSELAGE AND CANARD-TYPE CONTROL SURFACE ON THE FLOW FIELD ADJACENT TO A REARWARD FUSELAGE STATION AT A MACH NUMBER OF 2.0 - DATA PRESENTATION. Evan A. Fradenburgh, Leonard J. Obery, and John F. Mello. January 1952. 25p. diagrs., photos. (NACA RM E51K05)

A survey of local total pressures and flow-deflection angles was made at a rearward station for a body and canard-type control-surface combination at a Mach number of 2.0, at angles of attack from 0° to 6° and control-deflection angles from 0° to $9\text{-}1/2^\circ$. The effects of the trailing vortices on the flow field adjacent to the body are presented.

NACA RM E52K07

COMPARISON OF PRESSURE-LOSS CHARACTERISTICS OF SEVERAL TAIL-CONE AIR-INDUCTION SYSTEMS FOR AIR-COOLED GAS-TURBINE ROTORS. Gordon T. Smith and Arthur N. Curren. January 1953. 52p. diagrs., tab. (NACA RM E52K07)

Three configurations for introducing cooling air through a turbojet engine tail cone to a cooled turbine rotor were investigated by use of scale-model systems, and the pressure-loss characteristics of one model system were compared to a similar full-scale system. The effects of the pressure losses in the cooling-air-induction system on the sea-level and altitude performance of a turbojet engine were evaluated, and the design compromises between an aerodynamically refined and a mechanically simple air-induction system were discussed.

NACA RM E52K20

IGNITION DELAYS OF SOME NONAROMATIC FUELS WITH LOW-FREEZING RED FUMING NITRIC ACID IN TEMPERATURE RANGE -40° TO -105° F. Riley O. Miller. January 1953. 17p. diagrs., tabs. (NACA RM E52K20)

Ignition-delay experiments were conducted in a modified open-cup apparatus with a low-freezing red fuming nitric acid. Data indicate that allylamine, mixed alkyl thiophosphites and ethylenimine can be diluted with as much as 70 percent triethylamine and ignite with average delays of approximately 41 milliseconds or less at -76° F. Ethylenimine diluted with 50 percent n-heptane ignited with average delays of 60 and 104 milliseconds, respectively, at -40 and -105° F. Blends of 50-percent allylamine in triethylamine and 50 percent ethylenimine in triethylamine gave average delays of 50 and 33 milliseconds, respectively, at -105° F (acid supercooled).

NACA RM E52K25

IGNITION DELAYS OF ALKYL THIOPHOSPHITES WITH WHITE AND RED FUMING NITRIC ACIDS WITHIN TEMPERATURE RANGE 80° TO -105° F. Riley O. Miller and Dezso J. Ladanyi. February 1953. 24p. diagrs., photo., tabs. (NACA RM E52K25)

Ignition delays of alkyl thiophosphites were obtained in a modified open-cup apparatus and a small-scale rocket engine apparatus. At -40° F, mixed alkyl thiophosphites gave short delays with white fuming nitric acid containing 2 percent water and red fuming nitric acids of widely varying compositions. At -40° F and higher, triethyl trithiophosphite blended with as much as 40 percent n-heptane gave satisfactory ignition delays. With suitable acid, mixed alkyl thiophosphites have satisfactory self-igniting properties at temperatures as low as -76° F.

NACA RM E53I02

EVALUATION OF ETHYL ETHER AS AN IGNITION AID FOR TURBOJET ENGINE FUELS. Edmund R. Jonash and Hampton H. Foster. October 1953. 11p. diagrs., tab. (NACA RM E53I02)

An investigation was conducted to determine the effectiveness of ethyl ether as an ignition aid for low volatility turbojet engine fuels. The minimum spark energies required to ignite a single J33 combustor over a range of altitude inlet-air pressures and flow rates were obtained with a low-volatility reference fuel and with reference fuel blends containing (1) 10 percent ethyl ether, and (2) 10 percent normal pentane. Results indicated that the addition of ethyl ether improved the ignition characteristics of the low-volatility (1 lb RVP) fuel significantly; however, similar improvements in ignition were obtained with the addition of normal pentane in the same concentration. The improvement in ignition characteristics was, therefore, attributed solely to the increase in the front-end volatility characteristics of the reference fuel. The observed trend substantiates the results of previous investigations of the effect of fuel volatility on ignition characteristics.

NACA RM E54K17

PERFORMANCE OF AS-FORGED, HEAT-TREATED, AND OVERAGED S-816 BLADES IN A TURBOJET ENGINE. J. W. Weeton, F. J. Clauss, and J. R. Johnston. March 1955. 51p. diagrs., photos., tabs. (NACA RM E54K17)

From an investigation of several heat treatments on the operating life of S-816 turbine blades, an as-forged group of blades and a group aged without prior solution treatment performed twice as well as a group given the standard AMS heat treatment for S-816 and performed better than all other heat-treated groups. This superior performance was associated with a high hardness and a dense and uniform precipitation of carbides throughout the microstructure. Double aging the blades subsequent to solution treating and solution treating at high temperatures reduced the engine life of the blades. A low-temperature overaging of 16 hours at 1550° F was very damaging to blade performance, while a high-temperature overaging of 16 hours at 1950° F was not damaging.

NACA RM E54K23

AN EXPERIMENTAL EVALUATION OF SEVERAL DESIGN VARIATIONS OF HOLLOW TURBINE BLADES FOR EXPENDABLE ENGINE APPLICATION. W. C. Morgan and R. H. Kemp. February 1955. 33p. diagr., photos., tabs. (NACA RM E54K23)

An investigation was made to evaluate several design variations of hollow turbine blades intended for missile engine use. In one general type, the airfoils were formed from sheet metal; in a second type, the blades were cast. The blades were operated in a J47 engine at 7950 rpm turbine speed and 1260° F tailpipe temperature until a failure occurred or a service life of 30 hours had been attained. It was determined that a practical missile turbine blade can be made by either method of fabrication. In addition, useful data were obtained on root fastenings for application to light-weight rotors.

NACA RM E55L12a

USE OF MEAN-SECTION BOUNDARY-LAYER PARAMETERS IN PREDICTING THREE-DIMENSIONAL TURBINE STATOR LOSSES. Warner L. Stewart, Warren J. Whitney, and Robert Y. Wong. March 1956. 21p. diagrs. (NACA RM E55L12a)

A method is developed for using stator mean-section boundary-layer parameters in predicting three-dimensional stator losses. This method is applied to a highly loaded stator for critical velocity ratios ranging from approximately 0.5 to 1.2. These theoretical results are compared with the results obtained from two complete annular surveys of the stator. On the basis of these limited data, the method appears satisfactory for predicting three-dimensional stator losses, even though the effects of secondary flows are not considered.

NACA RM L7I26

FLIGHT-TEST EVALUATION OF THE LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF 0.5-SCALE MODELS OF THE LARK PILOTLESS-AIRCRAFT CONFIGURATION. David G. Stone. February 6, 1948. 60p. diagrs., photos., tabs. (NACA RM L7I26)

Longitudinal stability and control characteristics of 0.5-scale models of the Lark pilotless aircraft were investigated in flight for the standard configuration with horizontal wing flaps deflected 0°, 15°, 60°, and for a configuration with tail surfaces in line with the wings with wing flaps undeflected. Results are presented concerning static and dynamic longitudinal stability and control effectiveness characteristics.

NACA RM L50F21

THE ROLLING EFFECTIVENESS OF WING-TIP AILERONS AS DETERMINED BY ROCKET-POWERED TEST VEHICLES AND LINEAR SUPERSONIC THEORY. Carl A. Sandahl, H. Kurt Strass, and Robert O. Piland. Appendix: DETERMINATION OF THE THEORETICAL ROLLING EFFECTIVENESS OF WING-TIP AILERONS. Robert O. Piland. August 29, 1950. 32p. diagrs., photo., tab. (NACA RM L50F21)

The rolling effectiveness and drag of half-delta wing-tip ailerons on rectangular and tapered wings swept back 0° and 45° have been determined by means of rocket-powered test vehicles. The results are compared with those for plain partial-span ailerons and linear supersonic theory.

NACA RM L50G31

FLIGHT INVESTIGATION AT MACH NUMBERS FROM 0.8 TO 1.4 TO DETERMINE THE ZERO-LIFT DRAG OF WINGS WITH "M" AND "W" PLAN FORMS. Ellis Katz, Edward T. Marley, and William B. Pepper. September 18, 1950. 23p. diagrs., photos., tab. (NACA RM L50G31)

The zero-lift drag of wings having "M" and "W" plan forms has been measured in rocket model flight tests at Mach numbers from 0.8 to 1.4. The results are compared with the drag of wings having conventional rectangular and sweptback plan forms. Measurements of bending and torsional deflections for the test wings were made and are presented for comparison with sweptback wings.

NACA RM L50H04

FLIGHT MEASUREMENTS OF THE PRESSURE DISTRIBUTION ON THE WING OF THE X-1 AIRPLANE (10-PERCENT-THICK WING) OVER A CHORDWISE STATION NEAR THE MIDSPAN, IN LEVEL FLIGHT AT MACH NUMBERS FROM 0.79 TO 1.00 AND IN A PULL-UP AT A MACH NUMBER OF 0.96.
H. Arthur Carner and Ronald J. Knapp.
September 12, 1950. 25p. diagrs., photo., tab.
(NACA RM L50H04)

Presents results of flight measurements of the chordwise pressure distribution over a section at 64.4 percent semispan on the left wing of the X-1 airplane with 10-percent-thick wing. The data cover a Mach number range from 0.79 to 1.00 for a section normal-force coefficient of 0.32 and a section normal-force-coefficient range from 0.34 to 1.00 at a Mach number of 0.96.

NACA RM L50H25

TABULATED PRESSURE COEFFICIENTS AND AERODYNAMIC CHARACTERISTICS MEASURED ON THE WING OF THE BELL X-1 AIRPLANE IN LEVEL FLIGHT AT MACH NUMBERS FROM 0.79 TO 1.00 AND IN A PULL-UP AT A MACH NUMBER OF 0.96.
H. Arthur Carner and Mary M. Payne.
September 18, 1950. 43p. diagrs., photo., tabs.
(NACA RM L50H25)

Presents tabulated pressure coefficients and aerodynamic characteristics measured on the left wing of the Bell X-1 airplane in a level run at Mach numbers from 0.79 to 1.00 and in a pull-up to an airplane normal-force coefficient of 0.91 at a Mach number of approximately 0.96.

NACA RM L50H25a

A SMALL-SCALE INVESTIGATION OF "M" AND "W" WINGS AT TRANSONIC SPEEDS. George S. Campbell and William D. Morrison, Jr. October 2, 1950. 30p. diagrs., photo., tab.
(NACA RM L50H25a)

An aerodynamic investigation has been conducted in the Langley high-speed 7- by 10-foot tunnel in order to compare the characteristics of wings of "M" and "W" plan forms with those of a wing having conventional sweepback. Three semispan wings were investigated at Mach numbers from 0.60 to 1.08 at Reynolds numbers of the order of 600,000. The wings were of aspect ratio 6 and taper ratio 0.6 and had NACA 65A009 airfoil sections; the quarter-chord lines were swept 45°. In addition to the lift, drag, pitching-moment, and bending-moment data, changes in local wing incidence measured under simulated air loads are presented. Theoretical span loadings were calculated at a Mach number of 0.70.

NACA RM L51E10a

AERODYNAMIC CHARACTERISTICS OF WINGS DESIGNED FOR STRUCTURAL IMPROVEMENTS.
Joseph Weil and Edward C. Polhamus. May 28, 1951.
12p. diagrs. (NACA RM L51E10a)

A brief review of the effects of wing thickness and thickness distribution of the high-speed aerodynamic and structural characteristics of a representative swept-wing configuration is presented. The aerodynamic information available on several composite plan-form wings is also summarized.

NACA RM L51F25

TABULATED PRESSURE COEFFICIENTS AND AERODYNAMIC CHARACTERISTICS MEASURED ON THE WING OF THE BELL X-1 AIRPLANE IN AN UNACCELERATED LOW-SPEED STALL, IN PUSH-OVERS AT MACH NUMBERS OF 0.83 AND 0.99, AND IN A PULL-UP AT A MACH NUMBER OF 1.16.
Ronald J. Knapp. September 1951. 53p. diagrs., photo., tabs. (NACA RM L51F25)

Presents tabulated pressure coefficients and aerodynamic characteristics measured on the wing of the Bell X-1 research airplane in an unaccelerated low-speed stall, in push-overs at Mach numbers of 0.83 and 0.99, and in a pull-up at a Mach number of 1.16.

NACA RM L51K16

FREE-FLIGHT MEASUREMENTS OF SOME EFFECTS OF AILERON SPAN, CHORD, AND DEFLECTION AND OF WING FLEXIBILITY ON THE ROLLING EFFECTIVENESS OF AILERONS ON SWEPTBACK WINGS AT MACH NUMBERS BETWEEN 0.8 AND 1.6. Eugene D. Schult, H. Kurt Strass, and E. M. Fields. January 1952.
52p. diagrs., photos., tabs. (NACA RM L51K16)

As part of the NACA transonic research program some free-flight measurements were made over a Mach number range of 0.8 to 1.6 to determine some effects of aileron span, chord, and deflection on the rolling effectiveness of constant-percent-chord ailerons on wings with quarter-chord lines swept back 35° and 45°, aspect ratios of 4, taper ratios of 0.6, and NACA 65A006 airfoil sections. All data were corrected for aeroelastic effects of wing twist.

NACA RM L52E14a

TRANSONIC AERODYNAMIC CHARACTERISTICS OF THREE W-PLAN-FORM WINGS HAVING ASPECT RATIO 8, TAPER RATIO 0.45, AND NACA 63A-SERIES AIRFOIL SECTIONS. William D. Morrison, Jr. July 1952. 30p. diagrs., photo.
(NACA RM L52E14a)

The transonic aerodynamic characteristics of three W-plan-form wings having NACA 63A-series airfoil sections, aspect ratio 8, and taper ratio 0.45 have been determined by a reflection-plane technique over a Mach number range from 0.70 to 1.09 at Reynolds numbers of the order of 500,000. A 35° wing and one 45° wing had thickness ratios tapered from 0.10 at the root to 0.06 at the tip. The other 45° wing had a constant thickness ratio of 0.12. Comparisons were made to determine the effects on the aerodynamic characteristics of plan-form modifications, thickness, and sweep variation.

NACA RM L52F11

PRESSURE DISTRIBUTION AT LOW SPEED ON A MODEL INCORPORATING A W WING WITH ASPECT RATIO 6, 45° SWEEP, TAPER RATIO 0.6, AND AN NACA 65A009 AIRFOIL SECTION. Edward C. Polhamus and Albert G. Few, Jr. August 1952. 46p. diagrs., photo. (NACA RM L52F11)

An investigation of low-speed pressure distributions was conducted on a wing-fuselage configuration having a wing of W plan form with aspect ratio 6, 45° sweep, taper ratio 0.6, and an NACA 65A009 airfoil section placed parallel to the plane of symmetry. Wake surveys at several angles of attack for various spanwise positions and stall patterns obtained from tuft studies on the wing for several angles of attack are also presented.

NACA RM L52J21

STATIC AEROELASTIC PHENOMENA OF M-, W-, AND Λ-WINGS. Franklin W. Diederich and Kenneth A. Foss. February 1953. ii, 111p. diagrs., tabs. (NACA RM L52J21)

Some static aeroelastic calculations have been made for nine M-, W-, and Λ-wings, and some qualitative conclusions are drawn concerning the plan forms most suitable from an aeroelastic point of view.

NACA RM L52K04

TRANSONIC CHARACTERISTICS OF A 45° SWEPTBACK WING-FUSELAGE COMBINATION. EFFECT OF LONGITUDINAL WING POSITION AND DIVISION OF WING AND FUSELAGE FORCES AND MOMENTS. Joseph M. Hallissy and Donald R. Bowman. February 1953. 39p. diagrs., photo. (NACA RM L52K04)

Lift, drag, and pitching-moment data were obtained in the Langley 16-foot transonic tunnel on a 45° sweptback wing-fuselage combination with the wing mounted at the maximum fuselage diameter and 1.2 chords aft of the maximum diameter. In the forward wing position data were obtained on the wing in the presence of the fuselage as well as on the complete configuration. The Reynolds number was 5.5×10^6; the angle-of-attack range varied from -2° to 26° at the lowest Mach number (0.6) to -2° to 8° at the highest Mach number (1.03).

NACA RM L52K04a

ROCKET-MODEL INVESTIGATION OF LONGITUDINAL STABILITY AND DRAG CHARACTERISTICS OF AN AIRPLANE CONFIGURATION HAVING A 60° DELTA WING AND A HIGH UNSWEPT HORIZONTAL TAIL. Robert F. Peck and Jesse L. Mitchell. January 1953. 28p. diagrs., photo. (NACA RM L52K04a)

A rocket-propelled model was flown to investigate the longitudinal stability and drag characteristics of an airplane configuration having a 60° delta wing with an NACA 65A003 airfoil section and a high unswept horizontal tail. Data are presented for a Mach number range between 0.90 and 1.37. Comparisons were made with data from similar configurations.

NACA RM L52K06a

TRANSONIC WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF WING INCIDENCE ANGLE ON THE CHARACTERISTICS OF TWO WING-BODY COMBINATIONS. Francis G. Morgan, Jr. January 1953. 28p. diagrs., photo. (NACA RM L52K06a)

Two wing-body combinations, one with a 45° sweptback wing and one with an unswept wing, were tested at angles of incidence of 4° and 3°, respectively. The first wing has 45° sweepback of the 0.25-chord line, an aspect ratio of 4, a taper ratio of 0.6, and NACA 65A006 airfoil sections parallel to the model plane of symmetry. The other wing has zero sweep of the 0.25-chord line, an aspect ratio 4, and a taper ratio of zero. The streamwise sections of the wing are symmetrical, and consist of circular arcs with the maximum thickness of 0.04 chord located at the 0.40-chord stations. Lift, drag, pitching moment, and base pressures were measured. The effect of wing incidence on aerodynamic characteristics is discussed.

NACA RM L52K12a

TRANSONIC WIND-TUNNEL INVESTIGATION OF AN UNSWEPT WING IN COMBINATION WITH A SYSTEMATIC SERIES OF FOUR BODIES. Bruce B. Estabrooks. January 1953. 25p. diagrs., photos. (NACA RM L52K12a)

An investigation was conducted in the Langley 8-foot transonic tunnel of the interference effects between an unswept wing and a systematic series of bodies at Mach numbers from 0.60 to 1.13. The wing had 0° sweepback of the 0.25-chord line, an aspect ratio of 4, a taper ratio of 0, and 4-percent-thick, symmetrical airfoil sections parallel to the plane of symmetry. The airfoil sections consisted of circular arcs with the maximum thickness at the 0.40-chord station. The wing-body interference effects on the aerodynamic characteristics were most pronounced in the transonic speed range, and the drag was most significantly affected. At low lift coefficients, the drag rise associated with the increase in Mach number to 1.00 was reduced by 20 to 30 percent by replacing the curved afterbody of the basic model with a cylindrical afterbody.

NACA RM L52K13

SMALL-SCALE TRANSONIC INVESTIGATION OF A 45° SWEPTBACK WING OF ASPECT RATIO 4 WITH COMBINATIONS OF NOSE-FLAP DEFLECTIONS AND WING TWIST. William J. Alford, Jr., and Kenneth P. Spreemann. January 1953. 23p. diagrs., photo. (NACA RM L52K13)

A small-scale transonic investigation of a semispan wing swept back 45° and of aspect ratio 4 with combinations of nose-flap deflections and wing twist was made in the Langley high-speed 7- by 10-foot tunnel over a Mach number range from 0.60 to 1.11. Results are presented of the wing-alone configurations of the basic wing and modifications that consisted of a 6° nose-flap deflection in combination with 0°, 3.3°, and 6.5° washout. Lift, drag, and pitching-moment data were obtained for these configurations.

NACA RM L52K14

INITIAL FLUTTER TESTS IN THE LANGLEY TRANSONIC BLOWDOWN TUNNEL AND COMPARISON WITH FREE-FLIGHT FLUTTER RESULTS. William J. Bursnall. January 1953. 19p. diagrs., photos., tabs. (NACA RM L52K14)

An experimental wing-flutter investigation was conducted in the Langley transonic blowdown tunnel, which is equipped with a slotted test section, in order to determine the correlation between transonic wind-tunnel and free-fall flight flutter results. Excellent agreement between wind-tunnel and flight flutter tests shows the feasibility of conducting flutter tests in transonic wind tunnels with slotted test sections.

NACA RM L52K14b

FLIGHT INVESTIGATION OF A SUPERSONIC CANARD MISSILE EQUIPPED WITH AN AUXILIARY DAMPING-IN-PITCH CONTROL SYSTEM. Martin T. Moul. February 1953. 31p. diagrs., photos., tabs. (NACA RM L52K14b)

A canard missile equipped with a rate-gyro—servo control system acting through wing-tip controls to provide auxiliary damping in pitch was flight-tested at Mach numbers of 0.70 to 1.85. The rate system was effective in damping longitudinal transient responses, produced by a continuous square-wave deflection of canard fins, at all Mach numbers.

NACA RM L52K18

A TRANSONIC WIND-TUNNEL INVESTIGATION OF THE CHARACTERISTICS OF A TWISTED AND CAMBERED 45° SWEPTBACK WING-FUSELAGE CONFIGURATION. Daniel E. Harrison. December 1952. 20p. diagrs. (NACA RM L52K18)

An investigation was made in the Langley 8-foot transonic tunnel to determine effects of twist and camber on the aerodynamic characteristics of a 45° sweptback wing-fuselage configuration at transonic speeds. The wing was twisted and cambered to obtain uniform load distribution at $M = 1.2$ and $C_L = 0.4$. The wing had 45° sweepback, aspect ratio 4, taper ratio 0.6, and NACA 65A-series airfoil sections with 6-percent-thickness distribution parallel to the plane of symmetry. Lift, drag, and pitching-moment results are presented at Mach numbers from 0.80 to 1.10 and Reynolds numbers based on the mean aerodynamic chord from 1.91×10^6 to 1.99×10^6.

NACA RM L52L01

FLIGHT MEASUREMENTS OF PRESSURES ON BASE AND REAR PART OF FUSELAGE OF THE BELL X-1 RESEARCH AIRPLANE AT TRANSONIC SPEEDS, INCLUDING POWER EFFECTS. Ronald J. Knapp and Wallace E. Johnson. January 1953. 31p. diagrs., photos. (NACA RM L52L01)

Flight measurements of the pressure distribution over the base and rear portion of fuselage of the Bell X-1 rocket-propelled airplane at transonic speeds, including power effects, are presented.

NACA RM L53D20

FLIGHT-DETERMINED PRESSURE DISTRIBUTIONS OVER THE WING OF THE BELL X-1 RESEARCH AIRPLANE (10-PERCENT-THICK WING) AT SUBSONIC AND TRANSONIC SPEEDS. Ronald J. Knapp and Gareth H. Jordan. June 1953. 43p. diagrs., photo., tab. (NACA RM L53D20)

Aerodynamic section characteristics for various span locations, as determined by pressure-distribution measurements in flight to high lift at Mach numbers between 0.30 and 1.19, are presented for the 10-percent-thick wing of the Bell X-1 research airplane.

NACA RM L53F22

TRANSONIC AERODYNAMIC CHARACTERISTICS IN PITCH OF A W-WING HAVING 60° 48' PANEL SWEEP, ASPECT RATIO 3.5, AND TAPER RATIO 0.25. William D. Morrison, Jr. August 1953. 18p. diagrs., photo. (NACA RM L53F22)

The transonic aerodynamic characteristics in pitch of a W-wing having 60° 48' panel sweep, aspect ratio 3.5, and taper ratio 0.25 have been determined by a reflection-plane technique over a Mach number range from 0.70 to 1.10 at Reynolds numbers of the order of 850,000. Limited comparisons are made with swept-wing data to determine the effect on the various aerodynamic parameters of the plan-form modification.

NACA RM L53F30

HORIZONTAL-TAIL LOAD MEASUREMENTS AT TRANSONIC SPEEDS OF THE BELL X-1 RESEARCH AIRPLANE. John T. Rogers. September 1953. 23p. diagrs., photo., tab. (NACA RM L53F30)

Flight measurements of aerodynamic tail loads have been made on the Bell X-1 research airplane from which the balancing tail loads, the static-longitudinal-stability parameter $(dC_m/dC_L)_{WF}$, wing-fuselage aerodynamic center, and zero-lift wing-fuselage combination pitching-moment coefficient have been determined from a Mach number of 0.7 to a Mach number greater than 1.0. A comparison was made of measured tail loads and loads calculated using available wind-tunnel data.

NACA RM L53G14

WING LOADS ON THE BELL X-1 RESEARCH AIRPLANE (10-PERCENT-THICK WING) AS DETERMINED BY PRESSURE-DISTRIBUTION MEASUREMENTS IN FLIGHT AT SUBSONIC AND TRANSONIC SPEEDS. Ronald J. Knapp and Gareth H. Jordan. November 1953. 35p. diagrs., photo., tab. (NACA RM L53G14)

The wing loads (including some wing-to-fuselage load carry over) and some aerodynamic characteristics as determined by pressure-distribution measurements in flight to high lift at Mach numbers from 0.50 to 1.19 for the 10-percent-thick wing of the Bell X-1 research airplane are presented.

NACA RM L53I15

FUSELAGE PRESSURES MEASURED ON THE BELL X-1 RESEARCH AIRPLANE IN TRANSONIC FLIGHT. Ronald J. Knapp, Gareth H. Jordan, and Wallace E. Johnson. November 1953. 21p. diagrs., photo. (NACA RM L53I15)

Fuselage pressure distributions and integrated normal load on the fuselage of the Bell X-1 research airplane (10-percent-thick wing) in flight during pull-ups to near maximum lift at Mach numbers of about 0.78, 0.85, 0.88, and 1.02 are presented.

NACA RM L53J02a

AERODYNAMIC CHARACTERISTICS IN PITCH OF THREE STRUCTURALLY SIMILAR FLEXIBLE WINGS WITH 45° SWEEP: A SWEPTBACK WING, A WING WITH M PLAN FORM, AND A WING WITH W PLAN FORM. John W. McKee, Delwin R. Croom, and Rodger L. Naeseth. December 1953. 43p. diagrs., photos. (NACA RM L53J02a)

An investigation has been made in the Langley 300-MPH 7- by 10-foot tunnel to determine the aerodynamic characteristics in pitch of three structurally similar flexible wings with 45° of sweep of the quarter-chord line: a sweptback wing, a wing with M plan form, and a wing with W plan form. In addition, a rigid sweptback wing was tested. The wings were of aspect ratio 6 and taper ratio 0.6, and had NACA 65A009 airfoil sections parallel to the free airstream direction. The semispan wings were tested through a dynamic pressure range of approximately 4.7 to 46 pounds per square foot. The variation of Reynolds number was from approximately 0.4×10^6 to 1.25×10^6. In addition to lift, drag, pitching-moment, and bending-moment data, wing deflection and twist angles under air load were measured and flow surveys were made behind the wings. The effects of change of plan form from straight sweep to a change of sweep at midsemispan and the large degree of flexibility provided in the models combined to produce some pronounced effects on wing deflection and aerodynamic characteristics. The data are examined on the basis of constant dynamic pressure and on the basis of constant wing loading. The results of theoretical calculations are compared with the experimental results.

NACA RM L53K03a

THE TWISTING EFFECT AT TRANSONIC SPEEDS OF SPOILER AILERONS ON A 45° SWEPTBACK, ASPECT-RATIO-4, TAPERED WING. Alexander D. Hammond and Jean C. Graven, Jr. January 1954. 21p. diagrs., photo. (NACA RM L53K03a)

Results and discussion of the twisting moment and other aerodynamic characteristics resulting from projection of various-span inboard spoiler ailerons on a 45° sweptback, aspect-ratio-4, taper-ratio-0.6 wing from a Mach number of 0.61 to 1.09 are presented. Incremental lift, drag, pitching-moment, and twisting-moment coefficients, and rolling-moment and yawing-moment coefficients are presented for various inboard spoiler spans at angles of attack from -5° to 10°.

NACA RM L53K09

MEASURED AND ESTIMATED LATERAL STATIC AND ROTARY DERIVATIVES OF A 1/12-SCALE MODEL OF A HIGH-SPEED FIGHTER AIRPLANE WITH UNSWEPT WINGS. James L. Williams. January 1954. 24p. diagrs., photos., tab. (NACA RM L53K09)

Lateral static and rotary derivatives experimentally determined at low speed in the Langley stability tunnel for a model of a high-speed fighter airplane with unswept wings are presented in this paper. A comparison of the measured and estimated derivatives at three angles of attack is also presented, along with data on the effect of fuselage afterbody shape on the static lateral stability derivatives.

NACA RM L53K10

EFFECT ON TRANSONIC AND SUPERSONIC DRAG OF A FUSELAGE PROTUBERANCE DESIGNED TO IMPROVE THE AREA DISTRIBUTION OF AN ESSENTIALLY UNSWEPT WING-FUSELAGE COMBINATION. Carl A. Sandahl. January 1954. 10p. diagrs., photos., tab. (NACA RM L53K10)

An investigation was made to determine the effect on transonic and supersonic drag of a fuselage protuberance designed to improve the overall longitudinal distribution of cross-sectional area of an essentially unswept wing-fuselage configuration. The protuberance had no effect on drag at Mach numbers up to 1; at higher Mach numbers the protuberance increased the drag.

NACA RM L53K20

FLIGHT INVESTIGATION OF THE ROLLING EFFECTIVENESS OF FINGERED SEMAPHORE SPOILERS ON A TAPERED 45° SWEPTBACK WING BETWEEN MACH NUMBERS 0.6 AND 1.3. James D. Church. January 1954. 27p. diagrs., photos. (NACA RM L53K20)

By using rocket models in free flight, some effects of spoiler projection and chordwise position on rolling effectiveness and drag were determined for a fingered semaphore spoiler and a solid spoiler configuration between Mach numbers 0.6 and 1.3. The test wing was swept back 45° along the quarter-chord line, had an aspect ratio of 3.56, a taper ratio of 0.30, NACA 64A007 airfoil sections, and a solid or fingered spoiler located along a line of constant wing thickness. Wing damping in roll and some effects of roll helix angle on spoiler rolling-moment coefficient were found. Comparisons are made with theory and other rocket-model results.

NACA RM L54C19

LATERAL CONTROL CHARACTERISTICS OF TWO STRUCTURALLY SIMILAR FLEXIBLE WINGS WITH 45° SWEEP: A SWEPTBACK WING AND A WING WITH M PLAN FORM. Rodger L. Naeseth, Delwin R. Croom, and John W. McKee. April 1954. 44p. diagrs., photo., tabs. (NACA RM L54C19)

A low-speed wind-tunnel investigation was made to determine the static lateral control characteristics of flap-type and spoiler-type ailerons on a rigid

sweptback wing, a flexible sweptback wing, and a flexible M-wing. A few tests were also made with a half-delta tip control on the flexible sweptback wing. The wings were of aspect ratio 6.0, taper ratio of 0.6, and had NACA 65A009 airfoil sections parallel to the free-stream direction. The quarter-chord lines of the wings were swept 45°. At low angles of attack, both types of control lost effectiveness with increase in dynamic pressure on the flexible wings. Spoilers, however, tended to maintain a greater percent of rigid-wing control effectiveness; an inboard control location was better than a location near the tip, and controls on the M-wing maintained effectiveness better than those on the swept wing.

NACA RM L54F29

ASPECTS OF INTERNAL-FLOW-SYSTEM DESIGN FOR HELICOPTER PROPULSIVE UNITS. John R. Henry. September 1954. 24p. diagrs. (NACA RM L54F29)

Pertinent items relating to the design of internal-flow systems for reciprocating engine, turbine engine, and pressure-jet installations in helicopters are discussed. The importance of the following items is emphasized: controllable exit and ram recovery for reciprocating-engine cooling; performance penalties possible in turbine-engine installations attributed to distortions in the flow distribution at the face of the axial compressor; the effects of high subsonic flow velocities on the performance of duct elements; and the effects of centrifugal forces on the flow in a ducted helicopter rotor. Data on the maximum flow capacities of bends are included.

NACA RM L54H11

EXPERIMENTAL INVESTIGATION AT HIGH SUBSONIC SPEEDS TO DETERMINE THE ROLLING-STABILITY DERIVATIVES OF THREE WING-FUSELAGE CONFIGURATIONS. William C. Sleeman, Jr. October 1954. 43p. diagrs. (NACA RM L54H11)

Rolling-stability derivatives are presented for three wing-fuselage configurations over a Mach number range from 0.50 to 0.92 and for angles of attack up to 13°. Two of the wings were of aspect ratio 3 and had quarter-chord sweep angles of 12.53° and 30°. An aspect-ratio-4 wing was tested which had 45° sweepback. The range of Reynolds number encountered in tests of these wings was approximately from 2.0×10^6 to 4.0×10^6.

NACA RM L54K10

THE EFFECT OF BASE BLEED ON THE BASE PRESSURE, LIFT, DRAG, AND PITCHING MOMENT OF A 10-PERCENT-THICK BLUNT-BASE AIRFOIL AT A MACH NUMBER OF 2.72. Jim J. Jones. January 1955. 17p. diagrs., photo. (NACA RM L54K10)

An experimental investigation was made at a Mach number of 2.72 to measure the effect of base bleed on the base pressure, lift, drag, and pitching moment of a 10-percent-thick blunt-base airfoil model. On this model the base bleed was effected by bleeding air through small holes in the lower surface near the trailing edge into the base region. The zero-lift drag was reduced about 6 percent for the maximum value of the ratio of bleed-hole area to base area tested. Above a lift coefficient of about 0.075, an optimum value of this area ratio was found but the decrease in total drag at this optimum point over zero area (no base bleed) was very small.

NACA RM L54K15

AERODYNAMIC LOADING CHARACTERISTICS IN SIDESLIP OF A 45° SWEPTBACK WING WITH AND WITHOUT A FENCE AT HIGH SUBSONIC SPEEDS. Richard E. Kuhn and Andrew L. Byrnes, Jr. January 1955. 40p. diagrs., photo., tab. (NACA RM L54K15)

The effects of sideslip on the aerodynamic loading characteristics of a 45° sweptback wing of aspect ratio 4 in combination with a fuselage, as obtained for pressure-distribution measurements, are presented for the clean wing and for the wing with fences. The tests covered a Mach number range from 0.70 to 0.95, angles of attack up to 24°, and angles of sideslip of 0°, 4°, 8°, and 12°. The results indicate that the variations of root bending moment and the coefficient of rolling moment due to sideslip are, in general, due to variations in normal-force coefficients on the leading and trailing wings rather than to lateral center-of-pressure travel. With the fences installed, the rolling moment due to sideslip remained negative throughout the angle-of-attack range.

NACA RM L54K18

INVESTIGATION OF TWO SHORT ANNULAR DIFFUSER CONFIGURATIONS UTILIZING SUCTION AND INJECTION AS A MEANS OF BOUNDARY-LAYER CONTROL. Stafford W. Wilbur and James T. Higginbotham. January 1955. 43p. diagrs. (NACA RM L54K18)

As part of an extensive subsonic diffuser research program, results are presented of an investigation to determine the performance and the influence of boundary-layer controls (injection and suction) on the performance of a short annular diffuser which corresponded to an equivalent conical expansion angle of 100°. Data are also presented on the above diffuser with a fairing added to the downstream face of the inner body, which produced an equivalent cone angle of 32°. The auxiliary air was varied from approximately 0 to 6 percent of the main stream flow. Pressure surveys were made at the inlet and at two diffuser tailpipe stations which were located at 1/2 and 1 diameter downstream from the 100° diffuser inner body. Both suction and injection proved to be effective controls capable of producing flat velocity distributions.

NACA RM L54K22

THE HYDRODYNAMIC FORCE CHARACTERISTICS OF STREAMLINE BODIES OF REVOLUTION HAVING FINENESS RATIOS OF 6, 9, AND 12 WITH AND WITHOUT CHINE STRIPS. Bernard Weinflash and Rudolph E. Fontana. March 1955. 157p. diagrs., photos., tabs. (NACA RM L54K22)

Hydrodynamic force characteristics are given for three streamline bodies of revolution having fineness ratios of 6, 9, and 12, with and without chine strips and, to a limited extent, with tail cones removed to simulate a fuselage with jet exhaust. The data include hydrodynamic resistance, pitching moment, wetted length, and height of the model above the water surface for a range of trim, load, and speed.

NACA RM L54K23

EFFECTS OF SPANWISE LOCATION OF SWEEP DISCONTINUITY ON THE LOW-SPEED LONGITUDINAL STABILITY CHARACTERISTICS OF A COMPLETE MODEL WITH WINGS OF M AND W PLAN FORM. Paul G. Fournier. January 1955. 44p. diagrs., photo., tab. (NACA RM L54K23)

The present paper presents results of a low-speed investigation to determine the effects of spanwise location of sweep discontinuity on the longitudinal stability characteristics of a complete model with M- or W-wings of aspect ratio 6 and taper ratio 0.6. Included in this investigation is the effect of tail height on the longitudinal stability characteristics. All of the wings tested had $\pm 45^{\circ}$ panel sweep of the quarter-chord lines and NACA 65A009 airfoil sections parallel to the plane of symmetry.

NACA RM L54K26

CALCULATED EFFECTS OF THE LATERAL ACCELERATION DERIVATIVES ON THE DYNAMIC LATERAL STABILITY OF A DELTA-WING AIRPLANE. John P. Campbell and Carroll H. Woodling. January 1955. 22p. diagrs., tabs. (NACA RM L54K26)

Calculations were made to determine the dynamic lateral stability of a 60° delta-wing interceptor airplane with the lateral acceleration derivatives $C_{n_{\dot{\beta}}}$ and $C_{l_{\dot{\beta}}}$ included and neglected. Calculations were made for angles of attack of 10°, 20°, and 30° with the airplane flying at sea level and at an altitude of 50,000 feet.

NACA RM L55D22

EFFECTS OF SPANWISE LOCATION OF SWEEP DISCONTINUITY ON THE LOW-SPEED STATIC LATERAL STABILITY CHARACTERISTICS OF A COMPLETE MODEL WITH WINGS OF M AND W PLAN FORM. Paul G. Fournier. May 1955. 33p. diagrs., photo. (NACA RM L55D22)

Results are presented of a low-speed investigation to determine the effects of spanwise location of sweep discontinuity on the static lateral stability characteristics of a complete model with M- or W-wings of aspect ratio 6 and taper ratio 0.6. All the wings tested had $\pm 45^{\circ}$ panel sweep of the quarter-chord lines and NACA 65A009 airfoil sections parallel to the plane of symmetry.

NACA RM L55J06

LOW-SPEED STATIC STABILITY CHARACTERISTICS OF A COMPLETE MODEL WITH AN M-WING IN MID AND HIGH POSITIONS AND WITH THREE HORIZONTAL-TAIL HEIGHTS. Paul G. Fournier. January 1956. 32p. diagrs. (NACA RM L55J06)

Results are presented of a low-speed investigation to determine the effect of wing height on the static lateral and longitudinal stability characteristics of a complete model having an M-wing in mid and high positions with aspect ratio 6, taper ratio 0.60, NACA 65A009 airfoil sections parallel to plane of symmetry, and $\pm 45^{\circ}$ sweep of the quarter-chord lines. Included in this investigation is the effect of tail height on the longitudinal stability characteristics.

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1255

AN ANALYSIS OF THE STABILITY AND ULTIMATE COMPRESSIVE STRENGTH OF SHORT SHEET-STRINGER PANELS WITH SPECIAL REFERENCE TO THE INFLUENCE OF THE RIVETED CONNECTION BETWEEN SHEET AND STRINGER. Joseph W. Semonian and James P. Peterson. 1956. ii, 18p. diagrs., photo., tab. (NACA Rept. 1255. Supersedes TN 3431)

A method of strength analysis of short sheet-stringer panels subjected to compression is presented which takes into account the effect that the riveted attachments between the plate and the stiffeners have on the strength of panels. An analysis of experimental data shows that panel strength is highly influenced by rivet pitch, diameter, and location and that the degree of influence for a given riveting depends on the panel configuration and panel material.

NACA Rept. 1259

SOME POSSIBILITIES OF USING GAS MIXTURES OTHER THAN AIR IN AERODYNAMIC RESEARCH. Dean R. Chapman. 1956. ii, 22p. diagrs., tabs. (NACA Rept. 1259. Supersedes TN 3226)

A study is made of possible uses in compressible-flow research of various gas mixtures having the same specific-heat ratio as air. Such mixtures require low wind-tunnel power and have other possible applications in compressor research and firing-range research. Certain gas mixtures can be concocted which behave at wind-tunnel temperatures dynamically similar to air at flight temperatures.

NACA Rept. 1262

THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE EFFECT OF TUNNEL WALLS ON THE FORCES ON AN OSCILLATING AIRFOIL IN TWO-DIMENSIONAL SUBSONIC COMPRESSIBLE FLOW. Harry L. Runyan, Donald S. Woolston, and A. Gerald Rainey. 1956. ii, 21p. diagrs. (NACA Rept. 1262. Supersedes TN 3416)

The integral equation defining the problem of an oscillating wing in a tunnel is treated and is presented in a form adapted to calculations. Application is made to a number of examples to illustrate the influence on the magnitude of wall effects of variations in frequency, Mach number, and ratio of tunnel height to wing semichord. Comparison is made with experimental measurements for several subsonic Mach numbers.

NACA Rept. 1265

A THEORY FOR STABILITY AND BUZZ PULSATION AMPLITUDE IN RAM JETS AND AN EXPERIMENTAL INVESTIGATION INCLUDING SCALE EFFECTS. Robert L. Trimpi. 1956. ii, 24p. diagrs., photos., tabs. (NACA Rept. 1265. Supersedes RM L53G28)

From a theory developed on a quasi-one-dimensional-flow basis, it is found that the stability of the ram jet is dependent upon the instantaneous values of mass flow and total pressure recovery of the supersonic diffuser and immediate neighboring subsonic diffuser. Conditions for stable and unstable flow are presented. The theory developed in the report is in agreement with the experimental data of NACA TN 3506 and NACA RM L50K30. A simple theory for predicting the approximate amplitude of small pressure pulsation in terms of mass-flow decrement from minimum-stable mass flow is developed and found to agree with experiments. Cold-flow tests at a Mach number of 1.94 of ram-jet models having scale factors of 3.15:1 and Reynolds number ratios of 4.75:1 with several supersonic diffuser configurations showed only small variations in performance between geometrically similar models. The conditions at which buzz originated were nearly the same for the same supersonic diffuser (cowling-position angle) configurations in both large- and small-diameter models (both Reynolds numbers). There was no appreciable variation in stability limits of any of the models when the combustion-chamber length was increased by a factor of three. The unsteady-flow performance and wave patterns were also similar when considered on a reduced-frequency basis depending on the relative lengths of the model.

NACA Rept. 1266

CHARTS FOR ESTIMATING PERFORMANCE OF HIGH-PERFORMANCE HELICOPTERS. Alfred Gessow and Robert J. Tapscott. 1956. ii, 33p. diagrs. (NACA Rept. 1266. Supersedes TN 3323; TN 3482)

Theoretically derived charts are presented for use in predicting profile-drag—thrust ratios of rotors having hinged blades with 0°, -8°, or -16° twist.

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The charts are considered applicable to rotor-operating conditions in which high tip-speed ratios or large rotor angles of attack are encountered; however, they do not include the effects of compressibility. Limit lines showing the conditions of onset of stall are presented, and the effects of blade twist on the stall limits are discussed.

NACA Rept. 1271

ON BOATTAIL BODIES OF REVOLUTION HAVING MINIMUM WAVE DRAG. Keith C. Harder and Conrad Rennemann, Jr. 1956. ii, 9p. diagrs., tab. (NACA Rept. 1271. Supersedes TN 3478)

The problem of determining the shape of slender boattail bodies of revolution for minimum wave drag has been reexamined. It was found that minimum solutions for Ward's slender-body drag equation can exist only for the restricted class of bodies for which the rate of change of cross-sectional area at the base is zero. In order to eliminate this restriction, certain higher order terms must be retained in the drag equation and isoperimetric relations. The minimum problem for the isoperimetric conditions of given length, volume, and base area is treated as an example. According to Ward's drag equation, the resulting body shapes have slightly less drag than those determined by previous investigators.

NACA Rept. 1273

A STUDY OF THE ZERO-LIFT DRAG-RISE CHARACTERISTICS OF WING-BODY COMBINATIONS NEAR THE SPEED OF SOUND. Richard T. Whitcomb. 1956. ii, 22p. diagrs., tabs. (NACA Rept. 1273. Supersedes RM L52H08)

Results are presented which indicate that near the speed of sound the zero-lift drag rise of a low-aspect-ratio thin-wing—body combination is primarily dependent on the axial development of the cross-sectional areas normal to the airstream. Results are also presented of an investigation wherein applications of this concept to the reduction of the drag-rise increments of representative wing-body combinations are made.

NACA TM 1420

ON THE CONTRIBUTION OF TURBULENT BOUNDARY LAYERS TO THE NOISE INSIDE A FUSELAGE. G. M. Corcos and H. W. Liepmann, Douglas Aircraft Company, Inc. December 1956. (iii), 43p. diagrs. (NACA TM 1420)

The concept of attentuation is abandoned and instead the problem is formulated as a sequence of two linear couplings: the turbulent boundary-layer fluctuations excite the fuselage skin in lateral vibrations and the skin vibrations induce sound inside the fuselage. The techniques used are those required to determine the response of linear systems to random forcing functions of several variables. A certain degree of idealization has been resorted to. Thus the boundary layer is assumed locally homogeneous; the fuselage skin is assumed flat, unlined, and free from axial loads; and the "cabin" air is bounded only by the vibrating plate so that only outgoing waves are considered. The results, strictly applicable only to the limiting cases of thin boundary layers, show that the sound pressure intensity is proportional to the square of the free-stream density, the square of cabin air density, and inversely proportional to the first power of the damping constant and to the second power of the plate density. The dependence on free-stream velocity and boundary-layer thickness cannot be given in general without a detailed knowledge of the characteristics of the pressure fluctuations in the boundary layer. For a flat spectrum the noise intensity depends on the fifth power of the velocity and the first power of the boundary-layer thickness. Thus it appears that boundary-layer removal is not an economical means of decreasing cabin noise.

NACA TM 1424

ON THE THEORY OF ANISOTROPIC SHALLOW SHELLS. (K Teorii Anizotropnykh Pologikh Obolochek). S. A. Ambartsumyan. December 1956. 11p. tabs. (NACA TM 1424. Translation from Prikladnaia Matematika i Mekhanika, v. 12, 1948, p. 75-80)

Simultaneous equations for both the stress function and the deflection function of an anisotropic shallow shell are developed and reduced to a single eighth-order equation for each function. The lines of curvature are used as coordinates.

NACA TM 1425

ON THE CALCULATION OF SHALLOW SHELLS. (K Raschetu Pologikh Obolochek). S. A. Ambartsumyan. December 1956. 11p. diagr. (NACA TM 1425. Translation from Prikladnaia Matematika i Mekhanika, v. 11, 1947, p. 527-532)

Two simultaneous equations of V. Z. Vlasov for the stresses and deflections of shallow shells are stated and somewhat simplified for application to the problems of uniform and concentrated loading on a shell bounded by a coordinate rectangle. Numerical results are given. The lines of curvature are used as coordinates.

NACA TM 1426

ON THE THEORY OF THIN SHALLOW SHELLS. (K Teorii Tonkikh Pologikh Obolochek). A. A. Nazarov. December 1956. 7p. (NACA TM 1426. Translation from Prikladnaia Matematika i Mekhanika, v.13, 1949, p.547-550)

The equations for a shallow shell are set up in "almost Cartesian coordinates" using a tensor approach. These equations are then reduced to two simultaneous fourth-order equations for the deflection and a stress function analogous to Airy's.

NACA TN 3737

THE MOTIONS OF ROLLING SYMMETRICAL MISSILES REFERRED TO A BODY-AXIS SYSTEM. Robert L. Nelson. November 1956. 51p. diagrs. (NACA TN 3737)

The linearized equations of motion have been derived for a rolling missile having slight aerodynamic asymmetries. Time histories of rolling-missile motions referred to a body-axis system have been prepared to show the types of missile motions that can be encountered. The motions resulting from a trim change and a pulse-rocket disturbance are shown to be mainly determined by the ratio of rolling velocity to pitching frequency. Finally, the derived equations were used in establishing a technique for the reduction of oscillation data for rolling missiles. It is shown that the aerodynamic derivatives can be obtained from flight data if four accelerations are measured. The method was applied to the results obtained from a flight test of a missile configuration.

NACA TN 3774

PROPOSED INITIATING SYSTEM FOR CRASH-FIRE PREVENTION SYSTEMS. Jacob C. Moser and Dugald O. Black. December 1956. 18p. diagrs. (NACA TN 3774)

The initiating system was designed to meet the requirements of such a system as determined by a study of data obtained from full-scale experimental and accidental airplane crashes. An example of the application of these requirements in the design of an initiating system for a twin-engined piston-powered airplane is given. The system proposed can be designed so that it will act rapidly and so that accidental operation is improbable. In addition, if the system does operate accidentally, catastrophic results are also improbable. This system is selective in that it inerts only those damaged zones where combustibles are spilled. The system can be used on all airplanes whether powered by reciprocating, turboprop, or turbojet engines.

NACA TN 3794

DRAG INTERFERENCE BETWEEN A POINTED CYLINDRICAL BODY AND TRIANGULAR WINGS OF VARIOUS ASPECT RATIOS AT MACH NUMBERS OF 1.50 AND 2.02. Elliott D. Katzen and George E. Kaattari. November 1956. 41p. diagrs., photos., tabs. (NACA TN 3794. Supersedes RM A51C27)

The drag of a body alone, six triangular wings of various aspect ratios, and the combinations were measured at Mach numbers of 1.50 and 2.02 at a Reynolds number of 5.5 million (based on the body length). The experimental drag-interference results were in accordance with calculations based on NACA RM A9E19, 1949, with skin-friction effects taken into account, the interference effect being principally the result of fixing transition on the body by adding a wing.

NACA TN 3795

LIFT AND PITCHING-MOMENT INTERFERENCE BETWEEN A POINTED CYLINDRICAL BODY AND TRIANGULAR WINGS OF VARIOUS ASPECT RATIOS AT MACH NUMBERS OF 1.50 AND 2.02. Jack N. Nielsen, Elliott D. Katzen, and Kenneth K. Tang. December 1956. 49p. diagrs., photos., tabs. (NACA TN 3795. Supersedes RM A50F06)

The lift and pitching-moment characteristics of a body alone, six triangular wings of various aspect ratios, and the combinations were measured at Mach numbers of 1.50 and 2.02 at a Reynolds number of 5.5 million (based on the body length) for angles of attack up to 5.5°. The total lift and pitching-moment interference were determined and compared with theory. The agreement was found to be good.

NACA TN 3796

THEORETICAL LIFT DUE TO WING INCIDENCE OF SLENDER WING-BODY-TAIL COMBINATIONS AT ZERO ANGLE OF ATTACK. Alvin H. Sacks. November 1956. 35p. diagrs. (NACA TN 3796)

The theoretical lift of a cylindrical afterbody at zero angle of attack due to incidence of the wing is calculated by means of slender-body theory. It is assumed that the vortex sheet becomes fully rolled up ahead of the tail, and the vortex paths in the presence of the body are determined analytically. The total lift of a variety of slender wing-body-tail combinations due to wing incidence is also calculated.

NACA TN 3797

SECTION CHARACTERISTICS OF THE NACA 0006 AIRFOIL WITH LEADING-EDGE AND TRAILING-EDGE FLAPS. Bruno J. Gambucci. December 1956. 17p. diagrs., photo., tabs. (NACA TN 3797)

Lift and pitching-moment characteristics of an NACA 0006 airfoil are presented for various deflections of a 0.15-chord leading-edge flap and a 0.30-chord plain trailing-edge flap. Pressure-distribution data are presented in tabular form. The data were obtained at a Mach number of 0.15 and a Reynolds number of 4,500,000.

NACA TN 3817

TWO-DIMENSIONAL LOW-SPEED CASCADE INVESTIGATION OF NACA COMPRESSOR BLADE SECTIONS HAVING A SYSTEMATIC VARIATION IN MEAN-LINE LOADING. John R. Erwin, Melvyn Savage, and James C. Emery. November 1956. 129p. diagrs., tabs. (NACA TN 3817. Supersedes RM L53I30b)

The low-speed cascade performance of the high-speed NACA 65-($C_{l_0}A_2I_{8b}$)10 compressor blade sections has been systematically investigated. Comparative tests of blade sections having widely different loading distributions were also made. These data, in conjunction with previously published cascade data, permit a prediction of design performance for most compressor blade sections since the mean lines tested probably encompass the practical range.

NACA TN 3822

SOME MEASUREMENTS OF AERODYNAMIC FORCES AND MOMENTS AT SUBSONIC SPEEDS ON A WING-TANK CONFIGURATION OSCILLATING IN PITCH ABOUT THE WING MIDCHORD. Sherman A. Clevenson and Sumner A. Leadbetter. December 1956. 37p. diagrs., photo., tab. (NACA TN 3822)

Measurements are presented of the aerodynamic forces and moments acting on a wing-tank configuration, with or without fins, oscillating about the wing-root midchord. The reduced-frequency range was from 0.050 to 0.657, whereas the Mach number and Reynolds number range was from 0.18 to 0.75 and 0.9×10^6 to 9.5×10^6, respectively. Comparisons of the experimental aerodynamic forces and moments and their respective phase angles acting on the wing-tank combination with those acting on the tank alone indicated that the overall lifts and moments were greater when the tank was attached. The forces on the tank alone were compared with those determined by an engine-nacelle theory.

NACA TN 3836

SPREADING CHARACTERISTICS OF A JET EXPANDING FROM CHOKED NOZZLES AT MACH 1.91. Morris D. Rousso and L. Eugene Baughman. December 1956. 27p. diagrs., photos. (NACA TN 3836. Supersedes RM E51L19)

Total-temperature surveys were made to determine the gross spreading of jets expanding from axisymmetric convergent and convergent-divergent nozzles. The nozzles were located in the base of conically boattailed bodies of revolution. Surveys were made between the nozzle exit and a station 8 nozzle diameters downstream of the jet exit for jet pressure ratios from 2.5 to 0.16. The temperature profiles of jets expanding into a supersonic stream are considerably smaller in diameter than the temperature profiles of jets expanding into quiescent air. The effect on the wake of varying afterbody geometry was small.

NACA TN 3839

EXPERIMENTAL DROPLET IMPINGEMENT ON SEVERAL TWO-DIMENSIONAL AIRFOILS WITH THICKNESS RATIOS OF 6 TO 16 PERCENT. Thomas F. Gelder, William H. Smyers, Jr., and Uwe von Glahn. December 1956. 77p. diagrs., photos., tabs. (NACA TN 3839)

The rate and area of cloud droplet impingement on several two-dimensional swept and unswept airfoils were obtained experimentally in the NACA Lewis icing tunnel with a dye-tracer technique. Airfoil thickness ratios of 6 to 16 percent, angles of attack from 0° to 12°, and chord sizes from 13 to 96 inches were included in the study. The results are presented in the form of dimensionless impingement parameters in order to cover a wide range of flight and atmospheric conditions.

NACA TN 3847

FATIGUE-CRACK-PROPAGATION AND RESIDUAL-STATIC-STRENGTH RESULTS ON FULL-SCALE TRANSPORT-AIRPLANE WINGS. Richard E. Whaley, M. J. McGuigan, Jr., and D. F. Bryan. December 1956. 57p. diagrs., photos., tabs. (NACA TN 3847)

Results are presented of fatigue-crack propagation during fatigue tests on the wings of C-46 airplanes. Results are also presented of the residual static strength of these wings after fatigue test. The propagation curves along with an explanation of the crack growth are presented for each wing. Curves also show the trends that occur with changing load levels. The loss in static strength is also shown and is compared with the calculated strength and the results of small specimen tests.

NACA TN 3849

ANALYTICAL DETERMINATION OF THE NATURAL COUPLED FREQUENCIES AND MODE SHAPES AND THE RESPONSE TO OSCILLATING FORCING FUNCTIONS OF TANDEM HELICOPTERS. George W. Brooks and John C. Houbolt. December 1956. 45p. diagrs., tabs. (NACA TN 3849)

A method is presented for calculating the natural coupled frequencies and mode shapes of vertical vibrations of tandem helicopters; certain forced excitations are also considered. Degrees of freedom included are translation, pitching, and bending of the fuselage and the blades, and translation of the engine. Sample calculations show the modes for a given case, and indicate the changes in frequencies which result from variations in the uncoupled fuselage frequency and the Southwell coefficient. Frequency response functions of cockpit deflection for various applied oscillating forces are also given.

NACA TN 3850

EXPERIMENTAL INVESTIGATION ON THE LANGLEY HELICOPTER TEST TOWER OF COMPRESSIBILITY EFFECTS ON A ROTOR HAVING NACA 63_2-015 AIRFOIL SECTIONS. James P. Shivers and Paul J. Carpenter. December 1956. 28p. diagrs., photo. (NACA TN 3850)

An investigation has been conducted on the Langley helicopter test tower to determine experimentally the effects of compressibility on the hovering performance and the blade pitching moments of a helicopter rotor having NACA 63_2-015 airfoil sections. Data are presented for blade tip Mach numbers from 0.31 to 0.71. High-tip-speed performance of the rotor having NACA 63_2-015 airfoil sections is compared with that of a rotor having NACA 23015 airfoil sections.

NACA TN 3851

FAILURE CHARACTERISTICS OF PRESSURIZED STIFFENED CYLINDERS. Roger W. Peters and Norris F. Dow. December 1956. 18p. diagrs., photos., tabs. (NACA TN 3851)

Stiffened cylinders of 2024 and 7075 aluminum alloys, representative of fuselage construction, were tested under internal pressure and cyclic torsion. Fatigue cracks which developed in the skin resulted in both gradual and explosive types of failure. The types of failure depended upon the hoop stress and the structural configuration, and particularly upon the ratio of area in rings to associated skin area. The tests indicated that the 7075 alloy is somewhat more prone to the explosive type of failure.

NACA TN 3852

FLIGHT MEASUREMENTS OF THE VIBRATIONS ENCOUNTERED BY A TANDEM HELICOPTER AND A METHOD FOR MEASURING THE COUPLED RESPONSE IN FLIGHT. John E. Yeates, Jr. December 1956. 28p. diagrs., photo., tab. (NACA TN 3852)

A discussion of flight-test and analysis methods for some selected helicopter vibration studies is presented. The use of a mechanical shaker in flight to determine the structural response is reported. The analysis methods described are based on the determination of the power spectral density of the force and of the response due to the force through use of analog frequency-analysis techniques. Results obtained by these methods are presented to show the coupled response of a helicopter in flight for two different blade configurations. In addition, natural-vibration measurements of some of the more important harmonics of rotor speed are presented for a range of speed and power conditions.

NACA TN 3865

WIND-TUNNEL INVESTIGATION OF JET-AUGMENTED FLAPS ON A RECTANGULAR WING TO HIGH MOMENTUM COEFFICIENTS. Vernard E. Lockwood, Thomas R. Turner, and John M. Riebe. December 1956. 51p. diagrs., tab. (NACA TN 3865)

Results and a discussion are presented of a preliminary investigation of jet flaps made in the 300 mph 7- by 10-foot tunnel on an unswept, untapered wing with an aspect ratio of 8.4 and a thickness of 16.7 percent. The jet flaps consisted of air ejected at velocities ranging from zero to choking through a small gap on the upper surface of the wing, and backward over a rounded trailing edge. The ejected air flowed along the circumference of the round trailing edge by means of the Coanda effect and was separated from the surface by means of wedges at angles of 0°, 28°, 57°, 86°, and 110° with respect to the wing chord line. Results are also presented for a limited number of tests of a jet-augmented plain flap and a jet-augmented trim flap.

NACA TN 3867

WIND-TUNNEL INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS IN PITCH OF WING-FUSELAGE COMBINATIONS AT HIGH SUBSONIC SPEEDS. TAPER-RATIO SERIES. Thomas J. King, Jr., and Thomas B. Pasteur, Jr. December 1956. 36p. diagrs., photos., tab. (NACA TN 3867. Supersedes RM L53E20)

Aerodynamic characteristics are presented of wing-fuselage combinations having an aspect ratio of 4, a sweepback angle of 45°, and taper ratios of 0.3, 0.6, and 1.0. The tests covered a Mach number range from 0.4 to 0.95 at Reynolds numbers of 2,000,000 to 3,000,000 and an angle-of-attack range from -2° to 26°. The results indicate at low lift coefficients a reduction in lift-curve slope and a forward movement in aerodynamic center with an increase in taper ratio. Small differences in minimum drag, drag due to lift, and lift-drag ratio resulted from variation in taper ratio for the constant-thickness-ratio wings investigated.

NACA TN 3871

AN INVESTIGATION AT SUBSONIC SPEEDS OF SEVERAL MODIFICATIONS TO THE LEADING-EDGE REGION OF THE NACA 64A010 AIRFOIL SECTION DESIGNED TO INCREASE MAXIMUM LIFT. Ralph L. Maki and Lynn W. Hunton. December 1956. 50p. diagrs., tab. (NACA TN 3871)

Two-dimensional test data at both low and high subsonic speeds are presented for three airfoil sections comprised of three related modifications to the leading-edge region of the NACA 64A010 section designed to improve maximum lift characteristics. Comparisons are made with both the NACA 64A010 section and sections incorporating a distributed type of camber, the NACA $a = 1.0$ mean line.

NACA TN 3884

IGNITION DELAYS AND FLUID PROPERTIES OF SEVERAL FUELS AND NITRIC ACID OXIDANTS IN TEMPERATURE RANGE FROM 70° TO -105° F. Riley O. Miller. December 1956. 32p. diagrs., photos., tabs. (NACA TN 3884. Supersedes RM E51J11)

Out of 17 acids containing various amounts of nitric acid, water, nitrogen tetroxide, sulfuric acid, ammonium nitrate, potassium nitrate, and perchloric acid, red fuming nitric acids containing about 19 percent nitrogen tetroxide and 3 percent water were best for low freezing points and short ignition delays in the NACA open-cup apparatus. Of the 29 fuels studied, several blends of aromatic amines in triethylamine were fluid and gave short delays at -76° F; at very low temperatures 30 percent o-toluidine in triethylamine gave the shortest delays with low-freezing red fuming nitric acid.

NACA TN 3885

INVESTIGATION OF TRANSIENT POOL BOILING DUE TO SUDDEN LARGE POWER SURGE. Robert Cole. December 1956. 44p. diagrs., photos., tabs. (NACA TN 3885)

The transient heat-transfer characteristics of a system composed of a nickel ribbon immersed horizontally in a pool of water were determined at atmospheric pressure for average heat-generation rates of 3, 10, and 20 x 10^5 Btu/(hr)(sq ft), and fluid bulk temperatures from 76° to 203° F. The power surge duration was limited to 30 milliseconds. Analyses show that convective heat transfer in the nonboiling region was negligible within the time limits employed. Comparison was made between determined ribbon temperatures and those occurring had the ribbon been completely insulated. Transient heat-transfer coefficients and critical-heat-flux values are tabulated.

NACA TN 3886

AVERAGE PROPERTIES OF COMPRESSIBLE LAMINAR BOUNDARY LAYER ON FLAT PLATE WITH UNSTEADY FLIGHT VELOCITY. Franklin K. Moore and Simon Ostrach. December 1956. 35p. diagrs., tabs. (NACA TN 3886)

The time-average characteristics of boundary layers over either an insulated or isothermal flat plate in nearly quasi-steady flow are determined. Time averages are found without specifying plate velocity explicitly except that it is positive and has an average value. The time average quasi-steady terms are compared to steady flow values at the corresponding average velocity and the effects of the frequency dependent averages are discussed. The special case of harmonic velocity variation is considered, and it is found that large amplitudes accentuate the importance of the frequency-dependent terms. Oscillating the wall to increase the heat-transfer rate is not advantageous if the power to oscillate the plate is accounted for, unless the Prandtl number is in a certain range.

NACA TN 3887

EFFECT OF CONCENTRATION ON IGNITION DELAYS FOR VARIOUS FUEL-OXYGEN-NITROGEN MIXTURES AT ELEVATED TEMPERATURES. E. Anagnostou, R. S. Brokaw, and J. N. Butler. December 1956. 34p. diagrs. (NACA TN 3887)

Ignition delays for mixtures of ethane, n-butane, isobutane, hydrogen, or propane with oxygen and nitrogen were measured at various temperatures and fuel and oxygen concentrations using a flow system. Ignition delays for all fuels were inversely proportional to fuel concentration to some power between 0.6 and 1.7. They also decreased slightly with increasing oxygen concentration and decreased with increasing temperature. Two experimental procedures were used, and these gave different absolute values for the delay but the trends observed were the same by either method.

NACA TN 3888

SIMPLIFIED METHOD FOR ESTIMATING COMPRESSIBLE LAMINAR HEAT TRANSFER WITH PRESSURE GRADIENT. Eli Reshotko. December 1956. 16p. diagrs. (NACA TN 3888)

An approximation is made in the method of TN 3326 which simplifies the calculation of heat transfer. Good agreement with the method of TN 3326 is expected for isothermal surfaces with adverse and small favorable pressure gradients regardless of surface temperature and also for flow with large favorable pressure gradient over cooled surfaces.

NACA TN 3891

RAPID DETERMINATION OF CORE DIMENSIONS OF CROSSFLOW GAS-TO-GAS HEAT EXCHANGERS. Anthony J. Diaguila and John N. B. Livingood. December 1956. 19p. diagrs., tabs. (NACA TN 3891)

A generalized procedure is presented which permits a rapid determination of the core lengths of crossflow gas-to-gas heat exchangers. The heat capacities of both gases, inlet and exit gas conditions on both sides of the exchanger, and the exchanger core configuration must be known. The calculation procedure is applied to two typical core configurations with identical fluid conditions and to one core configuration with different fluid conditions.

NACA TN 3900

INVESTIGATION OF VERTICAL DRAG AND PERIODIC AIRLOADS ACTING ON FLAT PANELS IN A ROTOR SLIPSTREAM. Robert A. Makofski and George F. Menkick. December 1956. 23p. diagrs., photo. (NACA TN 3900)

Tests have been conducted on the Langley helicopter test tower to determine the vertical drag and pressure distributions on flat panels mounted below a helicopter rotor. Calculations of the vertical drag by use of a strip-analysis procedure outlined in the paper and the assumption of a fully contracted wake agreed well with the experimental results over the range from 0.2 to 0.64 rotor radius beneath the plane of zero flapping. The pressure increase caused by the passage of the blade over the panel is a maximum at about the 0.8 radius spanwise station. At this station, the pressure decreases from 10 times the disk loading per blade at 0.05 radius beneath the rotor plane of zero flapping to one-half of the disk loading per blade at 0.64 radius beneath the plane of zero flapping.

BRITISH REPORTS

N-42554*

Royal Aircraft Establishment (Gt. Brit.)
INSPECTION TECHNIQUES APPLIED TO THE METROLOGY OF AERODYNAMIC MODELS. H. T. Hill. January 1956. 22p. diagrs., photos. (RAE Tech.Note ADW 1)

With the increasing speeds of modern aircraft, and the related greater use of high-speed wind tunnels, together with the introduction of the "Free Flight" technique, there is not only a major model production problem, but also a parallel three-dimensional metrology problem. This problem is as divorced from normal inspection procedure as is the manufacture of the models themselves from mass production. This paper gives an appreciation of the problem confronting the metrologist, details of the present inspection methods employed by the Royal Aircraft Establishment, and thoughts on further development to improve the accuracy and speed at which these three-dimensional models can be inspected. There is an urgent need to make models more expeditiously and more accurately and also to measure them more completely and much quicker. Undoubtedly the human element must be replaced as far as possible in this work, and automatic means of measuring must assist the metrologist.

N-46777*

Royal Aircraft Establishment (Gt. Brit.)
ACCELERATION MEASUREMENTS DURING DROP TESTS. D. A. Webber. July 1956. 15p. diagrs., photos. (RAE Tech.Note Structures 198)

During an extensive drop-testing program on a complete aircraft, four types of accelerometer were fitted. The acceleration readings obtained were compared with each other and with accelerations derived from vertical reactions recorded by strain-gaged platforms beneath the main undercarriages. The relative merits of the four instruments for this special purpose are compared.

N-46782*

Royal Aircraft Establishment (Gt. Brit.)
SERVICE TRIALS OF TRIPLE-VIEW CAMERA METHOD OF MEASURING VERTICAL VELOCITIES IN LANDING (SEA HORNET Mk.XXI). D. A. Webber. June 1956. 21p. diagrs., photos., tabs. (RAE Tech.Note Structures 194)

Extensive trials of the triple-view camera method for measuring vertical velocity have been made on Sea Hornet Mk.XXI aircraft. Records were taken of airfield dummy deck landings and also of day and night landings on an aircraft carrier. Information was obtained on the landing characteristics of the aircraft and the values of vertical velocity obtained from the triple-view camera records are compared with those from the deck camera records. The type of information which can be obtained by the triple-view camera method is demonstrated. The method is critically reviewed and suggestions for its development are made.

N-46783*

Royal Aircraft Establishment (Gt. Brit.)
FURTHER EXPERIMENTS ON THE SINTERING OF ZINC OXIDE. J. Hutchings and J. P. Roberts. March 1956. 28p. diagrs. (RAE Met.91)

The sintering of zinc oxide powder pressings in mixtures of oxygen and argon was influenced markedly by the proportions of the two gases present. Some powders sintered more when oxygen preponderated, while others sintered more when argon preponderated. A detailed investigation of powders sintering more in a preponderance of oxygen was made. Oxygen was identified as the gas component affecting the sintering. The behavior in a series of pressures of oxygen alone and of argon alone was observed and interpreted. Prefiring and the duration of previous evacuation both influenced sintering. The permeability of the powder pressings to gases was studied.

N-46784*

Royal Aircraft Establishment (Gt. Brit.)
OPERATIONAL FORMULAE FOR RESPONSE CALCULATIONS. S. Neumark. June 1956. 65p. diagrs., tabs. (RAE Aero 2570)

The paper presents systematic tables of formulas whose purpose is to facilitate the operational solution of response problems reducible to linear differential equations with constant coefficients and with simple forcing functions. The formulas enable the user to find operational equivalents of a wide class of simple functions and, inversely, to find functional equivalents of a great number of operational expressions, in the most rapid and direct manner. In such a way, it is possible to reduce to a minimum the usual heavy algebraical work involved in response calculations. The tables include only such functions whose operational equivalents are algebraic fractions, but these cover a wide field of practical applications. Operational fractions of the first, second, third, and fourth order are treated in a comprehensive way, so that all possible particular cases are included. Additional tables make it possible to reduce every fraction of fifth or sixth order to a combination of fractions of lower order. The introductory text describes the method of deriving the formulas and explains how to use them in solving response problems. A number of examples are appended which show the advantages of the tables and give solutions of several typical problems.

MISCELLANEOUS

Errata on NACA Rept. 1259. By Dean R. Chapman. 1956.

Errata on NACA TN 3208. By H. S. Mickley, R. C. Ross, A. L. Squyers, and W. E. Stewart. July 1954.

Errata on NACA TN 3570. By William R. Mickelsen. October 1955.

Errata on NACA TN 3858. By Albert E. von Doenhoff and Elmer A. Horton. October 1956.

N-47886

Advisory Group for Aeronautical Research and Development. SELECTED COMBUSTION PROBLEMS, II. TRANSPORT PHENOMENA; IGNITION; ALTITUDE BEHAVIOUR AND SCALING OF AERO-ENGINES. COMBUSTION COLLOQUIUM, LIÈGE, BELGIUM, DECEMBER 5 TO 9, 1955. 1956. viii, 495p. diagrs., photos., tabs. (AGARD)

Contents: THE PERFORMANCE OF AIRPLANE ENGINES. (Les Performances des Moteurs D'Avions). A. Capetti, Laboratoire d'Aeronautique de l'Ecole Polytechnique de Turin. FUELS FOR TURBOJET POWERED AIRCRAFT. R. R. Hibbard and H. C. Barnett, National Advisory Committee for Aeronautics. FUNDAMENTAL PRINCIPLES OF FLAMMABILITY AND IGNITION. B. Lewis and G. von Elbe, Combustion and Explosives Research, Inc. THE IGNITION OF FLOWING GASES. L. D. Wigg, National Gas Turbine Establishment. IGNITION AND BURNING IN LIQUID-PROPERGOL ROCKET MOTORS. (Inflammation et Allumage Dans les Moteurs-Fusées à Propergols liquides). M. Barrere and A. Moutet, Office National d'Études et de Recherches Aéronautiques. THERMAL IGNITION, WITH PARTICULAR REFERENCE TO HIGH TEMPERATURES. R. S. Brokaw, National Advisory Committee for Aeronautics. FUNDAMENTAL EQUATIONS IN AEROTHERMOCHEMISTRY. Theodore von Kármán, Advisory Group for Aeronautical Research and Development. SOME CONSIDERATIONS ON HEAT CONVECTION AT HIGH SPEEDS AND HIGH TEMPERATURES. (Quelques Considérations sur la Convection de la Chaleur Aux Grandes Vitesses et Aux Températures Elevées). E. A. Brun, Faculté des Sciences. SOURCES OF TRANSPORT COEFFICIENTS AND CORRELATIONS OF THERMODYNAMIC AND TRANSPORT DATA. J. Hilsenrath, National Bureau of Standards. COMBUSTION AT ALTITUDE IN TURBOJET ENGINES. (Combustion en Altitude dans les Turbo-Réacteurs). J. Soissons, Centre d'Essais en Vol. THE INFLUENCE OF ALTITUDE OPERATING CONDITIONS ON COMBUSTION CHAMBER DESIGN. S. L. Bragg and J. B. Holliday, Rolls-Royce, Ltd. COMBUSTION IN THE TURBOJET ENGINE. S. Way, Westinghouse Research Laboratories. PROBLEMS OF COMBUSTION UNDER ALTITUDE CONDITION (TREATED FROM FUNDAMENTAL VIEWPOINT). H. G. Wolfhard, Royal Aircraft Establishment. SIMILARITIES IN COMBUSTION, A REVIEW. A. E. Weller, Battelle Memorial Institute. SCALING OF GAS TURBINE COMBUSTION SYSTEMS. D. G. Stewart, National Gas Turbine Establishment. INVESTIGATION ON OPTIMUM BURNERS FOR HIGH-SPEED AIR-KEROSENE FLOW. (Recherche du Brûleur Optimum en Écoulement Air-Kérosène À Grande Vitesse). B. Salmon and H. Vigne, Société Nationale d'Étude et de Construction de Moteurs d'Aviation. SCALING OF LIQUID FUEL ROCKET COMBUSTION CHAMBERS. Chandler C. Ross, Aerojet-General Corporation. CONSIDERATIONS ON THE PROBLEM OF SCALING ROCKET MOTORS. L. Crocco, Princeton University.

(May be purchased from Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, New York, at $12.50.)

UNPUBLISHED PAPERS

N-19061*

CONTRIBUTION TO THE THEORY OF DROP AND CRYSTAL FORMATION IN THE ATMOSPHERE. (Beitrag zur Theorie der Tropfen- und Kristallbildung in der Atmosphäre). L. Krastanow. (1956). 22p. (Translation from Meteorologische Zeitschrift, v. 58, no. 2, February 1941, p. 37-45)

A formula of nuclei formation for drops formed on condensation nuclei is derived mathematically. It is assumed that these nuclei are liquid particles or solid particles completely wet with water.

DECLASSIFIED NACA RESEARCH REPORTS

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1264

A THERMAL EQUATION FOR FLAME QUENCHING. A. E. Potter, Jr., and A. L. Berlad. 1956. ii, 7p. diagrs., tab. (NACA Rept. 1264. Supersedes TN 3398)

A thermal quenching equation is derived; the equation is essentially an extension of a previously proposed diffusional concept. By proper choice of the rate-controlling chemical reaction, the equation becomes suitable for use with rich as well as lean fuel-air mixtures. The equation was tested, using published quenching-distance data for propane-oxygen-nitrogen flames, which include the effect of oxygen-nitrogen ratio, equivalence ratio, pressure, and initial temperature.

NACA RM E56I11

A BALANCED-PRESSURE SLIDING SEAL FOR TRANSFER OF PRESSURIZED AIR BETWEEN STATIONARY AND ROTATING PARTS. Arthur N. Curren and Reeves P. Cochran. January 1957. 17p. diagrs. (NACA RM E56I11)

A combination sliding-ring and pressure-balancing seal capable of transferring pressurized air from stationary to rotating parts was developed and experimentally investigated at sliding velocities and cooling-air pressures up to 10,000 feet per minute and 38.3 pounds per square inch absolute, respectively. Leakage of cooling air was completely eliminated with an expenditure of balance air less than one-fourth the leakage loss of air from labyrinth seals under the same conditions. Additional cooling of the carbon-base seal rings was required, and the maximum wear rate on the rings was about 0.0005 inch per hour.

NACA RM E56J12

IDENTIFICATION OF FOREIGN OBJECTS DAMAGING COMPRESSOR BLADES IN TURBOJET ENGINES. A. E. Spakowski and J. Graab. January 1957. 12p. photos., tabs. (NACA RM E56J12)

Damage to the compressor blades of turbojet engines due to ingestion of foreign objects is a growing problem, the solution of which has been made more difficult by the large percentage of damaging materials that have remained unknown. A rapid emission spectroscopic method was devised to identify the chemical composition of these foreign objects. Results on laboratory-prepared specimens and blades from damaged engines show that the method can be utilized to determine the nature of the ingested foreign objects.

NACA RM L56I26

MEASUREMENTS OF RUNWAY ROUGHNESS OF FOUR COMMERCIAL AIRPORTS. Dexter M. Potter. January 1957. 86p. diagrs., tabs. (NACA RM L56I26)

Measurements of runway roughness were made on runways at Washington National Airport, New York International Airport, La Guardia Airport, and Logan International Airport, Boston, Mass. This report presents these measurements in the form of tables as well as plots.

NACA TM 1406

ON THE USE OF THE HARMONIC LINEARIZATION METHOD IN THE AUTOMATIC CONTROL THEORY. (K voprosu o primenenii metoda harmonicheskoi linearizatsii v teorii regulirovaniya). E. P. Popov. January 1957. 6p. (NACA TM 1406. Translation from Doklady Akademiia Nauk (SSSR), v.106, no.2, 1956, p.211-214)

This paper considers the use of harmonic linearization as applied to the analysis of nonlinear automatic control systems. This approach, which has been proven in practical engineering applications, involves the replacement of a nonlinear equation by a linear equation. In establishing the method a small parameter is considered which makes it possible to speak with some degree of approximation of the solution of the new equation to that of the given linear equation. Thus, the mathematics of nonlinear mechanics is brought to bear on the problem by explaining and extending the usefulness of automatic control theory and nonlinear systems.

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CURRENT NACA RESEARCH REPORTS

NACA TM 1421

A THEORETICAL INVESTIGATION OF THE DRAG OF GENERALIZED AIRCRAFT CONFIGURATIONS IN SUPERSONIC FLOW. E. W. Graham, P. A. Lagerstrom, R. M. Licher, and B. J. Beane, Douglas Aircraft Company, Inc. January 1957. (iv), 108p. diagrs. (NACA TM 1421)

It seems possible that, in supersonic flight, unconventional arrangements of wings and bodies may offer advantages in the form of drag reduction. It is the purpose of this report to consider the methods for determining the pressure drag for such unconventional configurations, and to consider a few of the possibilities for drag reduction in highly idealized aircraft. The idealized aircraft are defined by distributions of lift and volume in three-dimensional space, and Hayes' method of drag evaluation is the fundamental tool employed. Other methods of drag evaluation are considered also wherever they appear to offer simplifications. The basic singularities such as sources, dipoles, lifting elements, and volume elements are discussed, and some of the useful interrelations between these elements are presented. Hayes' method of drag evaluation is derived in detail starting with the general momentum theorem. In going from planar systems to spatial systems, certain new problems arise and are discussed.

NACA TM 1427

TURBULENCE IN THE WAKE OF A THIN AIRFOIL AT LOW SPEEDS. George S. Campbell, California Institute of Technology. January 1957. 63p. diagrs. (NACA TM 1427)

Experiments have been made to determine the nature of turbulence in the wake of a two-dimensional airfoil at low speeds. The experiments were motivated by the need for data which can be used for analysis of the tail-buffeting problem in aircraft design. Turbulent intensity and power spectra of the velocity fluctuations were measured at a Reynolds number of 1.6×10^5 for several angles of attack. Total-head measurements were also obtained in an attempt to relate steady and fluctuating wake properties. Mean-square downwash was found to have nearly the same dependence on vertical position in the wake as that shown by total-head loss. For this particular wing, turbulent intensity, integrated across the wake, increased roughly as the 3/2 power of the drag coefficient. Power-spectrum measurements indicated a decrease in frequency as wing angle of attack was increased. The average frequency in the wake was proportional to the ratio of mean wake velocity to wake width.

NACA TN 3704

MINIMUM-DRAG DUCTED AND CLOSED THREE-POINT BODY OF REVOLUTION BASED ON LINEARIZED SUPERSONIC THEORY. Hermon M. Parker. December 1956. 20p. diagrs., tab. (NACA TN 3704)

The problem of the three-point body of revolution that has minimum wave drag, based on linearized supersonic-flow theory, has been solved formally without resort to slender-body approximations. The evaluation of the source-distribution function, as well as the body shape, requires numerical procedures. Complete calculations are made for the special case of a closed body with a given section (the third point) at the midbody position. The existence of a corner at the third point is found to be characteristic of a linear-theory solution of the minimum-drag three-point problem. The conclusion is reached that the influence between the forward and rearward portions of a closed body results in a small increase in the radii of the minimum-drag shape.

NACA TN 3814

EFFECTS OF VERTICAL FINS NEAR THE NOSE OF THE FUSELAGE ON THE DIRECTIONAL AND DAMPING-IN-YAW STABILITY DERIVATIVES OF AN AIRPLANE MODEL UNDER STEADY-STATE AND OSCILLATORY CONDITIONS. M. J. Queijo and Evalyn G. Wells. December 1956. 54p. diagrs., photo., tab. (NACA TN 3814)

A wind-tunnel investigation has been made at low speed to determine the effects of vertical fins placed ahead of the vertical tail on the directional stability and damping-in-yaw characteristics of a swept-wing model under steady-state oscillatory conditions. Various sizes of fins were used above and below the fuselage center line. The vertical-tail size also was varied.

NACA TN 3819

BASE PRESSURE AT SUPERSONIC SPEEDS ON TWO-DIMENSIONAL AIRFOILS AND ON BODIES OF REVOLUTION WITH AND WITHOUT FINS HAVING TURBULENT BOUNDARY LAYERS. Eugene S. Love. January 1957. 65p. diagrs., photos. (NACA TN 3819. Supersedes RM L53C02)

An analysis is made of available experimental data to show the effect of most of the variables that are more predominant in determining base pressure at supersonic speeds. The analysis is restricted to turbulent boundary layers and covers two-dimensional bases and the bases of bodies of revolution with and without stabilizing fins. An analogy to the peak pressure rise associated with the separation of the boundary layer is presented as are simple semiempirical methods for the estimation of base pressure.

CURRENT NACA RESEARCH REPORTS

NACA TN 3823

INVESTIGATION OF ROTATING STALL IN A SINGLE-STAGE AXIAL COMPRESSOR. S. R. Montgomery and J. J. Braun, Massachusetts Institute of Technology. January 1957. 28p. diagrs., photos. (NACA TN 3823)

The rotating-stall characteristics of a single-stage axial-flow compressor were investigated. The number of stall cells and their propagation velocities were found with and without stator blades. The measured velocities were compared with those predicted by Stenning's theory (see NACA TN 3580), assuming the downstream pressure fluctuations to be negligible, and correlation within 10 percent was obtained at the onset of stall.

NACA TN 3828

INVESTIGATION OF THE NiAl PHASE OF NICKEL-ALUMINUM ALLOYS. Edward M. Grala. January 1957. 33p. diagrs., photos., tabs. (NACA TN 3828)

The effects of composition and homogenization heat treatments on the room- and elevated-temperature mechanical properties of the cast NiAl intermetallic were determined. Small changes in composition within the NiAl phase field resulted in appreciable strength and hardness changes. Room-temperature hardness of alloys containing 25 to 35 percent aluminum exhibited a sharp minimum at 31.5 percent aluminum (stoichiometric NiAl). Homogenized NiAl specimens had tensile strengths at room temperature ranging from 29,450 psi for the 25-percent-aluminum alloy to 14,900 psi for stoichiometric NiAl. At 1500° F the tensile strength of homogenized alloys ranged from 29,050 psi for the 25-percent-aluminum alloy to 14,500 psi for the stoichiometric alloy. Additions of 0.5 to 2.0 percent molybdenum to stoichiometric NiAl reduced the as-cast grain size and significantly increased both room- and elevated-temperature strength and ductility.

NACA TN 3834

EFFECT OF AMBIENT-TEMPERATURE VARIATION ON THE MATCHING REQUIREMENTS OF INLET-ENGINE COMBINATIONS AT SUPERSONIC SPEEDS. Eugene Perchonok and Donald P. Hearth. January 1957. 16p. diagrs. (NACA TN 3834)

The changes in ambient temperature ordinarily encountered in flight can markedly influence the performance of matched inlet-engine combinations for turbojet engines operated at constant mechanical speed. If variable geometry is designed into the inlet, the inlet should be sized for the lowest ambient temperature to be encountered regularly. Moreover, the capacity of the variable-geometry feature utilized must be appreciably increased over that for a constant ambient-temperature design. In addition, the capacity of certain matching techniques may be inadequate if both variations in free-stream Mach number and ambient temperature are considered.

NACA TN 3841

DISTRIBUTION OF NORMAL COMPONENT OF INDUCED VELOCITY IN LATERAL PLANE OF A LIFTING ROTOR. Walter Castles, Jr., and Howard L. Durham, Jr., Georgia Institute of Technology. December 1956. 26p. diagrs., tabs. (NACA TN 3841)

Values of the nondimensional normal component of induced velocity in the lateral plane of a uniformly loaded lifting rotor are given in the form of graphs and tables. The necessary auxiliary equations are given so that the graphs or tables of the induced velocity ratios may be used to estimate numerical values of the normal component of induced velocity and the associated flow angle in the lateral plane of any given rotor or set of laterally disposed rotors.

NACA TN 3842

CREEP BEHAVIOR OF STRUCTURAL JOINTS OF AIRCRAFT MATERIALS UNDER CONSTANT LOADS AND TEMPERATURES. Leonard Mordfin and Alvin C. Legate, National Bureau of Standards. January 1957. 53p. diagrs., tabs. (NACA TN 3842)

The results of 55 creep and creep-rupture tests on structural joints are presented. Methods are described by which the time to rupture, the mode of rupture, and the deformation of joints in creep may be predicted. These methods utilize creep data on the materials of the joint in tension, bearing, and shear.

NACA TN 3860

METHOD FOR CALCULATING EFFECTS OF DISSOCIATION ON FLOW VARIABLES IN THE RELAXATION ZONE BEHIND NORMAL SHOCK WAVES. John S. Evans. December 1956. 52p. diagrs., tabs. (NACA TN 3860)

Generalized expressions and charts are presented for the temperature, pressure, density, and flow velocity behind a shock wave that depend on the shock Mach number, the initial state of the gas, and an enthalpy parameter. The variation of this parameter behind the shock is related directly to the variation of the degree of dissociation. Estimated chemical reaction rates are used to illustrate the application of these results for the prediction of the variation of flow properties with distance behind a Mach number 14 shock wave in air at 300° K and 10^{-4} atmospheres.

NACA TN 3861

AERODYNAMIC CHARACTERISTICS OF A CIRCULAR CYLINDER AT MACH NUMBER 6.86 AND ANGLES OF ATTACK UP TO 90°. Jim A. Penland. January 1957. 32p. diagrs., photos. (NACA TN 3861. Supersedes RM L54A14)

Pressure-distribution and force tests of a circular cylinder have been made in the Langley 11-inch hypersonic tunnel at a Mach number of 6.86, a Reynolds number of 129,000, and angles of attack up to 90°. The results are compared with the hypersonic approximation of Grimminger, Williams, and

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Young and a simple modification of the Newtonian flow theory. An evaluation of the crossflow theory is made through comparison of present results with available crossflow Mach number drag coefficients.

NACA TN 3862

DETERMINATION OF THE STRUCTURAL DAMPING COEFFICIENTS OF SIX FULL-SCALE HELICOPTER ROTOR BLADES OF DIFFERENT MATERIALS AND METHODS OF CONSTRUCTION. Frederick W. Gibson. December 1956. 19p. diagrs., tab. (NACA TN 3862)

Results of an experimental investigation of the structural damping of six full-scale helicopter rotor blades, made to determine the variation of structural damping with materials and methods of construction, are presented. The damping of the blades was determined for the first three flapwise bending modes, first chordwise bending mode, and first torsion mode. The contribution of structural damping to the total damping of the blades is discussed for several aerodynamic conditions in order to point out situations where structural damping is significant.

NACA TN 3863

WIND-TUNNEL INVESTIGATION AT LOW SPEEDS TO DETERMINE THE EFFECT OF ASPECT RATIO AND END PLATES ON A RECTANGULAR WING WITH JET FLAPS DEFLECTED 85°. John G. Lowry and Raymond D. Vogler. December 1956. 21p. diagrs., tab. (NACA TN 3863)

Results are given of an investigation of the effect of aspect ratio and end plates on the aerodynamic characteristics of wings with a jet flap deflected 85° and operating with momentum coefficients from 0 to 17.5. The wings were unswept rectangular NACA 0012 airfoil sections modified for jet flaps. The lift coefficients increased with end plates and aspect ratio, and a design chart for estimating jet-circulation lift for various aspect ratios is included.

NACA TN 3864

THEORETICAL CALCULATION OF THE POWER SPECTRA OF THE ROLLING AND YAWING MOMENTS ON A WING IN RANDOM TURBULENCE. John M. Eggleston and Franklin W. Diederich. December 1956. 56p. diagrs., tabs. (NACA TN 3864)

An analytical solution is derived for the power spectral density of the rolling- and yawing-moment coefficients of a wing subjected to random isotropic atmospheric turbulence. The theory considers the random variations of the turbulence in the spanwise as well as the flight-path direction. Horizontal, vertical, and side gust components are considered. Plots of the power spectra are presented.

NACA TN 3866

FATIGUE TESTS ON NOTCHED AND UNNOTCHED SHEET SPECIMENS OF 2024-T3 AND 7075-T6 ALUMINUM ALLOYS AND OF SAE 4130 STEEL WITH SPECIAL CONSIDERATION OF THE LIFE RANGE FROM 2 TO 10,000 CYCLES. Walter Illg. December 1956. 40p. diagrs., photo., tabs. (NACA TN 3866)

Fatigue tests were performed on notched and unnotched fatigue specimens made of 2024-T3 and 7075-T6 aluminum alloys and of SAE 4130 steel. The notched specimens had theoretical stress-concentration factors of 2.0 and 4.0 and the mean loads were 0 and 20 or 50 ksi. It was found that repeated applications of stresses in the vicinity of the ultimate strength on notched and unnotched specimens produced failures in a much smaller number of cycles than might be inferred from previously published data. Ratios of fatigue strengths of unnotched specimens to those of notched specimens are given.

NACA TN 3872

EXPERIMENTAL DETERMINATION OF THE RANGE OF APPLICABILITY OF THE TRANSONIC AREA RULE FOR WINGS OF TRIANGULAR PLAN FORM. William A. Page. December 1956. 22p. diagrs., photos. (NACA TN 3872)

Further knowledge regarding the range of applicability of the transonic area rule has been gained by the results of an experimental investigation at transonic speeds of the zero-lift drag rise of a family of related wings of triangular plan form in combination with a cylindrical body.

NACA TN 3874

EXPERIMENTAL AND PREDICTED LATERAL-DIRECTIONAL DYNAMIC-RESPONSE CHARACTERISTICS OF A LARGE FLEXIBLE 35° SWEPT-WING AIRPLANE AT AN ALTITUDE OF 35,000 FEET. Stuart C. Brown and Euclid C. Holleman. December 1956. 74p. diagrs., photo., tabs. (NACA TN 3874)

Lateral-directional dynamic-response characteristics of a large flexible 35° swept-wing airplane at an altitude of 35,000 feet are presented. Frequency responses, transfer functions, and stability derivatives are evaluated from transient responses obtained from abrupt aileron or rudder inputs. The measured dynamic responses are compared with predicted responses for the airplane treated as both rigid and flexible.

NACA TN 3875

THE SIMILARITY RULES FOR SECOND-ORDER SUBSONIC AND SUPERSONIC FLOW. Milton D. Van Dyke. January 1957. 20p. diagrs. (NACA TN 3875)

The similarity rules for linearized compressible flow theory (Göthert's rule and its supersonic counterpart) are extended to second order. It is shown that any second-order subsonic flow can be related to "nearly incompressible" flow past the same body, which can be calculated by the Janzen-Rayleigh method.

CURRENT NACA RESEARCH REPORTS

NACA TN 3889

PRESSURE LOSSES OF TITANIA AND MAGNESIUM SLURRIES IN PIPES AND PIPELINE TRANSITIONS. Ruth N. Weltmann and Thomas A. Keller. January 1957. 22p. diagrs., photo., tab. (NACA TN 3889)

Experimental and calculated pressure losses are presented for Newtonian fluids and non-Newtonian slurries for laminar, transitional, and turbulent flow in straight pipelines and pipe transitions such as valves, 90° elbows, contractions, and expansions. Transition loss coefficients, which are independent of the flow rate in the pipeline even in laminar flow, were determined for these transitions. It was found that the transition loss coefficients for Newtonian fluids can be used in the calculations for the design of a pipeline system for the non-Newtonian slurries studied.

NACA TN 3890

ON POSSIBLE SIMILARITY SOLUTIONS FOR THREE-DIMENSIONAL INCOMPRESSIBLE LAMINAR BOUNDARY LAYERS. III - SIMILARITY WITH RESPECT TO STATIONARY POLAR COORDINATES FOR SMALL ANGLE VARIATION. Howard Z. Herzig and Arthur G. Hansen. January 1957. 36p. diagrs., photos., tab. (NACA TN 3890)

Approximate solutions are obtained describing mainstream flows confined to regions of small angle variation over flat surfaces for three-dimensional, laminar, incompressible, thin boundary-layer flows having similarity with respect to stationary polar coordinate systems. The solutions, summarized in a table, include accelerating or decelerating flows and stagnation-point, spiral, or circular flows. An experimental comparison of limiting overturning at the wall showed good agreement for the first 10° turning of circular mainstream flow.

NACA TN 3892

PERFORMANCE OF 110-MILLIMETER-BORE M-1 TOOL STEEL BALL BEARINGS AT HIGH SPEEDS, LOADS, AND TEMPERATURES. William J. Anderson. January 1957. 38p. diagrs., photos., tabs. (NACA TN 3892)

Eleven bearings lubricated with a synthetic of the diester type were run at speeds to 14,000 rpm and bearing temperatures to 678° F. Eight bearings failed in fatigue indicating that the fatigue life of M-1 bearings might be much shorter than the life (based on catalog ratings) of SAE 52100 bearings lubricated with mineral oil. Iron-silicon bronze and silver-plated iron-silicon bronze cages showed negligible wear, but the silver plate showed some tendency to blister and peel. Cast inconel coated with nickel oxide was not a satisfactory cage material at these temperatures and speeds.

NACA TN 3893

THEORY AND DESIGN OF A PNEUMATIC TEMPERATURE PROBE AND EXPERIMENTAL RESULTS OBTAINED IN A HIGH-TEMPERATURE GAS STREAM. Frederick S. Simmons and George E. Glawe. January 1957. 41p. diagrs., photo. (NACA TN 3893)

The basic theory of pneumatic temperature probes and deviations from this basic theory in practical application are presented. Design requirements and operating considerations are discussed. Temperatures between 1600° and 4000° R were measured with an experimental probe in hydrocarbon combustion exhaust gases and compared with those measured by thermocouples and a line-reversal pyrometer. Reasonable agreement among the instruments was obtained.

NACA TN 3895

OBLIQUE-SHOCK RELATIONS AT HYPERSONIC SPEEDS FOR AIR IN CHEMICAL EQUILIBRIUM. W. E. Moeckel. January 1957. 18p. diagrs., tab. (NACA TN 3895)

Oblique-shock relations for air in chemical equilibrium have been calculated for flight velocities up to 25,000 feet per second at altitudes up to 200,000 feet. Results show that those shock parameters which are functions only of Mach number normal to the shock for an ideal gas are strongly influenced by flight altitude (initial conditions), as well as normal Mach number, when dissociation takes place.

NACA TN 3896

SUBSONIC WIND-TUNNEL INVESTIGATION OF THE EFFECT OF FUSELAGE AFTERBODY ON DIRECTIONAL STABILITY OF WING-FUSELAGE COMBINATIONS AT HIGH ANGLES OF ATTACK. Edward C. Polhamus and Kenneth P. Spreemann. December 1956. 25p. diagrs., photo., tab. (NACA TN 3896)

A wind-tunnel study of the directional stability characteristics at high angles of attack of two wing-fuselage combinations has been conducted at subsonic speeds. The wings utilized were a 4-percent-thick unswept wing of aspect ratio 3.0 and a 6-percent-thick 45° sweptback wing of aspect ratio 4. The results indicated very large differences in the directional stability between the two wing-fuselage configurations at high angles of attack. Tests with the fuselage afterbody removed indicated that these effects were associated with wing induced sidewash over the fuselage afterbody.

CURRENT NACA RESEARCH REPORTS

NACA TN 3897

INCOMPLETE TIME RESPONSE TO A UNIT IMPULSE AND ITS APPLICATION TO LIGHTLY DAMPED LINEAR SYSTEMS. James J. Donegan and Carl R. Huss. December 1956. 17p. diagrs. (NACA TN 3897)

A study is made of the use of the incomplete time response to a unit impulse as a device to analyze lightly damped linear systems. The results indicate that such a system can be adequately described by an incomplete time response to a unit impulse which is computed from the incomplete-output time history (without the addition of an estimated end correction) and the complete-input time history. The incomplete response to a unit impulse may be used with Duhamel's integral to predict the response of the system to an arbitrary input up to at least 90 percent of the cutoff time of the incomplete-output time response.

NACA TN 3898

WIND-TUNNEL INVESTIGATION OF AN EXTERNAL-FLOW JET-AUGMENTED SLOTTED FLAP SUITABLE FOR APPLICATION TO AIRPLANES WITH POD-MOUNTED JET ENGINES. John P. Campbell and Joseph L. Johnson, Jr. December 1956. 47p. diagrs., tab. (NACA TN 3898)

A wind-tunnel investigation has been carried out to determine the characteristics of an external-flow jet-augmented slotted flap which appears suitable for application to airplanes with pod-mounted jet engines. The investigation included tests of an aspect-ratio-6 unswept wing and of a model of a swept-wing jet transport or bomber over a momentum coefficient range up to about 8. The jet transport or bomber model had a 30° sweptback wing with an aspect ratio of 6.62.

NACA TN 3899

EFFECTS OF WING POSITION AND VERTICAL-TAIL CONFIGURATION ON STABILITY AND CONTROL CHARACTERISTICS OF A JET-POWERED DELTA-WING VERTICALLY RISING AIRPLANE MODEL. Powell M. Lovell, Jr., and Lysle P. Parlett. January 1957. 35p. diagrs., photos., tab. (NACA TN 3899)

The results of a flight- and force-test investigation to determine the effects of wing position and vertical-tail configuration on the stability and control characteristics of a jet-powered delta-wing vertically rising airplane model are presented. The model had conventional flap-type controls in addition to jet-reaction controls. The effects of various artificial stabilizing devices were determined.

NACA TN 3901

SHEAR STRENGTH AT 75° F TO 500° F OF FOURTEEN ADHESIVES USED TO BOND A GLASS-FABRIC-REINFORCED PHENOLIC RESIN LAMINATE TO STEEL. John R. Davidson. December 1956. 21p. diagrs., photo., tab. (NACA TN 3901)

Fourteen adhesives used to bond a glass-fabric-reinforced phenolic resin laminate to steel were tested in order to determine their shear strengths at temperatures from 75° F to 500° F. Fabrication methods were varied to evaluate the effect of placing cloth between the faying surfaces to maintain a uniform bond-line thickness. One glass-fabric supported phenolic adhesive was found to have a shear strength of 3,400 psi at 300° F and over 1,000 psi at 500° F. Strength and fabrication data are tabulated for all adhesives tested.

NACA TN 3902

RESULTS OF TWO FREE-FALL EXPERIMENTS ON FLUTTER OF THIN UNSWEPT WINGS IN THE TRANSONIC SPEED RANGE. William T. Lauten, Jr., and Herbert C. Nelson. January 1957. 20p. diagrs., photo., tabs. (NACA TN 3902. Supersedes RM L51C08)

Results of four thin, unswept, flutter airfoils attached to two freely falling bodies are reported. Two airfoils fluttered at a Mach number of 0.85, a third airfoil fluttered at a Mach number of 1.03, and a fourth fluttered at a Mach number of 1.07. Results of calculations of flutter speed using incompressible and compressible air-force coefficients, including a Mach number of 1.0, are presented.

NACA TN 3904

INVESTIGATION OF THE EFFECTIVENESS OF BOUNDARY-LAYER CONTROL BY BLOWING OVER A COMBINATION OF SLIDING AND PLAIN FLAPS IN DEFLECTING A PROPELLER SLIPSTREAM DOWNWARD FOR VERTICAL TAKE-OFF. Kenneth P. Spreemann and Richard E. Kuhn. December 1956. 44p. diagrs., photo. (NACA TN 3904)

An investigation was conducted in order to determine the effectiveness of blowing a jet of air over the flaps of a wing equipped with a 50-percent-chord sliding flap and a 25-percent-chord plain flap in deflecting a propeller slipstream downward for vertical take-off and the results are presented herein. The effects of a leading-edge slat, ground proximity, end plate, and propeller position were also investigated. The tests were conducted in a static-thrust facility at the Langley Aeronautical Laboratory.

CURRENT NACA RESEARCH REPORTS

NACA TN 3907

SIMILITUDE RELATIONS FOR FREE-MODEL WIND-TUNNEL STUDIES OF STORE-DROPPING PROBLEMS. Carl A. Sandahl and Maxime A. Faget. January 1957. 26p. diagrs., photos., tab. (NACA TN 3907)

Two methods, in which the model and prototype Mach numbers are assumed equal and the Reynolds number effects are assumed negligible, are presented for scaling store models for wind-tunnel store-dropping studies. The light-model method gives exact simulation except that vertical displacements are deficient; this deficiency is reduced as the ejection velocity is increased, or it may be eliminated by accelerating the parent model upward. The heavy-model method gives complete simulation of the store motions except that the short-period oscillation is too poorly damped; this defect is inconsequential during the first phase of a drop. A brief description of the method of conducting store-dropping tests in the preflight jet of the Langley Pilotless Aircraft Research Station at Wallops Island, Va., is given.

NACA TN 3911

A METHOD FOR PREDICTING LIFT INCREMENTS DUE TO FLAP DEFLECTION AT LOW ANGLES OF ATTACK IN INCOMPRESSIBLE FLOW. John G. Lowry and Edward C. Polhamus. January 1957. 29p. diagrs. (NACA TN 3911)

A method is presented for estimating the lift due to flap deflection at low angles of attack in incompressible flow. In this method provision is made for the use of incremental section-lift data for estimating the effectiveness of high-lift flaps. The method is applicable to swept wings of any aspect ratio or taper ratio. The present method differs from other current methods mainly in its ease of application and its more general application. Also included is a simplified method of estimating the lift-curve slope throughout the subsonic speed range.

NACA TN 3915

FLIGHT INVESTIGATION OF A ROLL-STABILIZED MISSILE CONFIGURATION AT VARYING ANGLES OF ATTACK AT MACH NUMBERS BETWEEN 0.8 AND 1.79. Jacob Zarovsky and Robert A. Gardiner. January 1957. 36p. diagrs., photos., tab. (NACA TN 3915. Supersedes RM L50H21)

A missile research model was flown at supersonic speed to determine the quality of automatic roll stabilization at varying angles of attack. Aerodynamic rolling and pitching derivatives were determined from the flight record. It was concluded that the combination of the gyro-actuated automatic pilot with wing-tip ailerons provided adequate roll stabilization under conditions encountered in flight.

NACA TN 3922

ANALYTICAL INVESTIGATION OF THE EFFECT OF WATER INJECTION ON SUPERSONIC TURBOJET-ENGINE - INLET MATCHING AND THRUST AUGMENTATION. Andrew Beke. January 1957. 25p. diagrs. (NACA TN 3922)

Evaporation cooling by water injection in the subsonic diffuser was investigated. Results indicate that fixed-geometry inlets spilling 50 percent of engine airflow without water injection can be matched with water injection without spillage and with 56 percent higher thrusts than for a variable inlet. Liquid impulses with injection were lower than for a bypass inlet but were about equal to a fixed inlet. Maximum liquid consumption at Mach 2.0 was over twice that of the bypass but was only 56 percent greater at the same thrust levels. Diffuser cooling increased top flight speed from Mach 2.0 to 2.6, while cruise altitudes of vehicles without injection could be increased from 55,000 to 67,000 feet.

NACA TN 3941

COMPARISON OF CALCULATED AND EXPERIMENTAL LOAD DISTRIBUTIONS ON THIN WINGS AT HIGH SUBSONIC AND SONIC SPEEDS. John L. Crigler. January 1957. 46p. diagrs., tab. (NACA TN 3941)

A method for calculating the aerodynamic loading on a wing in combination with a body is presented. Calculated results are compared with experimentally measured data for two wing-body configurations throughout a range of Mach number up to 1.0. The magnitude and the distribution of spanwise loading of the calculated data are generally in good agreement with the experimental data.

BRITISH REPORTS

N-46934*

Royal Aircraft Establishment (Gt. Brit.)
A COLLECTION OF LONGITUDINAL STABILITY DERIVATIVES OF WINGS AT SUPERSONIC SPEEDS. A. Naysmith. June 1956. 47p. diagrs., tab. (RAE Tech.Note Aero 2423)

A collection has been made of theoretical data, for wings alone, on those stability derivatives that govern the short-period oscillation of aircraft traveling at supersonic speeds. All the derivatives available have been obtained by means of the linear theory, and so the information given is subject to the usual limitations. The information has been presented in what is hoped is the most convenient form to show its extent, and to expose the parts of the field where experimental investigation is most needed.

BRITISH REPORTS

N-46935*

Royal Aircraft Establishment (Gt. Brit.)
THERMAL DEGRADATION OF CERTAIN POLYMERS UNDER OXIDATIVE CONDITIONS. D. B. V. Parker. August 1956. 22p. diagrs., tab. (RAE Tech.Note Chem.1284)

The rate of loss of weight of a powdered polymer when heated in air was taken as an inverse measure of thermal stability under oxidative conditions. A series of hydrocarbon polymers containing benzene nuclei formed from a homologous series of monomers has been prepared by Wurtz and Friedel-Crafts reactions, and results indicate that thermal stability diminishes as the series is ascended. A number of other polymers and plastic materials has been examined using the same technique.

N-46936*

Royal Aircraft Establishment (Gt. Brit.)
A COMPARISON OF THE FATIGUE PROPERTIES OF THE HIGH-STRENGTH ALUMINUM-COPPER-ZINC ALLOYS WITH THE ALUMINUM-COPPER DURALUMIN TYPE ALLOYS. R. G. Ward. April 1956. 27p. diagrs., tabs. (RAE Tech.Note Met.244)

Using data from British and American sources for round specimens in reversed bending, an attempt is made to compare the fatigue properties of the complex zinc-bearing aluminum alloys as typified by DTD 363, DTD 683, and 75S, and the simple aluminum-copper alloys such as DTD 150, DTD 364, and 14S. Under all conditions of testing the performance of the high-strength alloys, if judged by the ratio of alternating stress/U.T.S., is inferior to that of the older aluminum-copper alloys, and it is emphasized that designing to static-strength requirements would result in a lower fatigue life for structures of the high-strength alloys.

N-46937*

Royal Aircraft Establishment (Gt. Brit.)
SOME OBSERVATIONS ON CORROSION AND THE FATIGUE TESTING OF AIRCRAFT IN WATER TANKS. N. J. Wadsworth. August 1956. 10p. diagrs. (RAE Tech.Note Met.246)

The corrosive effects of water upon fatigue life of pressure cabins when tested in water, and corresponding effects in service are reviewed. It is concluded that fatigue life is reduced by mild forms of corrosion in both cases. It is suggested that until more is known auxiliary tests should be made during all tank tests of airplanes, and that all parts of the tank should be painted. It is considered that, while local corrosive effects in the tank may have to be tolerated, measures should be taken to prevent corrosion on an extended scale.

N-46938*

Royal Aircraft Establishment (Gt. Brit.)
THE COMPRESSION STRENGTH OF STEEL SHEET MATERIALS TO SPECIFICATIONS D.T.D.124A AND D.T.D.138A. A. G. Cole. August 1956. 16p. diagrs., tabs. (RAE Tech.Note Structures 208)

The results of compression strength tests on steel sheet materials to specifications DTD 124A and DTD 138A are recorded and analyzed. Typical compression stress-strain curves and curves of tangent moduli are presented for each material.

N-46940*

Royal Aircraft Establishment (Gt. Brit.)
WIND TUNNEL TESTS ON THE EFFECT OF SPAR VARIATIONS ON THE FLUTTER OF A MODEL WING. D. R. Gaukroger. July 1956. 12p. diagrs., photo., tabs. (RAE Tech.Note Structures 203)

Results are given of wind-tunnel flutter tests to determine the effects of variations in spar structural properties in a model wing. A segmented model was built for the investigation, and the tests were made in a low-speed wind tunnel. The design of the model enabled different flexural axis positions to be obtained over the inboard and outboard portions of the wing. The spanwise stiffness distribution of the wing was also variable. Twenty-seven different spar combinations were tested, and in each condition the model was resonance tested and its flutter speed measured. It is concluded that the effect of the spar variations on flutter speed is no greater than would be expected from theoretical considerations.

N-46941*

Royal Aircraft Establishment (Gt. Brit.)
THE DEVELOPMENT OF AN IMPROVED DIFFUSER FOR THE 3 FT. x 3 FT. TUNNEL, ROYAL AIRCRAFT ESTABLISHMENT, BEDFORD. J. B. Scott-Wilson and D. I. T. P. Llewelyn-Davies. July 1956. 13p. diagrs. (RAE Tech.Note Aero 2446)

A summary is given of the significant results of diffuser development tests made in a 4-inch by 4-inch supersonic tunnel at Mach numbers from 1.4 to 2.0. The application of these results to the design of an improved first-diffuser stage for the 3-foot by 3-foot supersonic tunnel is described. The design incorporates a long single-wedge centerbody, which divides the diffuser into two approximately constant area passages. Using this improved diffuser, the pressure ratio needed to run the tunnel at its maximum Mach number of 2.0 is reduced from 2.04 to 1.76.

BRITISH REPORTS

N-46942*

Royal Aircraft Establishment (Gt. Brit.)
TURBULENCE ENCOUNTERED BY VIKING AIRCRAFT OVER EUROPE. J. R. Heath-Smith. July 1956. 16p. diagrs., tabs. (RAE Tech.Note Structures 204)

Accelerations in turbulence were recorded on B.E.A. Viking aircraft for 117,000 miles of flying over European routes during three years. The records show that the number of gusts decreases from sea level to 8000 feet. There is some evidence below 5000 feet that turbulence is greatest in spring and least in autumn. Average gust frequencies during climb and descent were twice those during cruise below 8000 feet and this is attributed to the pilot's discretion in the choice of cruising altitude.

N-46943*

Royal Aircraft Establishment (Gt. Brit.)
HALF-WAVE MAGNETIC AMPLIFIER BEHAVIOUR. J. Baranowski. May 1956. 38p. diagrs. (RAE Tech.Note EL 119)

Half-wave magnetic amplifier circuits, as proposed by C. W. Lufcy for servomotor control, are examined experimentally with a-c. input control signals. Magnetic cores of Mumetal (80 percent Ni), Permalloy F (65 percent Ni) and H.C.R. alloy (50 percent Ni) are used to establish the importance or otherwise of rectangular B-H properties. Interaction between stages in a cascade is investigated and for rectangular and nonrectangular materials it is shown that the flux reset processes differ and the quiescent triggering angles for magnetic amplifiers based on the two kinds of materials should differ accordingly. For nonrectangular hysteresis loop materials the nature of the interaction between stages results in there being advantages in 120° phase-shift of the supply voltages for cascaded stages. Use of a three-phase supply provided the desired effect without the need for special phase-shifting circuits. The improvement in gain and characteristic shape that is obtained is substantial for Mumetal and the static performance with a three-phase supply surpasses that of a rectangular loop material such as Permalloy F. The dynamic performance with Mumetal cores and a three-phase supply system remains to be examined.

N-46944*

Royal Aircraft Establishment (Gt. Brit.)
THE THERMAL DECOMPOSITION OF COMPLEX ZINC AND CADMIUM CHROMES. H. G. Cole and L. F. Le Brocq. May 1956. 4p. diagr., tab. (RAE Tech.Note Met. 242)

The thermal decomposition has been studied of four complex basic chromates; those of potassium and zinc, sodium and zinc, potassium and cadmium, and ammonium and cadmium. Two dehydrated forms of the potassium zinc compound were found, the second of which was stable to 380° C. The single dehydrated form of the potassium cadmium compound was stable to 550° C.

MISCELLANEOUS

Errata on NACA Rept. 1195. By Norris F. Dow, Charles Libove, and Ralph E. Hubka. 1954.

Errata on NACA Rept. 1263. By Richard E. Kuhn and John W. Draper. 1956.

Errata on NACA TN 3763. By Walton L. Howes and Harold R. Mull. October 1956.

N-3074, Suppl. 5

INDEX OF NACA TECHNICAL PUBLICATIONS, JUNE 1955 - JUNE 1956. viii, 222p. (NACA)

There is a classified listing of subject categories; a chronological listing of NACA publications under each subject category; an alphabetical index to the subject categories; and an author index.

N-42672

Advisory Group for Aeronautical Research and Development. ASSESSMENT OF THE AIRCRAFT FOR ITS PART IN A DEFENCE SYSTEM. R. P. Dickinson, Aeroplane and Armament Experimental Establishment. (Presented at the Eighth Meeting of the Flight Test Panel, Rome, Italy, February 20-25, 1956). February 1956. iv, 8p. diagr. (AGARD Report 32)

This report discusses the relative importance of the various aspects of behavior of the interceptor fighter aircraft in relation to its part in the overall defense system. Features governing the success of the aircraft in using its weapons effectively are discussed.

N-43735

Advisory Group for Aeronautical Research and Development. DETERMINATION OF INFLUENCE COEFFICIENTS. S. Levy, General Electric Company. (Presented at the Third Meeting of the Structures and Materials Panel, Washington, April 10-17, 1956). February 1956. iii, 5p. (AGARD Report 41)

The method of consistent deformations for determining influence coefficients of delta wings is reviewed. A discussion is given of computational difficulties which may arise in applying this method. A review is given of strain energy and differential-equation methods for computing influence coefficients.

MISCELLANEOUS

N-43739

Advisory Group for Aeronautical Research and Development. AUTOMATIC INDICATING AND RECORDING DATA SYSTEMS FOR WIND TUNNELS. J. B. D'Andrea, Wright Air Development Center. (Presented at the Eighth Meeting of the Wind Tunnel and Model Testing Panel, Rome, Italy, February 20-25, 1956). February 1956. v, 39p. diagrs., photos. (AGARD Report 16)

Describes the more simple and relatively less expensive systems for the rapid and accurate recording of raw data in tabulated, punched card, and/or tape, and plotted form. A particular system described is that used in the 10-foot transonic wind tunnel at the Wright Air Development Center, and a review is included of other types of instrumentation and recording equipment that could be similarly used.

UNPUBLISHED PAPERS

N-16321*

THEORETICAL STUDY OF AUTOMATIC FLIGHT CONTROL OF AIRCRAFT. (Étude Théorique du Pilotage Automatique des Avions). F. Haus. August 1956. 359p. diagrs. (Translation from Société Royale Belge des Ingénieurs et des Industriels, Memoire, Ser. B, no. 1, 1950)

Chapters on: Kinematics of the airplane, Utilization of dimensionless factors, Effects of the pilot, Effect of controls on conditions of equilibrium, Longitudinal motion, Linearization of equations of lateral motion, Lateral motion, Experimental results, Motions when aerodynamic actions depend on derivatives, Effect of continuous displacement of a control, The automatic pilot, The airplane and automatic servocontrol, Effect of automatic pilot on longitudinal motion, Effect of automatic pilot on lateral motion, Automatic pilot as a function of the integral of the perturbations, Applications of symbolic calculus to the preceding problems, Frequency response, Combination of several oscillating systems by the method of frequency response.

N-49282*

Battelle Memorial Institute.
A STUDY OF HYDROGEN EMBRITTLEMENT OF IRON BY INTERNAL-FRICTION AND X-RAY METHODS. R. E. Maringer, L. L. Marsh, and G. K. Manning. June 30, 1956. 76p. diagrs., photos., tab. (Battelle Memorial Inst.)

The effects of hydrogen introduced into high-purity iron and tempered 4340 steel by electrolysis on the internal friction at temperatures from -196° to 420° C were studied. The grain size of some of the iron specimens was coarsened to give essentially single crystals; certain of these single-crystal specimens were further purified by wet-hydrogen treatment before testing. The location and magnitude of the internal friction peaks, both before and after charging, are shown. Results are rationalized in terms of dislocation theory. Diffusion rates of hydrogen, calculated from peaks attributed to hydrogen, are compared with previously reported values. Photomicrographs showing damage resulting from hydrogen charging are included.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification January 10, 1957.

NACA RM A51J19

EXPERIMENTAL AND THEORETICAL STUDY OF FACTORS INFLUENCING THE LONGITUDINAL STABILITY OF AN AIR-TO-AIR MISSILE AT A MACH NUMBER OF 1.4. S. Sherman Edwards. January 1952. 51p. diagrs., photo., tabs. (NACA RM A51J19)

Approximate methods of analysis are applied to the estimation of the normal force and pitching moment of the body and the wing-body and tail-body combinations of an air-to-air missile and to the estimation of the same characteristics of the complete configuration. The results of the calculations are compared with experimentally determined normal force and pitching moments for the missile model obtained at a Mach number of 1.4, at a Reynolds number of 1.26 million, based on the mean aerodynamic chord of the wing. The experimental data and the results of the calculations are presented for a range of angle of attack from 0° to 22°, for angles of bank of 0°, 22-1/2°, and 45°.

NACA RM A51L21

A COMPARISON OF THE CHORDWISE PRESSURE DISTRIBUTION AND SPANWISE DISTRIBUTION OF LOADING AT SUBSONIC SPEEDS ON TWO TRIANGULAR WINGS OF ASPECT RATIO 2 HAVING NACA 0005 AND 0008 SECTIONS. Donald W. Smith and Verlin D. Reed. May 1952. 142p. diagrs., photo., tabs. (NACA RM A51L21)

Measurements of the distribution of surface pressures were made on two wing-body combinations employing a triangular wing having an aspect ratio of 2. The first of these combinations had a wing with the NACA 0008-63 section parallel to the airstream while the wing of the second had the NACA 0005-63 section in the stream direction. The measurements were made for Mach numbers from 0.11 to 0.95 at a constant Reynolds number of 3.0 million. Data were also obtained for Reynolds numbers up to 15.0 million at the lower Mach numbers. A summary of data obtained from previously published force tests of these same models is also included for completeness of the presentation of the effect of wing thickness.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM A52I23

INSTRUMENTATION AND CALIBRATION OF TECHNIQUE FOR FLIGHT CALIBRATION OF ANGLE-OF-ATTACK SYSTEMS ON AIRCRAFT. Norman M. McFadden, George R. Holden, and Jack W. Ratcliff. December 1952. 30p. diagrs., photos., tabs. (NACA RM A52I23)

The instrumentation and calibration technique used to determine the position error of angle-of-attack detectors mounted on the forward fuselage of a 35° swept-wing fighter airplane are presented. Corrections are applied to the indications of the reference angle-of-attack vanes for vane floating angle, upwash around the boom, and bending of the boom. The position error due to interference effects of wing and fuselage were measured and found to be negligibly small at the location of the most forward vane.

NACA RM A53L15

THE EFFECTS OF HORIZONTAL-TAIL LOCATION AND SIZE ON THE SUBSONIC LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF AN AIRPLANE MODEL HAVING A TRIANGULAR WING OF ASPECT RATIO 3. Bruce E. Tinling and Armando E. Lopez. March 1954. 85p. diagrs., photo., tabs. (NACA RM A53L15)

Wind-tunnel tests were conducted to evaluate the effects of horizontal-tail location and size on the longitudinal aerodynamic characteristics of an airplane model having a thin triangular wing of aspect ratio 3. The model was tested with horizontal tails, which had areas of either 16.7 or 21.9 percent of the wing area, placed -0.10, 0, 0.10, or 0.20 wing semispan above the wing chord plane, and either 1.2 or 1.5 mean aerodynamic chord behind the moment center. The horizontal tails had aspect ratios of 4 and no sweepback of the 50-percent-chord lines. The tests were conducted at a Reynolds number of 2.5 million at Mach numbers from 0.25 to 0.95.

NACA RM A54L07

THE EFFECTS OF TRAILING-EDGE FLAPS ON THE SUBSONIC AERODYNAMIC CHARACTERISTICS OF AN AIRPLANE MODEL HAVING A TRIANGULAR WING OF ASPECT RATIO 3. Bruce E. Tinling and A. V. Karpen. January 1955. 37p. diagrs., photos., tabs. (NACA RM A54L07)

Wind-tunnel tests were conducted to find the effects of single-slotted flaps on the longitudinal stability at low speed, the rolling effectiveness of trailing-edge ailerons and of differential deflection of the horizontal tail when the flaps were deflected 40°, and the effect of small deflections of the flaps on the lift-drag ratio at Mach numbers up to 0.95.

NACA RM A54L22

THE EFFECT OF A 4-PERCENT-HIGH SPOILER ON BUFFETING FORCES ON AN NACA $65_{(06)}$A004 TWO-DIMENSIONAL AIRFOIL AT SUBSONIC MACH NUMBERS. Jack A. Mellenthin. March 1955. 14p. diagrs., photos., tab. (NACA RM A54L22)

An investigation was conducted in the two-dimensional channel of the Ames 16-foot high-speed wind tunnel to determine the effects on buffeting of a solid-strip spoiler on an airfoil model having the NACA $65_{(06)}$A004 section. The spoiler protruded into the airstream a height equal to 0.04 of the airfoil chord and was mounted at the 0.70-chord station. Data are presented over a Mach number range from 0.30 to 0.64 and a Reynolds number range from about 4.0 million to 7.0 million.

NACA RM A55F02

THEORETICAL INVESTIGATION OF THE EFFECTS OF CONFIGURATION CHANGES ON THE CENTER-OF-PRESSURE SHIFT OF A BODY-WING-TAIL COMBINATION DUE TO ANGLE OF ATTACK AND MACH NUMBER AT TRANSONIC AND SUPERSONIC SPEEDS. J. Richard Spahr. September 1955. 43p. diagrs. (NACA RM A55F02)

A theoretical investigation was made to determine the effects of systematic configuration changes on the center-of-pressure shift of an unbanked canard missile configuration having coplanar triangular-wing and -tail surfaces due to angle of attack and Mach number in the transonic and supersonic ranges. The following geometric variables were investigated independently of the others: ratio of wing semispan to tail semispan, ratio of body radius to wing semispan, ratio of tail length to body length, wing aspect ratio, tail aspect ratio, wing taper ratio, tail taper ratio, wing sweep, tail sweep, ratio of tail height to body radius, and wing-tail interdigitation.

NACA RM A55L08

A THEORETICAL STUDY OF THE LIFTING EFFICIENCY AT SUPERSONIC SPEEDS OF WINGS UTILIZING INDIRECT LIFT INDUCED BY VERTICAL SURFACES. Vernon J. Rossow. March 1956. ii, 59p. diagrs. (NACA RM A55L08)

Pressure fields induced by the fuselage or wing end plates which produce indirect lift on the wing are studied by analyzing models of special design. Although specific optimum shapes are not derived, several airfoil systems studied are more efficient than that theoretically possible with planar wings. It is concluded that the lifting efficiency of planar wings could, in certain cases, be increased by employing the fuselage shape and/or vertical surfaces to induce interference or indirect lift.

#NACA RM E51L05, by Braithwaite and Renas

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM E52A31

SOME EFFECTS OF CHANGING SOLIDITY BY VARYING THE NUMBER OF BLADES ON PERFORMANCE OF AN AXIAL-FLOW COMPRESSOR STAGE. Raymond M. Standahar and George K. Serovy. April 1952. 46p. diagrs., photos., tabs. (NACA RM E52A31)

An investigation was conducted to determine some of the basic problems and effects involved in a change of solidity accomplished by a change in the number of blades in an axial-flow compressor rotor row and in a complete stage. Rotor data for a range of weight flows at each of five equivalent tip speeds from 669 to 962 feet per second indicated that peak pressure ratio for a given speed was higher and was obtained at a lower weight flow as solidity was increased. The peak efficiencies for the three rotor solidities investigated were nearly equal at a given speed and occurred at lower weight flows as solidity was increased. Complete stage data showed that the high-loss region near the hub behind the low-solidity stator blades was reduced by increasing the stator solidity.

NACA RM E52L18a

FORCE AND PRESSURE-RECOVERY CHARACTERISTICS AT SUPERSONIC SPEEDS OF A CONICAL NOSE INLET WITH BYPASSES DISCHARGING OUTWARD FROM THE BODY AXIS. Andrew Beke and J. L. Allen. March 1953. 20p. diagrs., photo., tab. (NACA RM E52L18a)

Aerodynamic and performance characteristics of a conical spike nacelle-type inlet with two bypasses are presented at Mach numbers of 1.6, 1.8, and 2.0 for angles of attack up to 9°. The bypasses were located 6 inlet diameters downstream of the inlet and were designed to discharge the bypass mass flow outward from the body axis. The inlet was designed to attain a mass-flow ratio of unity at a Mach number of 2.0. It is shown that discharging the bypass mass flow outward from the body nearly doubles the critical drag of a similar configuration but with bypass discharge in an axial direction. As a result of this greater drag, the net force on the model in the flight direction is reduced when comparison is made with the axial discharge case. The lift and pitching-moment coefficients are slightly higher that those for a configuration without bypasses. Approximately 25 percent of the maximum inlet mass flow was discharged through the bypasses, and the pressure-recovery and mass-flow characteristics were in qualitative and quantitative agreement with the results of an investigation of a similar configuration with axial discharge.

#NACA RM E53L11, by Braithwaite and Sivo

NACA RM E53L17a

ROTATING STALL INVESTIGATION OF 0.72 HUB-TIP RATIO SINGLE-STAGE COMPRESSOR. Robert W. Graham and Vasily D. Prian. March 1954. 21p. diagrs., photos., tabs. (NACA RM E53L17a)

The rotating stall characteristics of a 0.72 hub-tip ratio, single-stage compressor were investigated. The stage was a 14-inch-diameter replica of the fourth stage of an experimental multistage compressor. No similarity existed between the frequency and propagation rate of the stall patterns observed in the single-stage replica and those observed in the multistage compressor after the fourth stage. A fatigue failure of the rotor blades occurred during the testing which was attributed to a resonance between the stall frequency and the natural bending frequency of the blades.

NACA RM E53L24a

EFFECT OF PROPERTIES OF PRIMARY FLUID ON PERFORMANCE OF CYLINDRICAL SHROUD EJECTORS. Fred D. Kochendorfer. March 1954. 32p. diagrs. (NACA RM E53L24a)

The effects of the properties of the primary fluid on ejector performance are examined both theoretically and experimentally. Experimental effects are determined by comparing the results obtained for a carbon dioxide primary with those obtained from previous tests with air. Comparisons are made for a series of cylindrical shroud ejectors having diameter ratios varying from 1.1 to 1.6, shroud lengths up to 1.0 primary diameter, and weight-flow ratios up to 0.13. At primary pressure ratios for which the shroud is choked, density changes can be compensated by use of a weight-flow parameter equal to the weight-flow ratio multiplied by the square foot of the temperature ratio and divided by the square root of the molecular weight ratio. The effect of specific heat ratio appears to be small, a change from 1.4 to 1.3 decreasing the weight-flow parameter by an amount which averaged about 0.005. A theoretical analysis is also included to show that the effects of heat transfer between the primary and secondary streams can be large.

NACA RM E54L20

EFFECTS OF TURBINE COOLING WITH COMPRESSOR AIR BLEED ON GAS-TURBINE ENGINE PERFORMANCE. Jack B. Esgar and Robert R. Ziemer. March 1955. 45p. diagrs. (NACA RM E54L20)

Performance variations resulting from cooling-air bleed for a wide range of engine operating conditions for turboprop engines and for both afterburning and nonafterburning turbojet engines were analytically investigated. The effects of compressor bleed for turbine cooling are of such small magnitude that the beneficial effects of high-temperature operation are not materially affected.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM E54L29a

AN EVALUATION OF ELECTROPOLISHED AND NONELECTROPOLISHED BLADES OF ALLOYS REFRACTALOY 26, M-252, AND WASPALOY IN A J33-9 TURBOJET ENGINE. F. J. Clauss, R. A. Signorelli, and J. R. Johnston. June 1955. 27p. diagrs., photos., tabs. (NACA RM E54L29a)

Electropolished and nonelectropolished blades of alloys Refractaloy 26, M-252, and Waspaloy were evaluated in a J33-9 turbojet engine to determine if blade performance is improved by removal of the surface by electropolishing and to compare the blade performance of the alloys with S-816. The results obtained indicated that blade performance was not improved by electropolishing. The blade performance of Waspaloy was about equal to S-816, while that of M-252 and Refractaloy 26 was less.

NACA RM E55H15

A METHOD FOR DETERMINING THE COMPOSITION OF METHANOL - TRIMETHYL BORATE MIXTURES. Samuel Kaye and Frank Sordyl. November 1955. 11p. diagrs., tabs. (NACA RM E55H15)

A study of mixtures of pure methanol and trimethyl borate showed that the composition can be accurately obtained by a simple density determination. The refractive-index determination gives the composition with much less accuracy. The potentiometric titration of boric acid is also discussed.

NACA RM E56I19

PRELIMINARY INVESTIGATION OF GUY ALLOY AS A TURBOJET-ENGINE BUCKET MATERIAL FOR USE AT 1650° F. R. A. Signorelli, J. R. Johnston, and J. W. Weeton. November 1956. 22p. diagrs., photos., tab. (NACA RM E56I19)

As-cast buckets of Guy alloy, a cast nickel-base material, were run in a J33-9 turbojet engine for cycles of 15 minutes at rated speed and 5 minutes at idle speed. Stress rupture, impact, and engine-performance data indicate that Guy alloy may be considered for bucket use at a temperature of 1650° F. Ductility and impact strength of Guy alloy is limited but appears to be adequate for bucket applications.

NACA RM H54G16

A FLIGHT EVALUATION OF THE STABILITY AND CONTROL OF THE X-4 SWEPT-WING SEMITAILLESS AIRPLANE. Melvin Sadoff and A. Scott Crossfield. August 1954. 48p. diagrs., photos., tab. (NACA RM H54G16)

A flight evaluation of the handling qualities of the swept-wing semitailless X-4 airplane was made. Static and dynamic stability and control investigation covered a speed range from stall to Mach numbers of 0.92. Typical swept-wing instability at moderate lifts was encountered. Unsatisfactory and dangerous self-excited dynamic motions occurred at the high-speed end of the range investigated.

NACA RM H54J25a

FLIGHT MEASUREMENTS OF ELEVON HINGE MOMENTS ON THE XF-92A DELTA-WING AIRPLANE. Clinton T. Johnson and Albert E. Kuhl. January 1955. 26p. diagrs., photos., tab. (NACA RM H54J25a)

Elevon hinge-moment measurements were made during flight tests of the Convair XF-92A delta-wing airplane over the Mach number range from 0.70 to 0.95. Hinge moments were measured during longitudinal elevon pulses, aileron rolls, and windup turns. Data are presented giving the variation of C_{h_δ} and C_{h_α} as determined from these tests.

NACA RM H54K03

THE EFFECT OF BLUNT-TRAILING-EDGE ELEVONS ON THE LONGITUDINAL AND LATERAL HANDLING QUALITIES OF THE X-4 SEMITAILLESS AIRPLANE. Edwin J. Saltzman. January 1955. 29p. diagrs., photos., tab. (NACA RM H54K03)

The effects of thickening the trailing edges of the elevons on the static longitudinal stability and control, and lateral control for the X-4, a swept-wing semitailless airplane are presented. The results of this study are compared with similar tests for the X-4 with conventional elevon trailing edges.

NACA RM H54L03

FLIGHT MEASUREMENTS AT TRANSONIC SPEEDS OF THE BUFFETING CHARACTERISTICS OF THE XF-92A DELTA-WING RESEARCH AIRPLANE. Thomas F. Baker and Wallace E. Johnson. April 1955. 32p. diagrs., photos., tab. (NACA RM H54L03)

Measurements were made on the XF-92A delta-wing airplane of buffet-induced fluctuations in normal acceleration at the airplane center of gravity and of fluctuations in wing structural shear load in the Mach number range from 0.6 to 0.96 at altitudes from 25,000 to 38,000 feet. Airplane normal-force coefficients on the order of 0.7 were attained at Mach numbers less than 0.9. Buffet frequencies and the variations with Mach number, lift, and angle of attack of buffet intensity are given.

NACA RM H55D12

FLIGHT MEASUREMENTS OF WING LOADS ON THE CONVAIR XF-92A DELTA-WING AIRPLANE. Albert E. Kuhl and Clinton T. Johnson. May 1955. 37p. diagrs., photos., tab. (NACA RM H55D12)

Aerodynamic loads were obtained from strain-gage measurements during the NACA flight test program of the XF-92A research airplane. Wing-panel loads were measured during longitudinal pulses and windup turns over the Mach number range from 0.43 to 0.95. The wing-panel loads due to elevon deflection and angle of attack were determined for the Mach number range of these tests.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM H55H25

FLIGHT MEASUREMENTS OF THE VERTICAL-TAIL LOADS ON THE CONVAIR XF-92A DELTA-WING AIRPLANE. Clinton T. Johnson. October 1955. 23p. diagrs., photos., tab. (NACA RM H55H25)

Vertical-tail loads as obtained from strain-gage measurements during the NACA flight test program of the Convair XF-92A research airplane were measured during rudder pulses, rudder-fixed oscillations, and gradually increasing sideslips over the Mach number range from 0.50 to 0.87. The vertical-tail loads resulting from rudder deflection and sideslip angle were determined for the Mach number range of these tests.

NACA RM L9L05a

ANALYTICAL INVESTIGATION OF PROPELLER EFFICIENCY AT HIGH-SUBSONIC FLIGHT SPEEDS NEAR MACH NUMBER UNITY. Jean Gilman, Jr., John L. Crigler, and F. Edward McLean. February 13, 1950. 31p. diagrs. (NACA RM L9L05a)

The paper presents results of calculations to determine probable peak efficiency levels of single-rotating propellers operating at high-subsonic flight speeds near sonic velocity. Propeller drag losses are evaluated with airfoil-section data in the transonic range obtained from preliminary results of special propeller tests and with calculated airfoil-section data in the supersonic range. Use is made of conventional vortex theory in evaluating the induced losses.

NACA RM L9L06a

INVESTIGATION OF NACA 4-(0)(03)-045 AND NACA 4-(0)(08)-045 TWO-BLADE PROPELLERS AT FORWARD MACH NUMBERS TO 0.925. James B. Delano and Melvin M. Carmel. January 18, 1950. 22p. diagrs., photo. (NACA RM L9L06a)

The paper presents propeller characteristics for the NACA 4-(0)(03)-045 two-blade propeller for a blade angle of 60° and for the NACA 4-(0)(08)-045 two-blade propeller for blade angles of from 50° to 65° for forward Mach numbers up to 0.925. The results show that important gains in propeller performance are possible at high subsonic forward speeds through reductions in section thickness ratios.

NACA RM L9L20

PLANING CHARACTERISTICS OF SIX SURFACES REPRESENTATIVE OF HYDRO-SKI FORMS. Kenneth L. Wadlin and John R. McGehee. February 10, 1950. 150p. diagrs., photos., tab. (NACA RM L9L20)

Planing characteristics are presented for six planing surfaces. The surfaces varied in plan form and transverse bottom curvature. The plan forms included rectangles, triangles, and their combinations. The bottom curvatures included flat, convex, and concave-convex transverse sections. The ranges of trims and speeds investigated were 4° to 20° and 15 to 35 feet per second. The data are presented in the form of plots of wetted length, load, resistance, trimming moment, and draft against wetted area. Plots of wetted area forward of the observed wetted length at the chine are included.

NACA RM L50L06a

INVESTIGATION OF THE EFFECTS OF LEADING-EDGE CHORD-EXTENSIONS ON THE AERODYNAMIC AND CONTROL CHARACTERISTICS OF TWO SWEPTBACK WINGS AT MACH NUMBERS OF 1.41, 1.62, AND 1.96. Ellery B. May, Jr. January 16, 1951. 25p. diagrs., photo. (NACA RM L50L06a)

A wind-tunnel investigation was made to evaluate the effects of leading-edge chord-extensions on the longitudinal characteristics of swept wings and on control characteristics of flap-type and spoiler-type controls at Mach numbers of 1.41, 1.62, and 1.96. The wings had sharp leading edges and 51.7° leading-edge sweepback with aspect ratios of about 2.4 and taper ratios of about 0.62. The test Reynolds numbers ranged between 1.7×10^6 and 2.0×10^6.

NACA RM L50L14

DYNAMIC LONGITUDINAL STABILITY AND CONTROL OF TANDEM-COUPLED BOMBER-FIGHTER AIRPLANE MODELS WITH RIGID AND PITCH-FREE COUPLINGS. David C. Grana and Donald E. Hewes. January 22, 1951. 12p. diagrs., tabs. (NACA RM L50L14)

The results of flight tests in the Langley free-flight tunnel to determine the dynamic longitudinal stability and control characteristics of tandem-coupled bomber-fighter airplane models are presented. The investigation consisted of flight tests of the bomber alone, of a rigidly coupled combination, and of a freely coupled combination for a range of bomber center-of-gravity locations. Force tests were made with the bomber and fighter models alone and with the rigidly coupled combination.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM L50L20

EFFECTS OF SPOILER ON AIRFOIL PRESSURE DISTRIBUTION AND EFFECTS OF SIZE AND LOCATION OF SPOILERS ON THE AERODYNAMIC CHARACTERISTICS OF A TAPERED UNSWEPT WING OF ASPECT RATIO 2.5 AT A MACH NUMBER OF 1.90. D. William Conner and Meade H. Mitchell, Jr. January 24, 1951. 33p. diagrs., photo. (NACA RM L50L20)

Spoilers were investigated on two unswept wings in the Langley 9- by 12-inch supersonic blowdown tunnel. Chordwise and spanwise pressure distributions were measured on an unswept airfoil in the presence of a fuselage but without tip effects at $M = 1.96$ and $R = 1.3 \times 10^6$, both with and without a spoiler projected from either the upper or lower surface of the airfoil. Force and moment data were obtained on a semispan wing of aspect ratio 2.5 and taper ratio of 0.625 at $M = 1.90$ and $R = 2.2 \times 10^6$ where spoiler span and spanwise and chordwise location were varied. The spoiler characteristics were compared with flap results on this wing.

NACA RM L51L05

SOME EFFECTS OF AEROELASTICITY AT MACH NUMBERS FROM 0.7 TO 1.6 ON THE ROLLING EFFECTIVENESS OF THIN FLAT-PLATE DELTA WINGS HAVING 45° SWEPT LEADING EDGES AND FULL-SPAN CONSTANT-CHORD AILERONS. Edward T. Marley and Roland D. English. February 1952. 14p. diagrs., photo. (NACA RM L51L05)

Free-flight rocket-model tests at Mach numbers from 0.7 to 1.6 were made on thin flat delta wings having 45° swept leading edges and constant-chord ailerons in order to determine the effects of aeroelasticity on rolling effectiveness and drag. Within the accuracy of the tests the rolling effectiveness was approximately a linear function of the wing torsional rigidity.

NACA RM L52L01a

THE INFLUENCE OF VORTEX GENERATORS ON THE PERFORMANCE OF A SHORT 1.9:1 STRAIGHT-WALL ANNULAR DIFFUSER WITH A WHIRLING INLET FLOW. Charles C. Wood and James T. Higginbotham. February 1953. 38p. diagrs., photo., tab. (NACA RM L52L01a)

Results are presented of an investigation to determine the effect of vortex generators on the performance of a typical annular diffuser having inflow angles of 0°, 15.2°, and 20.6°. One arrangement having vortex generators on both walls of the diffuser improved the performance substantially when compared with no control and resulted in approximately equal values of static-pressure coefficient for all inlet whirl angles tested.

NACA RM L52L15

CONTROL HINGE-MOMENT AND EFFECTIVENESS CHARACTERISTICS OF A HORN-BALANCED, FLAP-TYPE CONTROL ON A 55° SWEPTBACK TRIANGULAR WING OF ASPECT RATIO 3.5 AT MACH NUMBERS OF 1.41, 1.62, AND 1.96. Lawrence D. Guy. January 1953. 29p. diagrs., photo., tab. (NACA RM L52L15)

A wind-tunnel investigation has been made of two horn-balanced flap-type controls (differing only in trailing-edge thickness) mounted on a 55° sweptback, triangular wing of aspect ratio 3.5 at Mach numbers of 1.41, 1.62, and 1.96 and Reynolds numbers of 2.2×10^6, 2.0×10^6, and 1.8×10^6, respectively. Limited tests were conducted in an experimental nozzle at Mach numbers of 0.72 to 0.82 and Reynolds numbers from 1.9×10^6 to 2.2×10^6, respectively. Control hinge moments as well as aerodynamic characteristics of the complete wing-body combination were obtained throughout a maximum control-deflection range of 0° to 20° and a maximum angle-of-attack range of ±20°. Two different size fences, mounted at the parting line between the wing and tip balance area, were tested on the basic configuration.

NACA RM L52L16

A TRANSONIC WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF LONGITUDINAL WING LOCATION AND VARYING BODY SIZE ON THE INTERFERENCE CHARACTERISTICS OF A 45° SWEPTBACK WING. Donald L. Loving. March 1953. 31p. diagrs., photo., tabs. (NACA RM L52L16)

The effect of wing location and body size on the characteristics of a 45° sweptback wing in the presence of a body is presented for Mach numbers from 0.60 to 1.13 at angles of attack of 0°, 2°, 4°, and 7°. The wing was investigated at two longitudinal locations, one 4 inches ahead of the other on the body. The wing, also, was investigated on two differently sized bodies, one approximately 10 percent larger than the other.

NACA RM L52L19

A TRANSONIC WIND-TUNNEL INVESTIGATION OF AN UNSWEPT-WING-BODY COMBINATION AT ANGLES OF ATTACK UP TO 24°. Bruce B. Estabrooks. February 1953. 23p. diagrs., tab. (NACA RM L52L19)

An investigation was conducted in the Langley 8-foot transonic tunnel of an unswept wing at two longitudinal positions on a body at angles of attack up to 24° at Mach numbers from 0.60 to 1.11. The wing had 0° sweepback of the 0.25-chord line, an aspect ratio of 4, a taper ratio of 0, and 4-percent-thick symmetrical circular-arc airfoil sections parallel to the plane of symmetry. Force and moment characteristics were determined for the unswept-wing-fuselage combinations.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM L52L22a

TRANSONIC WIND-TUNNEL INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS OF A 60° TRIANGULAR WING IN COMBINATION WITH A SYSTEMATIC SERIES OF THREE BODIES. Thomas C. Kelly. April 1953. 22p. diagrs., photo. (NACA RM L52L22a)

Aerodynamic characteristics and the effect of body shape on wing-fuselage interference are presented for a 60° triangular wing at Mach numbers from 0.60 to 1.125 and angles of attack from 0° to 7°. Basic aerodynamic characteristics are also presented for the wing with interference of one configuration through the same Mach number range at angles of attack to 24°. Analysis showed that the principal effects of the various body shapes on the wing-fuselage interference occurred in the transonic range, with the drag characteristics being most significantly affected. Variation of body shape had little interference effect on lift and pitching moment of the wing.

NACA RM L52L31

INVESTIGATION OF SPOILERS AT A MACH NUMBER OF 1.93 TO DETERMINE THE EFFECTS OF HEIGHT AND CHORDWISE LOCATION ON THE SECTION AERODYNAMIC CHARACTERISTICS OF A TWO-DIMENSIONAL WING. James N. Mueller. March 1953. 52p. diagrs., photos. (NACA RM L52L31)

The results of a pressure-distribution investigation of spoilers to determine the effects of height and chordwise location on the section aerodynamic characteristics of a two-dimensional, 6-percent-thick, symmetrical wing are presented for a Mach number of 1.93 and Reynolds number of approximately 1×10^6. The values of section normal force and pitching moment are presented as a function of angle of attack, spoiler height, and spoiler chordwise location. Some effects of spoiler height on spoiler pressure drag are shown for several angles of attack and two chordwise spoiler locations.

NACA RM L53B06

PRELIMINARY MEASUREMENTS OF STATIC LONGITUDINAL STABILITY AND TRIM FOR THE XF-92A DELTA-WING RESEARCH AIRPLANE IN SUBSONIC AND TRANSONIC FLIGHT. Thomas R. Sisk and John M. Mooney. March 1953. 19p. diagrs., photo., tab. (NACA RM L53B06)

Preliminary longitudinal-trim and static longitudinal stability measurements were made on the XF-92A delta-wing research airplane from Mach number of 0.18 to 0.97 at altitudes from 11,000 to 40,000 feet.

NACA RM L53E14

PRELIMINARY FLIGHT MEASUREMENTS OF THE DYNAMIC LONGITUDINAL STABILITY CHARACTERISTICS OF THE CONVAIR XF-92A DELTA-WING AIRPLANE. Euclid C. Holleman, John H. Evans, and William C. Triplett. June 1953. 17p. diagrs., tab. (NACA RM L53E14)

Longitudinal airplane oscillations obtained during U. S. Air Force performance tests of the Convair XF-92A airplane have been analyzed to give limited static stability and damping measurements for a Mach number range of 0.59 to 0.94.

NACA RM L53H17a

PERFORMANCE CHARACTERISTICS OF A 24° STRAIGHT-OUTER-WALL ANNULAR-DIFFUSER-TAILPIPE COMBINATION UTILIZING RECTANGULAR VORTEX GENERATORS FOR FLOW CONTROL. Charles C. Wood and James T. Higginbotham. October 1953. 33p. diagrs., tabs. (NACA RM L53H17a)

Results are presented of an investigation to determine the performance and the influence of vortex generators on the performance of a 24° annular-diffuser—tailpipe combination having fully developed pipe flow at the diffuser inlet. Tests were conducted both for axial flow and for flow whirling at 20.6°, at Mach numbers up to 0.40, and Reynolds numbers up to 1.28×10^6. Measurements were made at the diffuser exit and in the tailpipe $8\frac{11}{16}$ inches downstream of the diffuser exit. The best vortex-generator installation improved the diffuser static-pressure rise and downstream radial distribution without significantly altering the loss coefficient. Considering performance, geometry, and weight, the combination of the 24° diffuser and tailpipe compares very favorably in general with a 15° diffuser previously tested.

NACA RM L53J23

PRELIMINARY DRAG MEASUREMENTS OF THE CONSOLIDATED VULTEE XF-92A DELTA-WING AIRPLANE IN FLIGHT TESTS TO A MACH NUMBER OF 1.01. Donald R. Bellman and Thomas R. Sisk. January 1954. 21p. diagrs., photos., tab. (NACA RM L53J23)

Lift and drag data for the Consolidated Vultee XF-92A delta-wing airplane were obtained for Mach numbers from 0.63 to 0.90. The drag coefficients for a lift coefficient of 0.08 are extended to a Mach number of 1.01.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM L53L09

THE EFFECTS OF CHANGES IN ASPECT RATIO AND TAIL HEIGHT ON THE LONGITUDINAL STABILITY CHARACTERISTICS AT HIGH SUBSONIC SPEEDS OF A MODEL WITH A WING HAVING 32.6° SWEEPBACK. William J. Alford, Jr. and Thomas B. Pasteur, Jr. February 1954. 61p. diagrs., photos., tab. (NACA RM L53L09)

An investigation was made in the Langley high-speed 7- by 10-foot tunnel to determine the effects of changes in horizontal-tail height on the longitudinal stability characteristics of wing-fuselage combinations having 32.6° sweepback and aspect ratios of 3.0, 3.5, and 4.0. Also investigated were the effects of a leading-edge discontinuity. Lift, drag, and pitching-moment data were obtained at Mach numbers of 0.80, 0.90, and 0.93.

NACA RM L53L11

SUMMARY OF SOME ROCKET-MODEL INVESTIGATIONS OF EFFECTS OF WING ASPECT RATIO AND THICKNESS ON AILERON ROLLING EFFECTIVENESS INCLUDING SOME EFFECTS OF SPANWISE AILERON LOCATION FOR SWEPTBACK WINGS WITH ASPECT RATIO OF 8.0. H. Kurt Strass. February 1954. 26p. diagrs., photos., tab. (NACA RM L53L11)

The rolling effectiveness of 0.2-chord, trailing-edge ailerons on high-aspect-ratio sweptback wings over a Mach number range of 0.6 to 1.6 has been investigated by the Langley Pilotless Aircraft Research Division by utilizing rocket-propelled test vehicles in free flight. Some effects of spanwise aileron location on rolling effectiveness were measured by testing ailerons on the inboard half, the outboard half, and the full length of the exposed wings. The test wings had NACA 65_1A012 airfoil sections, an aspect ratio of 8.0, 45° sweepback of the midchord line, and taper ratios of 0.5 and 1.0. In addition, these data are correlated with the results of previous investigations of various plan forms to show some effects of wing aspect ratio and airfoil section thickness ratio.

NACA RM L53L14a

FREE-FLIGHT MEASUREMENTS OF THE ROLLING EFFECTIVENESS AND DRAG OF TRAILING-EDGE SPOILERS ON A TAPERED SWEPTBACK WING AT MACH NUMBERS BETWEEN 0.6 AND 1.4. Eugene D. Schult and E. M. Fields. February 1954. 14p. diagrs., photos. (NACA RM L53L14a)

A limited free-flight investigation of the rolling effectiveness and drag of 0.02-chord trailing-edge spoilers has been conducted between Mach numbers of 0.6 and 1.4 by use of the rocket-model technique. The test wings were swept back 45° at the quarter chord, had a taper ratio of 0.6, an aspect ratio of 4.0, and an NACA 65A006 profile parallel to the free stream. Solid, sharp-edged, half-span spoilers were tested at both inboard and outboard spanwise locations. The inboard spoiler produced considerably more rolling effectiveness but higher drag than the outboard spoiler. Compared with the same spoiler located at the 0.70-chord position, the trailing-edge spoiler had more rolling effectiveness at subsonic speeds but less rolling effectiveness at supersonic speeds. Less drag was obtained with the trailing-edge spoiler than with the same spoiler located at the 0.70-chord position throughout the speed range tested.

NACA RM L53L18a

WIND-TUNNEL INVESTIGATION AT HIGH SUBSONIC SPEEDS TO DETERMINE THE ROLLING DERIVATIVES OF TWO WING-FUSELAGE COMBINATIONS HAVING TRIANGULAR WINGS, INCLUDING A SEMIEMPIRICAL METHOD OF ESTIMATING THE ROLLING DERIVATIVES. James W. Wiggins. February 1954. 32p. diagrs. (NACA RM L53L18a)

This paper presents results of an investigation to determine the rolling stability derivatives of two wing-body combinations having triangular wings, including a semiempirical method for estimating the rolling derivatives C_{n_p} (yawing moment due to rolling) and C_{Y_p} (lateral force due to rolling). One wing had a leading-edge sweep angle of 45°, aspect ratio of 4, and an NACA 65A006 airfoil section, and the other wing had a leading-edge sweep angle of 60°, aspect ratio of 2.31, and an NACA 65A003 airfoil section. The angle-of-attack range was from 0° to about 13° and the Mach number range was from 0.50 to 0.95.

NACA RM L53L28a

PRESSURES AND ASSOCIATED AERODYNAMIC AND LOAD CHARACTERISTICS FOR TWO BODIES OF REVOLUTION AT TRANSONIC SPEEDS. Harold L. Robinson. March 1954. 34p. diagrs., tab. (NACA RM L53L28a)

Detailed pressure distributions for two bodies of revolution having the same nose shape, one with a cylindrical afterbody and the other with a curved afterbody, have been determined at transonic speeds. The data indicated that the cylindrical body exhibits more desirable stability characteristics than the curved body and that variation of the aerodynamic characteristics with Mach number was rather small. Comparisons with theory are also presented.

NACA RM L54G21

EFFECTS OF DIFFUSER AND CENTER-BODY LENGTH ON PERFORMANCE OF ANNULAR DIFFUSERS WITH CONSTANT-DIAMETER OUTER WALLS AND WITH VORTEX-GENERATOR FLOW CONTROLS. Charles C. Wood and James T. Higginbotham. September 1954. 39p. diagrs., photo., tab. (NACA RM L54G21)

Data obtained in a program to determine the performance improvements attainable through use of boundary layer controls in annular diffusers applicable to turbojet afterburners are summarized for five diffusers tested with and without vortex-generator controls. The diffusers had a constant-diameter outer body and an area ratio of 1:9 to 1. With axial or

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whirling inlet flow, reductions in diffuser length produced appreciable losses in performance. A diffuser with an outer-body length equivalent to that of a 15° diffuser and a center body about half that length produced optimum performance.

NACA RM L54K24a

FLIGHT INVESTIGATION AND ANALYSIS OF THE WING DEFORMATIONS OF A SWEPT-WING BOMBER DURING PUSH-PULL MANEUVERS. Alton P. Mayo and John F. Ward. April 1955. 34p. diagrs., photo., tabs. (NACA RM L54K24a)

The results of deflection measurements made at 12 stations on the wing of a swept-wing jet bomber (Boeing B-47A) during 18 push-pull maneuvers are presented in the form of coefficients expressing the deflections due to the zero-lift loads, the additional-lift loads, the pitching-angular-acceleration loads, and the pitching-angular-velocity loads on the airplane. The procedures used to obtain the coefficients are presented, along with comparisons of the experimental deflections and twists with those obtained from theoretical calculations.

NACA RM L54L03a

A LOW-SPEED INVESTIGATION OF A THIN 60° DELTA WING EQUIPPED WITH A DOUBLE SLOTTED FLAP TO DETERMINE THE CHORDWISE PRESSURE DISTRIBUTION AND THE EFFECT OF VANE SIZE. Delwin R. Croom. March 1955. 42p. diagrs., tabs. (NACA RM L54L03a)

Results and discussion are presented of a wind-tunnel investigation to determine the effect of vane size and the chordwise pressure distribution at one spanwise station on a thin 60° delta wing-fuselage configuration equipped with double slotted flaps. Increasing the vane size resulted in a larger increment of lift at zero angle of attack, greater maximum lift, and also extends the flap-deflection range.

NACA RM L54L23

DEVELOPMENT OF A NEW FLUTTER TESTING TECHNIQUE USING A TOWED DYNAMIC AIRPLANE MODEL EQUIPPED WITH AN AUTOMATIC STABILIZING SYSTEM. EXPERIMENTAL AND CALCULATED DYNAMIC STABILITY CHARACTERISTICS FOR SPEEDS UP TO 200 MPH. William C. Schneider. March 1955. 50p. diagrs., photo., tabs. (NACA RM L54L23)

The results of tests of a model-autopilot-towline combination used in the development of a flutter testing technique are presented. Flights were made at speeds up to 200 mph with both rigid and flexible wings. An analytic study of the dynamic stability of the model was made and an attempt was made to correlate the results with experiment.

NACA RM L56F18a

AN EXPERIMENTAL INVESTIGATION OF STING-SUPPORT EFFECTS ON DRAG AND A COMPARISON WITH JET EFFECTS AT TRANSONIC SPEEDS. Maurice S. Cahn. September 1956. 67p. diagrs., tabs. (NACA RM L56F18a)

Various dummy stings were tested on the rear of a related series of afterbody shapes for Mach numbers from 0.80 to 1.10 and Reynolds numbers based on body length from 15.0×10^6 to 17.4×10^6. A method is presented whereby approximate sting interference corrections can be made to models having afterbody shapes and sting supports similar to those of these tests if the Reynolds numbers are of the same order of magnitude and a turbulent boundary layer exists at the model base. Also presented is an analysis of jet duplication by use of a sting.

#NACA RM SA9J07, by Barnes
#NACA RM SL51I24, by Ramsen, Wadlin, and Gray
#NACA RM SL52I10, by Alford
#NACA RM SL52I26, by Lovell, Smith, and Kirby
#NACA RM SL52L10, by Lee
#NACA RM SL53B20, by Queijo, Wolhart, and Fletcher
#NACA RM SL53D01, by Queijo, Wolhart, and Fletcher
#NACA RM SL53E13, by Queijo, Wolhart, and Fletcher
#NACA RM SL53E18, by Lovell, Kirby, and Smith
#NACA RM SL54B03a, by Hastings and Mitcham
#NACA RM SL54B16a, by Lovell; also Film Supplement L-10
#NACA RM SL54E07, by Lovell; also Film Supplement L-31
#NACA RM SL54E28, by Schade, Smith, and Lovell; also Film Supplement L-33
#NACA RM SL54F11, by Hastings and Mitcham
#NACA RM SL54J04, by Johnson
#NACA RM SL55J31, by Hollinger and Mitcham

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NACA Rept. 1234

ON THE KERNEL FUNCTION OF THE INTEGRAL EQUATION RELATING THE LIFT AND DOWNWASH DISTRIBUTIONS OF OSCILLATING FINITE WINGS IN SUBSONIC FLOW. Charles E. Watkins, Harry L. Runyan and Donald S. Woolston. 1955. ii, 16p. tab. (NACA Rept. 1234. Supersedes TN 3131)

The kernel function of an integral equation relating the downwash to the lift distribution of a finite wing oscillating in subsonic compressible flow is treated. The kernel is reduced to a form which is amenable to calculations and the types of singularities are shown. As a check, it is shown that the kernel for the three-dimensional case reduces exactly to the known kernel for the two-dimensional case. In addition, results for the special cases of Mach number of 0 (incompressible case) and frequency of 0 (steady case) are given.

NACA Rept. 1243

HIGH-RESOLUTION AUTORADIOGRAPHY. George C. Towe, Henry J. Gomberg, and J. W. Freeman. University of Michigan. 1955. iii, 52p. diagrs., photos., tabs. (NACA Rept. 1243. Supersedes TN 3209)

This investigation was made to adapt wet-process autoradiography to metallurgical samples to obtain high resolution of segregated radioactive elements in microstructures. Results are confined to development of the technique, which was perfected to a resolution of less than 10 microns. The radioactive samples included carbon-14 carburized iron and steel, nickel-63 electroplated samples, a powder product containing nickel-63, and tungsten-185 in N-155 alloy.

NACA Rept. 1244

FREE-STREAM BOUNDARIES OF TURBULENT FLOWS. Stanley Corrsin and Alan L. Kistler, Johns Hopkins University. 1955. ii, 32p. diagrs., photos. (NACA Rept. 1244. Supersedes TN 3133)

The instantaneously sharp and irregular front which separates turbulent fluid from contiguous "nonturbulent" fluid at a free-stream boundary is studied. The overall behavior of the front is described statistically in terms of its wrinkle-amplitude growth and its lateral propagation relative to the fluid as functions of downstream coordinate. Theoretical analysis is backed up by experimental results.

NACA Rept. 1245

ANALYSIS AND CALCULATION BY INTEGRAL METHODS OF LAMINAR COMPRESSIBLE BOUNDARY LAYER WITH HEAT TRANSFER AND WITH AND WITHOUT PRESSURE GRADIENT. Morris Morduchow, Polytechnic Institute of Brooklyn. 1955. ii, 19p. diagrs., tabs. (NACA Rept. 1245)

A survey of integral methods in laminar-boundary-layer analysis is given. Simple and fairly accurate methods of calculating the properties (including stability) of the laminar compressible boundary layer in an axial pressure gradient with heat transfer at the wall and of determining the separation point in a compressible flow with an adverse pressure gradient over a surface at a given uniform wall temperature are developed. From the equations derived here, conclusions regarding the effect of pressure gradient, Mach number, and wall temperature on the boundary-layer characteristics are derived and illustrated. In particular the effects on skin-friction, heat-transfer coefficient, separation point in an adverse pressure gradient, and stability of the laminar boundary layer are analyzed.

NACA Rept. 1254

FRICTION, WEAR, AND SURFACE DAMAGE OF METALS AS AFFECTED BY SOLID SURFACE FILMS. Edmond E. Bisson, Robert L. Johnson, Max A. Swikert, and Douglas Godfrey. 1956. iii, 19p. diagrs., photos., tab. (NACA Rept. 1254. Supersedes TN 3444)

A summation is presented of NACA results obtained from friction and wear investigations from 1946 to 1954. The results are consistent with theoretical predictions that solid surface films of low shear strength can serve to reduce both friction and surface damage. Metallic oxides can have very marked effects. Wear studies show that the ability of materials to form surface films is an important factor in wear. Solid lubricants (MoS_2 and graphite) are beneficial under severe operating conditions, including temperatures approaching 1000° F; both materials are, however, subject to oxidation at these temperatures.

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NACA Rept. 1269

THEORETICAL SPAN LOAD DISTRIBUTIONS AND ROLLING MOMENTS FOR SIDESLIPPING WINGS OF ARBITRARY PLAN FORM IN INCOMPRESSIBLE FLOW. M. J. Queijo. 1956. ii, 15p. diagrs. (NACA Rept. 1269. Supersedes TN 3605)

A method is presented for determining the span load distribution and rolling moment due to sideslip for wings of arbitrary plan form in incompressible flow. The method was used to prepare charts from which the rolling moment due to sideslip can be obtained for wings having a large variety of aspect ratio, sweep, and taper ratio. Calculated values of span loads and rolling moments are compared with those of other theories and with experimental results.

NACA Rept. 1284

THEORY OF WING-BODY DRAG AT SUPERSONIC SPEEDS. Robert T. Jones. 1956. ii, 7p. diagrs. (NACA Rept. 1284. Supersedes RM A53H18a)

The relation of Whitcomb's "area rule" to the linear formulas for wave drag at slightly supersonic speeds is discussed. By adopting an approximate relation between the source strength and the geometry of a wing-body combination, the wave-drag theory is expressed in terms involving the areas intercepted by oblique planes or Mach planes. The resulting formulas are checked by comparison with the drag measurements obtained in wind-tunnel experiments and in experiments with falling models in free air. Finally, a theory for determining wing-body shapes of minimum drag at supersonic Mach numbers is discussed and some preliminary experiments are reported.

NACA RM E56K14

THEORETICAL ROCKET PERFORMANCE OF JP-4 FUEL WITH MIXTURES OF LIQUID OZONE AND FLUORINE. Vearl N. Huff and Sanford Gordon. January 1957. 22p. diagrs., tabs. (NACA RM E56K14)

Data were estimated by means of a heat-correction equation using data for JP-4 fuel with mixtures of oxygen and fluorine. The estimated data were checked for several cases by direct calculations. The difference in specific impulse between the estimated and directly calculated values was from 0.2 to 0.8 pound-second per pound. The maximum value of specific impulse was 334.9 pound-seconds per pound for a combustion-chamber pressure of 600 pounds per square inch absolute and an exit pressure of 1 atmosphere.

NACA RM E56K21

MATERIAL COMPATIBILITY WITH GASEOUS FLUORINE. Harold G. Price, Jr., and Howard W. Douglass. January 1957. 5p. tab. (NACA RM E56K21)

Static tests on the compatibility of fluorine with nonmetals at atmospheric temperature eliminated many materials from further consideration for use in fluorine systems. Several materials were found compatible at atmospheric pressure. Only Teflon and ruby (aluminum oxide) were compatible at 1500 pounds per square inch gage.

NACA RM E56L10a

THEORETICAL PERFORMANCE OF LIQUID HYDROGEN AND LIQUID FLUORINE AS A ROCKET PROPELLANT FOR A CHAMBER PRESSURE OF 600 POUNDS PER SQUARE INCH ABSOLUTE. Anthony Fortini and Vearl N. Huff. January 1957. 38p. diagrs., tabs. (NACA RM E56L10a)

Performance is given for both frozen and equilibrium composition during isentropic expansion. Data were calculated for equivalence ratios of 1.2 to 0.15, and pressure ratios of 1 to 1500. A correlation is given which permits the determination of performance for a wide range of chamber pressures. The maximum values of specific impulse for frozen and equilibrium composition with an exit pressure of 1 atmosphere were 380.9 and 392.5, respectively.

NACA TN 3700

ON SUBSONIC FLOW PAST A PARABOLOID OF REVOLUTION. Carl Kaplan. February 1957. 21p. diagrs., tab. (NACA TN 3700)

The Janzen-Rayleigh method is utilized for the calculation of the velocity potential for steady subsonic compressible flow past a paraboloid of revolution. Formulas are obtained for the fluid velocity at the solid boundary and along the axis of symmetry and are compared numerically with corresponding formulas for the two-dimensional parabolic cylinder.

NACA TN 3725

AERODYNAMIC INTERFERENCE OF SLENDER WING-TAIL COMBINATIONS. Alvin H. Sacks. January 1957. 81p. diagrs., photos. (NACA TN 3725)

The variations of total forces and moments with angles of attack and sideslip are calculated for a number of slender plane- and cruciform-wing-tail combinations under the assumption that the vortex sheet is fully rolled up ahead of the tail. Significant nonlinearities are found which are discussed at length. Water-tank photographs of the wake in the presence of the tail are presented.

NACA TN 3806

COMPARISON OF NACA 65-SERIES COMPRESSOR-BLADE PRESSURE DISTRIBUTIONS AND PERFORMANCE IN A ROTOR AND IN CASCADE. Willard R. Westphal and William R. Godwin. March 1957. 53p. diagrs., photos. (NACA TN 3806. Supersedes RM L51H20)

An investigation has been conducted to compare the performance of NACA 65-series compressor blades in two-dimensional cascade with that in an axial flow

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compressor. Blade pressure distributions were obtained by the use of a mercury-seal pressure-transfer device. The comparison indicated that cascade data accurately predicted the turning angle and blade pressure distribution obtained in the compressor at design conditions.

NACA TN 3825

COMPARISON OF MECHANICAL PROPERTIES OF FLAT SHEETS, MOLDED SHAPES, AND POST-FORMED SHAPES OF COTTON-FABRIC PHENOLIC LAMINATES. F. W. Reinhart, C. L. Good, P. S. Turner, and I. Wolock, National Bureau of Standards. January 1957. 60p. diagrs., photos., tabs. (NACA TN 3825)

Tests were conducted to determine the properties of flat sheets, molded shapes, and postformed shapes of cotton-fabric phenolic laminates. Most of the sheet materials showed directional variations in strength when tested parallel to, perpendicular to, and at 45° to the warp yarn in the face ply of the fabric. Industrial postforming decreased the strength of flat sections whereas laboratory postforming had no effect. The strength of curved sections was decreased and the water absorption increased by postforming. The strength of industrially molded parts was significantly less than that of similar sheet laminates whereas the strength of the flat sections of laboratory molded shapes was equal to or higher than that of similar sheet laminates.

NACA TN 3844

THEORY OF SELF-EXCITED MECHANICAL OSCILLATIONS OF HELICOPTER ROTORS WITH HINGED BLADES. Robert P. Coleman and Arnold M. Feingold. Chapter I: THEORY OF SELF-EXCITED MECHANICAL OSCILLATIONS OF HINGED ROTOR BLADES. Robert P. Coleman. Chapter II: THEORY OF MECHANICAL OSCILLATIONS OF ROTORS WITH TWO HINGED BLADES. Arnold M. Feingold. Chapter III: THEORY OF GROUND VIBRATIONS OF A TWO-BLADE HELICOPTER ROTOR ON ANISOTROPIC FLEXIBLE SUPPORTS (REVISED). Robert P. Coleman and Arnold M. Feingold. Appendix B: THE GENERAL EQUATIONS OF MOTION FOR TWO-BLADE ROTORS. George W. Brooks. February 1957. vii, 131p. diagrs. (NACA TN 3844. Supersedes ARR 3G29; WR L-308; ARR 3I13; WR L-312; TN 1184)

A theoretical analysis for the self-excited mechanical oscillations of hinged rotor blades is described and methods for its application are explained. The theory includes the effects of unequal stiffness of the pylon for deflections in different directions and the effects of damping in the hinges and in the pylon. Both the derivation of the characteristic equation and the methods of application of the theory are given. Charts are presented from which the shaft critical and self-excited instabilities can be predicted for a great variety of cases.

NACA TN 3855

THE EFFECT OF FORWARD-FLIGHT SPEED ON THE PROPULSIVE CHARACTERISTICS OF A PULSE-JET ENGINE MOUNTED ON A HELICOPTER ROTOR. Robert D. Powell, Jr. January 1957. 23p. diagrs., photos. (NACA TN 3855)

The effect of helicopter forward flight on the propulsive characteristics of a blade-tip-mounted pulse-jet engine was determined in the Langley full-scale tunnel for forward speeds up to 101 feet per second. For a representative cruising flight speed of 90 feet per second and an engine velocity of about 370 feet per second, a loss in propulsive thrust of about 5.5 percent and a 4-percent increase in specific fuel consumption were obtained. Whirling (centrifugal acceleration of 178g to 286g) at a rotor forward speed of zero resulted in a 10- to 20-percent reduction in engine thrust from that obtained in the tests with the nonwhirling engine.

NACA TN 3873

TABLES OF CHARACTERISTIC FUNCTIONS FOR SOLVING BOUNDARY-VALUE PROBLEMS OF THE WAVE EQUATION WITH APPLICATION TO SUPERSONIC INTERFERENCE. Jack N. Nielsen. February 1957. 245p. diagrs., tabs. (NACA TN 3873)

Tables are presented containing 69,000 values of a set of characteristic functions of two variables which first arose in problems of supersonic wing-body interference. The functions solve boundary-value problems of the second kind for the wave equation in three dimensions with circular cylindrical boundaries or problems of the unsteady heat-conduction equation in two space dimensions with circular boundaries. The functions themselves have the physical significance of cylindrical pressure waves. The tables have extensive use in problems of aerodynamic interference at supersonic speeds.

NACA TN 3877

ON STOKES' STREAM FUNCTION IN COMPRESSIBLE SMALL-DISTURBANCE THEORY. Milton D. Van Dyke. February 1957. 15p. diagrs. (NACA TN 3877)

Stokes' stream function is studied for subsonic or supersonic flow past axisymmetric bodies of small slope. The first-order equation is found to be nonlinear. It can be linearized if one seeks only the formal order of accuracy of the slender-body approximation. In any case, serious loss of accuracy results from imposing the condition of tangent flow at the body on the mass flux rather than on the velocity. In a second approximation, neglect of the nonlinearity leads to a false solution even in the slender-body expansion.

NACA TN 3881

WIND-TUNNEL TECHNIQUE FOR SIMULTANEOUS SIMULATION OF EXTERNAL FLOW FIELD ABOUT NACELLE INLET AND EXIT AIRSTREAMS AT SUPERSONIC SPEEDS. Gerald W. Englert and Roger W. Luidens. January 1957. 25p. diagrs. (NACA TN 3881)

An investigation was made of several ways of simultaneously simulating an external pressure field generated by an engine exhaust jet and an air inlet. The

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techniques investigated used high-pressure air piped upstream through a simulated jet to the exhaust nozzle of the engine. It was then discharged through perforations in the pipe or in a downstream direction through a target-type reverser at the end of the pipe. This air combined with the engine-inlet air to form a jet contour. The measured results indicated that the pressure field in the vicinity of the exit station and external to a real jet could be adequately simulated while keeping the inlet at critical or supercritical mass flow.

NACA TN 3894

A STUDY OF THE IMPACT BEHAVIOR OF HIGH-TEMPERATURE MATERIALS. H. B. Probst and Howard T. McHenry. March 1957. 23p. diagrs., photos., tabs. (NACA TN 3894)

The impact behavior of titanium carbide base cermets and high-temperature alloys was investigated from room temperature to 1750° F. The effects of amount of binder, binder composition, microstructure, temperature, and stress concentration on the impact strength of cermets are discussed. The NACA drop test was used in order to eliminate "toss energy," and the test variables which affect impact energies measured by the drop test are discussed.

NACA TN 3905

DIFFERENTIAL EQUATIONS OF MOTION FOR COMBINED FLAPWISE BENDING, CHORDWISE BENDING, AND TORSION OF TWISTED NONUNIFORM ROTOR BLADES. John C. Houbolt and George W. Brooks. February 1957. 47p. diagrs. (NACA TN 3905)

The differential equations of motion for the lateral and torsional deformations of twisted rotating beams are developed for application to helicopter rotor and propeller blades. No assumption is made regarding the coincidence of the neutral, elastic, and mass axes, and the generality is such that previous theories involving various simplifications are contained as subcases to the theory developed and presented in this paper. Special attention is given to coupling terms not found in previous theories, and methods of solution of the equations of motion are indicated by selected examples.

NACA TN 3906

FREE-JET TESTS OF A 1.1-INCH-DIAMETER SUPERSONIC RAM-JET ENGINE. Joseph H. Judd and Otto F. Trout, Jr. February 1957. 24p. diagrs., photos., tabs. (NACA TN 3906. Supersedes RM L51L18)

Results are presented of free-jet tests of a 1.1-inch-diameter hydrogen-burning ram-jet engine over a Mach number range from 1.42 to 2.28 and a Reynolds number range from 6.01×10^6 to 15.78×10^6. Tests demonstrated the reliability and wide operating range of the engine and showed its suitability for installation on wind-tunnel models of airplane and missile configurations. A comparison of engine operation with combustion-chamber lengths of 3.33 and 1.51 engine diameters was made at a Mach number of 2.06. A maximum test thrust coefficient of 0.905 was obtained at fuel-air ratio of 0.034 and a Mach number of 2.06 for the engine with the 3.33-diameter combustion chamber.

NACA TN 3909

VERTICAL FORCE-DEFLECTION CHARACTERISTICS OF A PAIR OF 56-INCH-DIAMETER AIRCRAFT TIRES FROM STATIC AND DROP TESTS WITH AND WITHOUT PREROTATION. Robert F. Smiley and Walter B. Horne. February 1957. 41p. diagrs., photo., tabs. (NACA TN 3909)

The vertical force-deflection characteristics were experimentally determined for a pair of 56-inch-diameter tires under static and drop-test conditions with and without prerotation. For increasing force, the tires were found to be least stiff for static tests, almost the same as for the static case for prerotation drop tests as long as the tires remain rotating, and appreciably stiffer for drop tests without prerotation.

NACA TN 3913

SUMMARY OF 65-SERIES COMPRESSOR-BLADE LOW-SPEED CASCADE DATA BY USE OF THE CARPET-PLOTTING TECHNIQUE. A. Richard Felix. February 1957. 18p. diagrs. (NACA TN 3913. Supersedes RM L54H18a)

The carpet-plotting technique is presented in this paper as a more useful and concise method of summarizing cascade data on the NACA 65-series compressor blades given in NACA Technical Note 3916. Carpet plots included permit the selection of the blade camber and the design angle of attack required to fulfill a design vector diagram. Other carpet plots provide means for the prediction of off-design turning angles. Also presented are carpet plots of an isentropic pressure-rise coefficient as a function of inlet-air angle, turning angle, and entering Mach number.

NACA TN 3914

SOME EXPERIMENTAL STUDIES OF PANEL FLUTTER AT MACH NUMBER 1.3. Maurice A. Sylvester and John E. Baker. February 1957. 25p. diagrs., photos., tab. (NACA TN 3914. Supersedes RM L52I16)

Experimental studies of panel flutter using thin metal plates were conducted at a Mach number of 1.3 to verify its existence and to study the effects of some structural parameters on the flutter characteristics. The effects of tensile forces and buckling were studied on panels clamped front and rear, in addition to initially buckled panels clamped on all four edges. Panel flutter was obtained under controlled laboratory conditions and it was found that tensile forces, shortening the panels, and increasing the bending stiffness were effective means for eliminating flutter. Buckled panels were more susceptible to flutter than unbuckled panels. No apparent systematic trends in the flutter modes or frequencies could be observed.

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NACA TN 3916

SYSTEMATIC TWO-DIMENSIONAL CASCADE TESTS OF NACA 65-SERIES COMPRESSOR BLADES AT LOW SPEEDS. L. Joseph Herrig, James C. Emery, and John R. Erwin. February 1957. 223p. diagrs., photo., tabs. (NACA TN 3916. Supersedes RM L51G31)

A two-dimensional low-speed porous-wall cascade tunnel investigation has been conducted to establish the performance of the NACA 65-series compressor blade sections over the useful range of inlet angle, solidity, and section camber. Design points for optimum high-speed operation are presented. The loading limitation is determined for some conditions. Trends of section operating range with increasing section camber are determined for the four inlet angles tested.

NACA TN 3917

EFFECT OF PROPELLER LOCATION AND FLAP DEFLECTION ON THE AERODYNAMIC CHARACTERISTICS OF A WING-PROPELLER COMBINATION FOR ANGLES OF ATTACK FROM 0° TO 80°. William A. Newsom, Jr. January 1957. 45p. diagrs. (NACA TN 3917)

The investigation was conducted with a model having four propellers, the slipstream from which covered practically the entire span of the wing. The wing had a 30-percent-chord slotted flap and an 8.5-percent-chord slat. The tests covered two longitudinal and two vertical positions of the propeller relative to the wing, and a range of flap deflections, with slat off and slat on. For one propeller position the power input to the model was measured and tuft studies of the flow on the wing were made. The results indicate that with proper propeller position and programming of flap deflection, it is possible to design a configuration for a vertical-take-off-and-landing airplane in which essentially no change in trim is required throughout the transition from hovering to normal unstalled forward flight.

NACA TN 3918

WIND-TUNNEL INVESTIGATION OF EFFECT OF PROPELLER SLIPSTREAMS ON AERODYNAMIC CHARACTERISTICS OF A WING EQUIPPED WITH A 50-PERCENT-CHORD SLIDING FLAP AND A 30-PERCENT-CHORD SLOTTED FLAP. Richard E. Kuhn and William C. Hayes, Jr. February 1957. 72p. diagrs., photo., tab. (NACA TN 3918)

Results are presented of an investigation at low speed of the effect of propeller slipstreams on the aerodynamic characteristics of a wing equipped with a 50-percent-chord sliding flap in combination with a 30-percent-chord slotted flap. Tests covered a thrust-coefficient range representing free-stream velocities from zero to the normal range of cruising speeds and included the effects of flap deflection, stabilizer incidence, and leading-edge-slat settings. Large tunnel-wall effects were experienced for which there is no known correction method; however, because of the current interest in and general scarcity of data applicable to aircraft designed for vertical take-off and landing (VTOL) and for short take-off and landing (STOL), the results are presented without correction for these tunnel-wall effects.

NACA TN 3919

INVESTIGATION OF EFFECTIVENESS OF A WING EQUIPPED WITH A 50-PERCENT-CHORD SLIDING FLAP, A 30-PERCENT-CHORD SLOTTED FLAP, AND A 30-PERCENT-CHORD SLAT IN DEFLECTING PROPELLER SLIPSTREAMS DOWNWARD FOR VERTICAL TAKE-OFF. Richard E. Kuhn. January 1957. 39p. diagrs., photo., tab. (NACA TN 3919)

Results are presented of an investigation of the effectiveness of a wing equipped with a 50-percent-chord sliding flap and a 30-percent-chord slotted flap in deflecting a propeller slipstream downward for vertical take-off. Tests were conducted at zero forward speed in a large room and included the effects of flap deflection, proximity to the ground, a leading-edge slat, and end plates. A turning angle of about 70° and a resultant force of about 100 percent of the thrust were achieved near the ground. Out of the ground-effect region, the turning angle was also about 70° but the resultant force was reduced to about 86 percent of the thrust.

NACA TN 3921

APPROXIMATE SOLUTION FOR STREAMLINES ABOUT A LIFTING ROTOR HAVING UNIFORM LOADING AND OPERATING IN HOVERING OR LOW-SPEED VERTICAL-ASCENT FLIGHT CONDITIONS. Walter Castles, Jr., Georgia Institute of Technology. February 1957. 41p. diagrs., tabs. (NACA TN 3921)

A realistic approximation for low-speed flow patterns is obtained by adding the stream functions for the displacement velocity of a disk and a ring source coincident with the rim of the rotor to the stream functions for the uniform vortex cylinder and the free-stream velocity. Equations are derived for the relative strengths of the stream functions that are necessary to satisfy certain selected physical conditions. Tables of values of the composite stream function are given for hovering and three rates of vertical ascent which cover the helicopter flight range. A method is outlined for using the tabulated values of the stream functions to compute the induced velocity components at any selected locations.

NACA TN 3923

EFFECT OF CHORD SIZE ON WEIGHT AND COOLING CHARACTERISTICS OF AIR-COOLED TURBINE BLADES. Jack B. Esgar, Eugene F. Schum, and Arthur N. Curren. January 1957. 37p. diagrs., tabs. (NACA TN 3923)

This analysis shows that turbine blade weight is affected to a much smaller degree by the size of the blade chord for air-cooled blades than for solid uncooled blades. The heat-transfer analysis shows that considerable savings in coolant flow are possible by using a smaller number of large-chord blades rather than a larger number of small-chord blades (constant blade solidity). In addition to the high coolant flows, the small-chord blades are often unable to pass the required flow at the pressure levels encountered in engine operation.

CURRENT NACA RESEARCH REPORTS

NACA TN 3926

EXPERIMENTAL COMPARISON OF SPEED - FUEL-FLOW AND SPEED-AREA CONTROLS ON A TURBO-JET ENGINE FOR SMALL STEP DISTURBANCES. L. M. Wenzel, C. E. Hart, and R. T. Craig. March 1957. 56p. diagrs. (NACA TN 3926)

Optimum proportional-plus-integral control settings for speed - fuel-flow control, determined by minimization of integral criteria, correlated well with analytically predicted optimum settings. Engine response data are given for a range of control settings around the optimum. An inherent nonlinearity in the speed-area loop necessitated the use of nonlinear controls. Response data for two such nonlinear control schemes are presented.

NACA TN 3927

PRELIMINARY INVESTIGATION OF THE EFFECT OF SURFACE TREATMENT ON THE STRENGTH OF A TITANIUM CARBIDE - 30 PERCENT NICKEL BASE CERMET. Leonard Robins and Edward M. Grala. February 1957. 16p. diagrs., photos., tabs. (NACA TN 3927)

Specimens of a nickel-bonded titanium carbide cermet were given the following surface treatments: (1) grinding, (2) lapping, (3) blast cleaning, (4) acid roughening, (5) oxidizing, and (6) oxidizing and refinishing. Room-temperature modulus-of-rupture and impact strength varied with the different surface treatments. Considerable strength losses resulted from the following treatments: (1) oxidation at 1600° F for 100 hours, (2) acid roughening, and (3) severe grinding with 60-grit silicon carbide abrasive. The strength loss after oxidation was partially recovered by grit blasting or diamond grinding.

NACA TN 3928

BOUNDARY-LAYER TRANSITION AT MACH 3.12 AS AFFECTED BY COOLING AND NOSE BLUNTING. N. S. Diaconis, John R. Jack, and Richard J. Wisniewski. January 1957. 17p. diagrs., photos. (NACA TN 3928)

Transition studies were made on a blunted cone-cylinder and parabolic-nosed cylinder at Reynolds numbers per foot up to 8×10^6. At all temperature levels, blunting the cone-cylinder model yielded increases in transition Reynolds number over that obtained on the sharp model. However, no such increase was obtained by blunting the parabolic model. On both models, moderate cooling resulted in an increase in the transition Reynolds number; extreme cooling, on the other hand, decreased the transition Reynolds number.

NACA TN 3929

A GENERAL SYSTEM FOR CALCULATING BURNING RATES OF PARTICLES AND DROPS AND COMPARISON OF CALCULATED RATES FOR CARBON, BORON, MAGNESIUM, AND ISOOCTANE. Kenneth P. Coffin and Richard S. Brokaw. February 1957. 56p. diagrs., tabs. (NACA TN 3929)

A system with general equations for computing burning rates of small particles has been devised; the effects of diffusion, heat conduction, and dissociation are included. The equations have been applied directly to carbon and boron and reduced to simpler forms used previously for isooctane and magnesium. The simpler computations appear to give sufficient accuracy for many purposes. For the combustion of boron particles, three graphs permit rapid determination of burning rate for a wide range of ambient temperature and ambient partial pressure of oxygen.

NACA TN 3930

STRESS-LIFE RELATION OF THE ROLLING-CONTACT FATIGUE SPIN RIG. Robert H. Butler and Thomas L. Carter. March 1957. 23p. diagrs., photos., tabs. (NACA TN 3930)

The rolling-contact fatigue spin rig was used to test groups of SAE 52100 9/16-inch-diameter balls lubricated with a mineral oil at 600,000-, 675,000-, and 750,000-psi maximum Hertz stress. Cylinders of AISI M-1 vacuum and commercial melts and MV-1 (AISI M-50) were used as race specimens. Stress-life exponents produced agree closely with values accepted in industry. The type of failure obtained in the spin rig was similar to the subsurface fatigue spalls found in bearings.

NACA TN 3931

A STUDY OF THE "TOSS FACTOR" IN THE IMPACT TESTING OF CERMETS BY THE IZOD PENDULUM TEST. H. B. Probst and Howard T. McHenry. February 1957. 13p. diagrs., photo., tab. (NACA TN 3931)

The test method presented shows that the "toss energy" contributed by the apparatus for brittle materials is negligible. The total toss energy is considered to consist of two components, (a) recovered stored elastic energy and (b) kinetic energy contributed directly by the apparatus. The results were verified by high-speed motion pictures of the test in operation. From these photographs, velocities of tossed specimens were obtained and toss energy computed. In addition, impact energies of some titanium carbide base cermets and high-temperature alloys, as measured by the low-capacity Izod pendulum test, compare well with impact energies measured by the NACA drop test.

NACA TN 3933

EFFECT OF FIBER ORIENTATION ON BALL FAILURES UNDER ROLLING-CONTACT CONDITIONS. Robert H. Butler, H. Robert Bear, and Thomas L. Carter. February 1957. 35p. diagrs., photos., tabs. (NACA TN 3933)

The rolling-contact fatigue spin rig was used to test balls of a bearing steel at maximum Hertz stresses of 600,000 to 750,000 psi. The effect of fiber orientation was observed with the ball track restricted to passing directly over the poles, coincident with the equator, or randomly around the ball. The polar areas were found to be weaker in fatigue than the nonpolar areas. This resulted in a much greater portion of the failures occurring in the polar areas than would be expected from a homogeneous material. The early failures are discussed.

CURRENT NACA RESEARCH REPORTS

NACA TN 3938

SIDEWASH IN THE VICINITY OF LIFTING SWEPT WINGS AT SUPERSONIC SPEEDS. Percy J. Bobbitt and Peter J. Maxie, Jr. February 1957. 49p. diagrs. (NACA TN 3938)

Equations and charts have been presented for the conical part of the sidewash above and below swept wings at small angles of attack. This flow-field component is necessary in making calculations of the wing-induced forces and moments on stores, missiles, and pylons. All supersonic Mach numbers and wing leading-edge sweep angles have been considered.

NACA TN 3940

IMPACT-LOADS INVESTIGATION OF CHINE-IMMERSED MODELS HAVING CONCAVE-CONVEX TRANSVERSE SHAPE AND STRAIGHT OR CURVED KEEL LINES. Philip M. Edge, Jr. February 1957. 66p. diagrs., photos., tabs. (NACA TN 3940)

Hydrodynamic-loads data obtained at the Langley impact basin from impacts of a concave-convex transversely curved bottom mounted on narrow-beam models having straight keel, curved bow, and curved stern are presented. Impacts were made at fixed trim angles over a range of landing conditions, including a few rough-water landings. The data are analyzed to show the effects of transverse curvature, longitudinal curvature, and rough water on maximum impact loads for narrow-beam models tested.

NACA TN 3942

INVESTIGATION OF VARIATION IN BASE PRESSURE OVER THE REYNOLDS NUMBER RANGE IN WHICH WAKE TRANSITION OCCURS FOR NONLIFTING BODIES OF REVOLUTION AT MACH NUMBERS FROM 1.62 TO 2.62. Vernon Van Hise. January 1957. 41p. diagrs., photo. (NACA TN 3942)

Results are presented of the effects of Mach number and Reynolds number upon the base pressure of nonlifting ogival bodies of revolution over the Reynolds number range in which wake transition occurs. The Mach number varied from 1.62 to 2.62 and the overall Reynolds number range was approximately from 20,000 to 10,000,000.

NACA TN 3945

METHODS FOR OBTAINING DESIRED HELICOPTER STABILITY CHARACTERISTICS AND PROCEDURES FOR STABILITY PREDICTIONS. F. B. Gustafson and Robert J. Tapscott. February 1957. 28p. diagrs., tabs. (NACA TN 3945. Supersedes RM L54F30; RM L54G05)

Part I summarizes the methods available to the helicopter designer for obtaining desired stability characteristics by modifications to the airframe design. The discussion is based on modifications made during establishment of flying-qualities criteria and includes sample results of theoretical studies of additional methods. In part II some of the methods of predicting rotor stability derivatives have been reviewed and the methods by which the derivatives are employed to estimate stability characteristics are summarized.

NACA TN 3946

DITCHING INVESTIGATIONS OF DYNAMIC MODELS AND EFFECTS OF DESIGN PARAMETERS ON DITCHING CHARACTERISTICS. Lloyd J. Fisher and Edward L. Hoffman. February 1957. 58p. tabs. (NACA TN 3946)

Data from ditching investigations conducted at the Langley Aeronautical Laboratory with dynamic scale models of various airplanes are presented in the form of tables. The effects of design parameters on the ditching characteristics of airplanes, based on scale-model investigations and on reports of full-scale ditchings, are discussed. Various ditching aids are also discussed as a means of improving ditching behavior.

NACA TN 3947

INSTRUMENT FLIGHT TRIALS WITH A HELICOPTER STABILIZED IN ATTITUDE ABOUT EACH AXIS INDIVIDUALLY. Seymour Salmirs and Robert J. Tapscott. January 1957. 17p. diagrs., photo. (NACA TN 3947)

Pilots' opinions and a simplified statistical analysis of the data were used to evaluate the results of helicopter flight investigations of single-axis attitude stabilization during low-speed instrument approaches. During calm-air flight, heading stabilization provided the most favorable results, with pitch stabilization and roll stabilization following in that order. Under variable-wind conditions, pitch stabilization provided the most significant contribution.

NACA TN 3948

PRELIMINARY DATA AT A MACH NUMBER OF 2.40 OF THE CHARACTERISTICS OF FLAP-TYPE CONTROLS EQUIPPED WITH PLAIN OVERHANG BALANCES. James N. Mueller and K. R. Czarnecki. March 1957. 43p. diagrs., photos. (NACA TN 3948. Supersedes RM L52F10)

The preliminary results of an investigation to determine the aerodynamic characteristics of plain overhang balances on flap-type controls are presented for a Mach number of 2.40 and a Reynolds number of 0.78×10^6. The values of section hinge moment, pitching moment, normal force, and chord force as a function of flap deflection and angle of attack for a basic wing equipped with flaps of 38-, 60-, and 82-percent balance are included. Some effects of gap size are shown for the flap of least balance.

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NACA TN 3972

EFFECT OF FREQUENCY AND TEMPERATURE ON FATIGUE OF METALS. S. R. Valluri, California Institute of Technology. February 1957. 15p. diagrs. (NACA TN 3972)

Phenomenological considerations applied to a standard-linear-solid physical model indicated that for particular temperatures there are corresponding frequencies of fatigue stressing above which the fatigue behavior changes. It is suggested that at room temperature the critical frequency is above that usually encountered in engineering practice.

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N-46303*

Royal Aircraft Establishment (Gt. Brit.)
THE FLIGHT SIMULATOR IN AIRCRAFT CONTROL RESEARCH AND DESIGN. W. J. G. Pinsker. August 1956. 32p. diagrs., photos. RAE Tech. Note Aero 2467. (Request N-46303*)

The possibilities of simulating manually controlled flight are discussed and the principal types of flight simulators are described. Particular attention is given to the importance of realistic visual and physical flight impressions. It is shown that useful conclusions on the handling characteristics of an aircraft can be drawn from experiments on relatively simple simulators. This is illustrated by results obtained on the RAE aiming flight simulator. It is suggested in conclusion that a flight simulator can be a very powerful tool for the design and optimization of aircraft control systems, if sufficiently realistic sensations of flight are simulated. Flight tests will, however, be always necessary as the final check and for the exploration of aerodynamic phenomena, which the simulator cannot predict but only accept as data.

N-46939*

Aeronautical Inspection Directorate (Gt. Brit.)
THE PRECISION MEASUREMENT OF THE DIAMETER OF SOFT THIN WIRE. V. H. Cripps. June 1956. 5p. diagrs. AID Metro/5. (Request N-46939*)

In order to assess certain electrical characterisitcs of soft thin wire, it is necessary to know its diameter accurately. In some instances measurements are required to an accuracy of the order of 0.00001 in. Apparatus has been so designed that the deformation of the wire due to the measuring pressure of the contacting anvils can be assessed and allowed for in the final result.

N-46952*

Royal Aircraft Establishment (Gt. Brit.)
CHARTS OF THE THEORETICAL WAVE DRAG OF WINGS AT ZERO-LIFT. R. A. Bishop and E. G. Cane. June 1956. 35p. diagrs. RAE Tech. Note Aero 2421. Supersedes RAE Tech. Note Aero 2139, Rev. (Request N-46952*)

Charts are presented for the theoretical wave drag at zero lift of straight-tapered wings with streamwise tips and with double-wedge or parabolic-arc sections. A bibliography of theoretical reports is included, and their contents are reviewed. This note supersedes RAE Technical Note No. Aero 2139 revised (CP 116), which contains errors.

N-46955*

Royal Aircraft Establishment (Gt. Brit.)
TEMPERATURE AND DIFFUSION NEAR SLIP BANDS DURING FATIGUE. N. J. Wadsworth. August 1956. 21p. RAE Tech. Note Met. 251. (Request N-46955*)

The average and instantaneous temperatures which can occur in slipbands during fatigue tests are discussed. It is shown that the mean temperature of a slipband is not appreciably above that of the surrounding material. The local temperature generated by moving dislocations cannot be sufficient to cause an appreciable increase in local diffusion rate. Increase in diffusion rate can, however, be produced by increases in the concentration of dislocations, vacancies, and interstitials at slipbands. The first two might allow diffusion to occur at about half the temperature normally needed while the third might be effective at even lower temperatures. In addition local atomic rearrangements can occur at all temperatures when dislocations, vacancies, or interstitials are annihilated.

N-46958*

Royal Aircraft Establishment (Gt. Brit.)
INSTALLATION TESTING AIR MILEAGE UNIT, MK. 4. A. G. Bone and R. G. Anderson. May 1956. 10p. diagrs., photo. RAE Tech. Note IAP 1043. (Request N-46958*)

For the Air Mileage Units Mks. 1 and 2 it was possible to lay down a minimum air-flow requirement past the fan chamber in order to obtain a satisfactory installation. In the case of the Air Mileage Unit Mk. 4 series the different method of cooling makes this impossible and the only satisfactory method of checking the installation is to measure and compare the fan and outside air temperatures during flight tests. This note outlines the method proposed and the analysis of the results obtained.

N-46961*

Royal Aircraft Establishment (Gt. Brit.)
NOTE ON THE AXISYMMETRICAL COMPRESSIBLE FLOW PAST A CYLINDER ALONG WHICH THE VELOCITY DISTRIBUTION IS PRESCRIBED. W. T. Lord and R. C. Hastings. May 1956. 13p. RAE Tech. Note Aero 2456. (Request N-46961*)

This note gives a short account of a solution, to a high order of approximation, of the axisymmetrical compressible flow past a cylinder along which the velocity distribution is prescribed. It contains a critical examination of various methods of solution rather than a presentation of detailed results, which are to follow in a comprehensive report.

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N-46964*

National Gas Turbine Establishment (Gt. Brit.)
THE FOULING OF TURBINE BLADES BY FUEL ASH. PART IV. PRESSURE TESTS WITH CAMBERED BLADES. J. J. Macfarlane and F. S. E. Whitcher. July 1956. 22p. diagrs., tabs. NGTE R. 193. (Request N-46964*)

This report describes a short series of rig tests to investigate ash deposition and corrosion on a cascade of cambered blades at pressures up to 4 atmospheres absolute. Severe choking of the cascade by low temperature deposits is demonstrated, and limited conclusions are drawn concerning the relationship between weight of deposit and cascade pressure drop. Tests at 700° C using Nimonic 80A blades have confirmed the existence of a maximum rate of corrosion at intermediate rates of deposition of vanadium pentoxide. Two special tests were carried out, using a Kuwait fuel oil of low vanadium content, and suggestions are made concerning the combustion problem raised by these results.

N-48071*

Aeronautical Research Council (Gt. Brit.)
THE EFFECTS OF CONVEX SURFACE CURVATURE ON BOUNDARY LAYER SEPARATION IN SUPERSONIC FLOW. G. E. Gadd. 1956. 16p. diagrs., photos. ARC CP 289. (Request N-48071*)

The effects of convex surface curvature on boundary-layer separation in supersonic flow are investigated experimentally and theoretically. The radius of curvature used in the experiments was about three times the distance from the leading edge of the surface on which the boundary layer was formed to the separation point. In accordance with theory, the surface curvature greatly reduced the separation pressure coefficient for laminar layers, but for turbulent layers (for which no theory of the effects of curvature has yet been developed) there was little effect.

N-48101*

Aeronautical Research Council (Gt. Brit.)
FLOW DIRECTION MEASUREMENTS IN SUPERSONIC WIND TUNNELS. D. J. Raney. 1956. 17p. diagrs. ARC CP 262. (Request N-48101*)

Some general requirements for satisfactory flow direction measurements in supersonic tunnels are stated and examples are given of the design and calibrations of typical yawmeters. The results of the flow direction measurements made in two tunnels are given and some of the flow characteristics are discussed.

N-48102*

Aeronautical Research Council (Gt. Brit.)
A SIMPLE METHOD FOR CALCULATING THE SPAN AND CHORDWISE LOADING ON STRAIGHT AND SWEPT WINGS OF ANY GIVEN ASPECT RATIO AT SUBSONIC SPEEDS. D. Küchemann. 1956. 52p. diagrs. ARC R & M 2935; ARC 15,633. Supersedes RAE Aero 2476. (Request N-48102*)

The methods of classical airfoil theory are used to derive a general theory for wings of any given plan form. The load over the whole surface of a given wing can be calculated at a given subcritical Mach number, and the procedure is as simple and rapid as that of the classical airfoil theory. The calculated results are confirmed by experiment.

N-48137*

Ministry of Supply (Gt. Brit.)
ANTI-ICING INVESTIGATION WITH VIKING VL. 229. March 1956. 53p. diagrs., photos., tabs. MOS S & T Memo. 2/56. (Request N-48137*)

The investigations fall into three divisions: (a) determination of the heating intensity required to maintain the section ice-free and prevent run-back water freezing on the surface at the continuous maximum severity condition defined in A.P.970; (b) assessment of behavior of the heated surface with heating intensity sufficient to cope with continuous maximum severity but with water concentration increased to give intermittent maximum severity; and (c) observation of the effect of a reduction of heat input on anti-icing and subsequent de-icing, performance (reduced heat tests).

N-48139*

Royal Aircraft Establishment (Gt. Brit.)
A STRAIGHT-LINE GENERATOR AS IN USE AT THE ROYAL AIRCRAFT ESTABLISHMENT FOR THE MACHINING OF AEROFOIL SHAPES. S. W. Potter. September 1956. 6p. photos. RAE Tech. Note ADW 3. (Request N-48139*)

A hand-propelled machine tool designed and made at RAE for the removal of material from a workpiece by a succession of sweeps of the cutter tangential to the required profile of an airfoil model, has been in use for some time. The continuing interest shown in this machine by other manufacturers of similar models has prompted this technical note which is intended mainly as a guide to the setting-up and operation.

N-48141*

Royal Aircraft Establishment (Gt. Brit.)
THE SEAM STRENGTH OF A NYLON FABRIC. J. E. Swallow and M. Fox. September 1956. 15p. diagrs., photos., tabs. RAE Tech. Note Chem. 1285. (Request N-48141*)

The seaming of a nylon fabric and the possible mechanisms of failure under load are discussed. The load-extension behavior and ultimate strength of seamed fabric in tensile, bursting, and tearing tests are compared with those properties in the unseamed fabric. Seams made by the method described were found to have but a slight effect.

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N-48142*

Royal Aircraft Establishment (Gt. Brit.)
AN OPTICAL APPARATUS FOR CONTINUOUS MEASUREMENT OF SHRINKAGE AT HIGH TEMPERATURE. J. Hutchings and J. P. Roberts. August 1956. 11p. diagrs., photo. RAE Tech. Note Met. 253. (Request N-48142*)

The apparatus works on the principle of the optical lever and is suitable for use in small furnaces up to at least 1300° C. It is made of sintered alumina, apart from the high-temperature mirrors of (i) fused silica sputtered with platinum, or (ii) corundum crystal. The magnification of the change of thickness of the rectangular specimen is 70 times. The shrinkage of specimens approximately 1 cm thick can be determined to within 10μ, so that shrinkages greater than 5 percent are accurate to one part in 50 or better. The apparatus has been used to measure the shrinkage occurring during sintering of powder pressings.

N-48143*

Royal Aircraft Establishment (Gt. Brit.)
A LOW POWER UNIVERSAL JOINT FOR USE AT X BAND. V. Russell and G. H. Peter. October 1956. 30p. diagrs., photos. RAE Tech. Note GW 431. (Request N-48143*)

A universal joint in a 50Ω coaxial feeder was developed for an application of microwave equipment, where miniaturization and low friction were important. Satisfactory operation was obtained over a 5-percent band with a voltage standing wave ratio of better than 0.72 and less than 0.5 db loss. The design is suitable for azimuth and elevation movements of $\pm$45° and it allows continuous rotation of one of the feeders. Normally the joint is intended for operation with a receiver, but preliminary power tests suggest that it should be satisfactory at 10 kw peak and 10 w mean.

N-48144*

Royal Aircraft Establishment (Gt. Brit.)
SOME DATA ON THE NOISE FACTOR OF 3 CM. RECEIVERS USING SILICON MIXERS. M. G. B. Weedon and R. G. Guttridge. September 1956. 32p. diagrs., tab. RAE Tech. Note GW 433. (Request N-48144*)

A series of measurements is reported on the noise factor of X band superheterodyne receivers using silicon mixers. The valves used were CV154, CV155, CV253, CV2226, CV2258, and CV4141. The effects of receiver intermediate frequency, crystal current, and the use of balanced, or single-ended mixers were investigated. Values of mean noise factor are presented for various valves in a variety of conditions including low frequency I. F's suitable for simple CW receivers combining the Doppler and intermediate frequency.

N-48145*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF KLYSTRON PRIMING UPON THE NOISE SPECTRUM OF THE C.W. MAGNETRON VX8114. M. G. B. Weedon and R. G. Guttridge. September 1956. 26p. diagrs. RAE Tech. Note GW 432. (Request N-48145*)

An account is given of measurements upon the VX8114 C.W. magnetron to determine the spectrum due to amplitude and frequency modulation by noise. The level of the noise spectrum found was too high for the valve to be useful in C.W. radars. When primed by power from a CV.129 klystron isolated from the magnetron by "Uniline" ferrite isolators, there was a reduction in the frequency modulation noise but it was insufficient to make the valve useful in C.W. radar applications.

N-48146*

National Gas Turbine Establishment (Gt. Brit.)
THE ηq METER, A RAPID INSTRUMENTAL METHOD OF COMBUSTION GAS ANALYSIS. F. H. Holderness. November 1956. 52p. diagrs., photos. NGTE R. 194. (Request N-48146*)

An account is given of the operating principles of an apparatus for rapid instrumental gas analytical measurements on combustion gases. An analysis can be completed with the apparatus in 6 to 10 minutes, using a stream of sample taken directly from a combustion chamber. The measurements made are of net carbon dioxide concentration, carbon monoxide, hydrogen, and total carbon dioxide. The last quantity is estimated after all carbon compounds in the sample have been fully oxidized to carbon dioxide in a furnace system. The direct indicating instruments which are incorporated into the meter are two infrared gas analyzers, for carbon dioxide and carbon monoxide measurements, and a sonic gas analyzer for hydrogen measurement. These instruments are described in a section of the report which gives complete constructional details of the meter. The measurements made can be used to derive values of combustion efficiency and fuel/air mixture strength. The calculations involved are included in an appendix. The meter is capable of handling gases from zones where combustion efficiency is in the range 0 to 100 percent and the mixture strength is in the range 0.0125 to 0.125.

N-48149*

National Gas Turbine Establishment (Gt. Brit.)
BUBBLE-POINTS, FLAMMABILITY LIMITS AND FLASH POINTS OF PETROLEUM PRODUCTS. B. P. Mullins. November 1956. 34p. diagrs., tabs. NGTE R. 200. (Request N-48149*)

Relationships between the bubble points, flammability limits, and flash points of a fuel have been demonstrated numerically for four hydrocarbon fuels ranging from aviation spirit to gas oil. The mean molecular weights of the fuel vapors at the bubble points

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have been computed and several nomographic methods of presenting corrected bubble-point data are outlined with examples. Weak and rich flammability limits in air of the four fuels were calculated over a range of static pressures. The weak limit curve represents the conditions of the closed flash point test and so by differentiation of this curve a flash point pressure correction factor was obtained for each fuel. Excellent agreement between theoretical and measured values was found in all cases and a simple general rule for estimating flash points is given.

MISCELLANEOUS

Errata on NACA Rept. 1245. By Morris Morduchow. 1955.

Errata on NACA Rept. 1254. By Edmond E. Bisson, Robert L. Johnson, Max A. Swikert, and Douglas Godfrey. 1956.

Errata on NACA RM E56D23. By Vearl N. Huff, Anthony Fortini, and Sanford Gordon. September 7, 1956.

Errata on NACA TN 3747. By Alfred Gessow. October 1956.

Errata on NACA TN 3760. By William R. Michelsen and Lionel V. Baldwin. August 1956.

N-41416, 1956

FORTY-SECOND ANNUAL REPORT OF THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS. ADMINISTRATIVE REPORTS WITHOUT TECHNICAL REPORTS. 1956. ix, 89p. NACA. (Request N-41416, 1956)

N-49802*

Advisory Group for Aeronautical Research and Development. THE USE OF RHEOELECTRICAL ANALOGIES IN AERODYNAMICS. L. C. Malavard, Faculté des Sciences de Paris. Wilbur C. Nelson, editor, University of Michigan. August 1956. (vi), 175p. diagrs., photos. AGARDograph 18. (Request N-49802*)

The study describes the equipment and experimental technique used in model construction, in the physical realization of the given problem data, in the exploration of the potential fields, and in carrying out the necessary adjustments and measurements. Next the different aerodynamic applications are examined: representations of plane flows, studies of airfoil sections and turbine blade lattices, practical accomplishment of conformal mappings, and studies of axially symmetric and three-dimensional flows. Detailed descriptions are given of the analog methods and setups used for the solution of lifting line, propeller, lifting surface, and compressible flow problems.

UNPUBLISHED PAPERS

N-38324*

COMPARISON OF THE RESISTANCE TO SHOCK OF LUBRICATING FILMS. (Comparaison de la résistance au choc des films lubrifiants). F. Charron. January 1957. 19p. diagrs., photos., tabs. Translation of Ministere de l'Air Publications Scientifiques et Techniques No. 298, 1955. (Request N-38324*)

The purpose of this paper is to compare the protective properties of lubricating films with regard to continuous or suddenly applied forces. First, a test apparatus is described which has been especially constructed to take care of this double program. The result of steady-state tests shows that the viscosity under atmospheric pressure is a predominant factor whereas the coefficient of the increase of viscosity with pressure appears to be without interest, contrary to expectations. Tests under shock-loading conditions confirm these conclusions. In order to classify lubricants, we form the ratio of breaking-load of the film to the viscosity. This ratio is not constant; it is seen to be higher for certain oils which are particularly suitable for resisting large forces, due to properties little known or even unknown.

N-49857*

Georgia Institute of Technology, Engineering Experiment Station. HEAT TRANSFER TO VIBRATING AIR COLUMNS. W. B. Harrison, W. C. Boteler, T. W. Jackson, A. Lowi, Jr., and F. A. Thomas, Jr. December 1955. iv, 38p. diagrs., photo., tabs. Georgia Inst. of Tech. (State) Engineering Experiment Station. (Request N-49857*)

Experimental studies of the effects of acoustic vibrations on convective heat transfer have been made in a vertical steam-heated tube, with air as the heat transfer medium. The studies were made in the range of superposed free and forced convection, and the runs without acoustic vibrations were correlated by predictions of Martinelli and Boelter (and a modified equation based on their predictions).

N-49902*

SECOND ANNUAL REPORT OF THE DIRECTORATE OF THE INSTITUTE ON THE WORK OF THE RESEARCH INSTITUTE FOR PHYSICS OF JET PROPULSION, STUTTGART, AT THE THIRD REGULAR CONFERENCE OF THE MEMBERS ON JULY 20, 1956. Eugen Sänger and Irene Sänger-Bredt. December 1956. 18p. diagr. Translation of Zweiter Jahresbericht der Institutsleitung über die Arbeiten des Forschungsinstituts Für Physik Der Strahlantriebe E. V., Stuttgart, anlässlich der dritten ordentlichen Mitgliederversammlung am July 20, 1956. (Request N-49902*)

Includes sections on size, membership, and scope of work of the institute. Reports on booster rockets, ram jets, chemical liquid-fuel rockets, thermonuclear rockets, and photon-jets are listed with abstracts.

UNPUBLISHED PAPERS

N-49904*

OBSERVATIONS REGARDING A CRITERION OF LAMINAR SEPARATION IN THE THREE-DIMENSIONAL BOUNDARY LAYER. (Observations sur un Critere de Décollement Laminaire dans la Couche-Limite Tridimensionelle). E. A. Eichelbrenner and A. Oudart. November 1956. 9p. diagrs. Translation from Recherche Aeronautique, no. 40, July-August, 1954, p. 3-5. (Request N-49904*)

The criteria of laminar separation of the three-dimensional boundary layer considered up till now have as general form $\left(\frac{\partial v^*}{\partial n}\right)_p = 0^{1,2}$ with v^* being the component of the velocity v within the boundary layer along a determined direction. This general form permits arriving at a condition with immediate physical significance. Thus it is possible to compare a criterion given by Gruschwitz with one proposed by Sears, in the particularly simple case of an elliptic cylinder in oblique approach flow. This comparison leads to a rejection of the criterion of Gruschwitz in favor of that of Sears which requires, however, an extension.

N-49932*

THE PIPE WIND TUNNEL. (Der Rohrwindkanal). Hubert Ludwieg. December 1956. 27p. diagrs., tab. Translation from Zeitschrift für Flugwissenschaften, v. 3, no. 7, 1955, p. 206-216. (Request N-49932*)

The possibility of employing less expensive methods for solving the problems of large and costly wind tunnels is investigated. The demand of the operators of wind tunnels for ever increasing Reynolds numbers and Mach numbers which is the cause of the enormous increase in costs is dealt with first. The possibility of satisfying this requirement by a less costly method is investigated and previous attempts in this direction are mentioned. These investigations lead to a suggestion for the design of a new type of wind tunnel which deviates greatly from conventional types and which, in the opinion of the author, is suitable for solving a great many of the aerodynamic problems at considerably reduced costs. Finally, the technique of testing required for this new type of wind tunnel is briefly discussed.

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#NACA MR dated December 30, 1941, by Davis and Foster (1105.5 - Hughes D-2/1)
#NACA MR dated January 30, 1945, by Ellis and Brown (5375 - 479)
#NACA MR L6A03a, by Zalovcik and Sawyer (1104 - 429a)

NACA RM A51A03

DAMPING IN ROLL OF A MISSILE CONFIGURATION WITH A MODIFIED TRIANGULAR WING AND A CRUCIFORM TAIL AT A MACH NUMBER OF 1.52. Richard Scherrer and David H. Dennis. March 6, 1951. 23p. diagrs., photo., tab. (NACA RM A51A03)

The damping-in-roll stability derivatives of a missile configuration and of its components were determined both theoretically and experimentally at a Mach number of 1.52. The damping of the cruciform-tail-body combination was 86 percent of the theoretical value and the damping of the wing-body-combination was 67 percent of the theoretical value. The damping of the complete configuration was not equal to the sum of the derivatives of its components because of the effect of the wing downwash on the damping of the tail.

NACA RM A52A14

THEORETICAL INVESTIGATION OF THE STABILITY AT NEGATIVE STATIC MARGINS OF A SUPERSONIC MISSILE WITH AN AUTOPILOT SENSITIVE TO PITCH ANGLE AND PITCHING VELOCITY. Henry A. Cole, Jr., and Marvin Abramovitz. March 1952. 28p. diagrs., tab. (NACA RM A52A14)

Stability charts covering a range of small positive and negative static margins are presented for a supersonic missile with an autopilot sensitive to angle of pitch and rate of pitch. Emphasis is placed on the stability at negative static margins as affected by autopilot components, gain settings, time lags, and natural frequencies. Assumptions to simplify the characteristic stability equation are also presented.

NACA RM E50A09

PERFORMANCE OF HIGH-PRESSURE-RATIO AXIAL-FLOW COMPRESSOR USING HIGHLY CAMBERED NACA 65-SERIES BLOWER BLADES AT HIGH MACH NUMBERS. Charles H. Voit, Donald C. Guentert, and James F. Dugan. March 28, 1950. 22p. diagrs., photos., tabs. (NACA RM E50A09)

A complete stage of an axial-flow compressor was designed and built to investigate the possibility of obtaining a high pressure ratio with an acceptable efficiency through the use of the optimum combination of high blade loading and high relative inlet Mach number. Overall stage performance was investigated over a range of flows at equivalent tip speeds of 418 to 836 feet per second. At design speed (836 ft/sec), a peak total-pressure ratio of 1.445 was obtained with an adiabatic efficiency of 0.89. For design angle of attack at the mean radius, a total-pressure ratio of 1.392 was obtained.

NACA RM E51A24

IGNITION-ENERGY REQUIREMENTS IN A SINGLE TUBULAR COMBUSTOR. Hampton H. Foster. March 27, 1951. 27p. diagrs., tab. (NACA RM E51A24)

Minimum spark energy requirements for ignition in a single tubular combustor were investigated for three fuels of different volatility. A spark energy of about 1.5 joules provided satisfactory ignition at sea-

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level engine cranking conditions at an ambient temperature of -60° F for the fuels investigated. About 10 joules provided satisfactory ignition at inlet conditions close to the steady-state burning limits of the combustor at low and intermediate air-flow rates. The ignition-energy requirements at both sea-level and altitude conditions decreased with an increase in fuel volatility.

NACA RM E53A02

INFLUENCE OF END PLATES ON LIFT AND FLOW FIELD OF A CANARD-TYPE CONTROL SURFACE AT A MACH NUMBER OF 2.00. George A. Wise. March 1953. 14p. photos., diagrs. (NACA RM E53A02)

The influence of triangular-shaped end plates on the lift and the flow field of a canard-type control surface mounted on a symmetrical fuselage was investigated in the Lewis 8- by 6-foot supersonic wind tunnel at a Mach number of 2.00, body angle of attack of 2°, and control-surface deflection angles of 3°, 6°, 8°, and 10°. The investigation demonstrated that the addition of end plates to a canard-type control surface increased its lift and rearranged the single vortex into a two-vortex system. Perforating the end plates reduced these effects and resulted in a decrease in lift and a change in the flow-field characteristics.

NACA RM E53H24

AIR-FLOW CHARACTERISTICS OF BRAZED AND ROLLED WIRE FILTER CLOTH FOR TRANSPIRATION-COOLED AFTERBURNERS. William K. Koffel. October 1953. 55p. diagrs., photos., tabs. (NACA RM E53H24)

An experimental investigation was made of the permeability and air-flow uniformity of wire filter cloth for application of transpiration cooling to afterburner combustion-chamber walls. Permeability coefficients in the desired range of 10^{-8} to 10^{-9} square inch for transpiration cooling of afterburner combustion chamber walls were obtained by combined brazing and rolling of the wire cloth. Thickness variations of ±0.0003 inch due to rolling tolerances in combination with initial nonuniformities in the air-flow passages through the wire cloth as woven were largely responsible for localized variations in air-flow uniformity within a given sheet of brazed and rolled wire cloth. Data are presented on the effect of oxidation of the brazing alloy on the pressure-square difference per unit thickness after periods of exposure up to 7 hours at temperatures up to 1560° R. Data are also presented on the effects of brazing and rolling on the short-time ultimate tensile strengths at temperatures up to 1460° R. An afterburner having a porous combustion-chamber wall fabricated from brazed and rolled wire cloth was still in serviceable condition after 4 hours and 10 minutes of afterburning at fuel-air ratios from about 0.030 to 0.050.

NACA RM E55A05

EFFECT OF FLIGHT SPEED ON DYNAMICS OF A TURBOPROP ENGINE. S. Nakanishi, R. T. Craig, and D. B. Wile. April 1955. 40p. diagrs., photo., tabs. (NACA RM E55A05)

An altitude-wind-tunnel investigation of the dynamics of a turboprop engine using approximate step inputs of fuel flow and blade angle was conducted at a simulated altitude of 35,000 ft over a range of flight Mach numbers from 0.15 to 0.5. The generalized time constant of the engine-propeller combination varied with Mach number and power level. Steady-state propeller characteristics were useful in predicting the time constant, and values of the time constant obtained from blade-angle disturbances agreed well with predicted values.

NACA RM E55A21

ENGINE PERFORMANCE OF PRECISION-FORGED, ELECTRO-POLISHED AND MACHINED BLADES OF NIMONIC 80 AND 80A ALLOYS. Paul F. Sikora and James R. Johnston. April 1955. 27p. diagrs., photos., tabs. (NACA RM E55A21)

An investigation of Nimonic 80 and Nimonic 80A turbine blades was conducted in a J33-9 turbojet engine to determine the effect of electropolishing blades and machining blades from oversize forgings. The results are as follows: (1) electropolishing did not improve the engine life of the blades; (2) machining from oversize blades did not improve the engine life of the blades.

NACA RM E55A28

INTERFEROMETRIC OBSERVATION OF FLOW ABOUT AN ISENTROPIC (REVERSE PRANDTL-MEYER STREAMLINE) COMPRESSION WEDGE AT MACH 3.0. James F. Connors, Richard R. Woollett, and Robert E. Blue. March 1955. 12p. diagrs., photos. (NACA RM E55A28)

A map of constant-density contour lines was made of the flow field about a wedge designed to produce a focussed isentropic compression with a static-pressure rise equal to that across a normal shock at free-stream Mach number. A strong-branch-shock configuration resulted. The predicted and experimental modifications of the flow due to boundary-layer displacement effects agreed rather well. By assuming the vortex sheet analogous to a blunt body, some correlation between experiment and theoretical estimates for detached waves was obtained.

NACA RM E55L06

EFFECTS OF A STRAIGHTENING OPERATION ON PERFORMANCE OF INCONEL 550 BUCKETS. C. A. Gyorgak, J. R. Johnston, and J. W. Weeton. February 1956. 24p. diagrs., photos., tabs. (NACA RM E55L06)

An investigation of the effects of straightening of Inconel 550 buckets showed that stress-rupture life was reduced and atypical microstructures were observed in buckets that were straightened and aged. A flash solution treatment given to straightened buckets caused recovery of stress-rupture life and normal microstructure. The engine life of the Inconel 550 buckets was not seriously affected by the straightening operation used in this investigation.

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NACA RM E55L06a

ENGINE PERFORMANCE OF OVERTEMPERATURE HEAT-TREATED S-816 BUCKETS. R. A. Signorelli, F. B. Garrett, and J. W. Weeton. March 1956. 26p. diagrs., tabs. (NACA RM E55L06a)

S-816 buckets heat-treated at temperatures above bucket operating temperature were run in a J33-9 turbojet engine. Results indicate that short-time overtemperature heat treatments ranging from 1550° to 2350° F changed stress-rupture properties but did not reduce bucket life.

NACA RM L50A31a

INVESTIGATION OF THE NACA 4-(0)(03)-045 TWO-BLADE PROPELLER AT FORWARD MACH NUMBERS TO 0.925. Melvin M. Carmel and Joseph R. Milillo. March 14, 1950. 29p. diagrs., photo., tab. (NACA RM L50A31a)

The paper presents propeller characteristics for the NACA 4-(0)(03)-045 two-blade propeller for forward Mach numbers to 0.925 and blade angles from 20° to 65°. A comparison of results for this propeller with those for the NACA 4-(0)(08)-045 propeller is presented to show the effect of section thickness ratio on propeller performance. A comparison of this propeller with a propeller using highly swept sections (NACA 4-(4)(06)-057-45A) is also presented in order to indicate whether thickness ratio or sweep is the more effective means of obtaining relatively high efficiencies at transonic speeds.

NACA RM L52A10

RECENT DATA ON CONTROLS. David G. Stone. January 1952. 18p. diagrs. (NACA RM L52A10)

Recent information is presented on flap-type and spoiler controls for use on swept wings (both rigid and flexible), methods for balancing trailing-edge flaps, and the characteristics of some all-movable tails. Comparison of these experimental results from various test facilities shows the effectiveness of flaps and spoilers on swept wings; effectiveness of balance devices such as tabs, horns, and overhangs; and characteristics of all-movable tails of delta and swept plan forms.

NACA RM L52A15

CHARACTERISTICS OF SWEPT WINGS AT HIGH SPEEDS. Charles J. Donlan and Joseph Weil. January 1952. 19p. diagrs. (NACA RM L52A15)

In this paper are presented some of the results of recent swept-wing investigations undertaken by the NACA to determine the effects of thickness and thickness distribution, camber and twist, nose-flap deflection, and devices or "fixes" for improving the wing pitching-moment characteristics at high lift coefficients.

NACA RM L52A31

LONGITUDINAL STABILITY AND DRAG CHARACTERISTICS AT MACH NUMBERS FROM 0.70 TO 1.37 OF ROCKET-PROPELLED MODELS HAVING A MODIFIED TRIANGULAR WING. Rowe Chapman, Jr., and John D. Morrow. May 1952. 35p. diagrs., photos., tab. (NACA RM L52A31)

Longitudinal-stability and drag tests were made using rocket-propelled models having a modified triangular wing. The wing had a leading-edge sweep of 57.08°, an aspect ratio of 2.53, and a root-section thickness of 3.7 percent. Aerodynamic coefficients for lift, drag, static stability, and damping are presented for the Mach number range of 0.70 to 1.37.

NACA RM L53K20a

COMPARISON OF EXPERIMENTAL HYDRODYNAMIC IMPACT LOADS AND MOTIONS FOR A V-STEP AND A TRANSVERSE-STEP HYDRO-SKI. Robert W. Miller. February 1954. 14p. diagrs., tabs. (NACA RM L53K20a)

A comparison is presented of the hydrodynamic impact loads and motions encountered in testing a V-step and a transverse-step flat-bottom hydro-ski having beam loadings of about 4.5 in fixed-trim smooth-water impacts at various velocities and flight-path angles. The comparisons are presented as plots of the nondimensional load, draft, vertical velocity, and time coefficients against flight-path angle at contact. The results show that the V-step reduces maximum impact loads up to 50 percent, increases the depth of penetration, and changes some of the vertical velocity and time characteristics of the hydro-ski.

NACA RM L55A07

EXPERIMENTAL DETERMINATION OF THE AERODYNAMIC DERIVATIVES ARISING FROM ACCELERATION IN SIDESLIP FOR A TRIANGULAR, A SWEPT, AND AN UNSWEPT WING. Donald R. Riley, John D. Bird, and Lewis R. Fisher. March 1955. 27p. diagrs., photos. (NACA RM L55A07)

Angle-of-attack variations of the aerodynamic derivatives arising from acceleration in sideslip which were obtained from a low-speed wind-tunnel investigation are presented for a 60° triangular, a 45° sweptback, and an unswept wing. Data were obtained by forcing the wings to perform a lateral plunging oscillation across the jet of the 6- by 6-foot test section of the Langley stability tunnel. Static-lateral-stability derivatives obtained from static sideslip tests are compared with values obtained from the oscillation tests. Some indication of the effect of changes in frequency of oscillation is also presented.

NACA RM L55A18

EXPERIMENTAL FLUTTER INVESTIGATION OF A THIN UNSWEPT WING AT TRANSONIC SPEEDS. George L. Pratt. April 1955. 24p. diagrs., tabs. (NACA RM L55A18)

Zero-lift experimental flutter data have been obtained in the Mach number range from 0.75 to 1.25 on a 1.5-percent-thick, untapered, unswept solid

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steel wing having hexagonal airfoil sections and aspect ratios of 3.75 and 4.00. The experimental results have been normalized by utilizing flutter speeds calculated by a strip-analysis procedure with two-dimensional aerodynamic coefficients for incompressible flow. For one case the results have been normalized by taking into account three-dimensional aerodynamic effects.

NACA RM L55E16b

A STUDY OF THE CORRELATION BETWEEN FLIGHT AND WIND-TUNNEL BUFFETING LOADS. Wilber B. Huston, A. Gerald Rainey, and Thomas F. Baker. July 1955. 15p. diagrs. (NACA RM L55E16b)

Comparison of the buffet loads measured on wind-tunnel models with loads measured in flight indicates that, during the course of the regular wind-tunnel testing program on a model, a simple strain-gage measurement can be made which can be used to predict the wing buffet loads on the airplane. The comparison is made for airplanes with swept and with unswept wings. The relation between buffet loads on a model and buffet loads on an airplane in flight is discussed from the standpoint of the input-output relationships of generalized harmonic analysis. The analysis of buffet load measurements on a statistical basis is outlined.

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NACA RM A54B08a

INVESTIGATION OF THE EFFECTS OF PROFILE SHAPE ON THE AERODYNAMIC AND STRUCTURAL CHARACTERISTICS OF THIN, TWO-DIMENSIONAL AIRFOILS AT SUPERSONIC SPEEDS. Elliott D. Katzen, Donald M. Kuehn, and William A. Hill, Jr. May 1954. 59p. diagrs., tabs. (NACA RM A54B08a)

The effects of thickness, trailing-edge bluntness, boattailing, and forward profile were determined. The results indicated that available theoretical methods were adequate for calculating the lift and pitching moment of the airfoils under all conditions of the test. The theoretical methods for calculating foredrag and correlation curves for estimating base pressure were adequate for predicting the total drag when the position of transition was known.

NACA RM A54B09

TESTS IN THE AMES 40- BY 80-FOOT WIND TUNNEL OF THE EFFECTS OF VARIOUS WING MODIFICATIONS ON THE LONGITUDINAL CHARACTERISTICS OF TWO TRIANGULAR-WING AIRPLANE MODELS WITH AND WITHOUT HORIZONTAL TAILS. David G. Koenig. April 1954. 29p. diagrs., tabs. (NACA RM A54B09)

An investigation was made with the objective of eliminating destabilizing changes of pitching moment through the use of wing modifications for two airplane models having triangular wings of aspect ratios 2 and 3. The models were tested with horizontal tails located above the extended wing chord plane as well as with the tails off. Chord extensions, fences, and combinations of these were the principal wing modifications considered. The unfavorable stability changes of the basic models at high lift coefficients were not entirely eliminated by the modifications tested. However, considerable improvement was obtained for both models with the use of a chord extension in combination with a fence. Reynolds numbers of the investigation were 14.6 and 12.8×10^6 for the models with aspect-ratio-2 and -3 wings, respectively, and the Mach number was 0.13.

NACA RM A55B11

THE STATIC LATERAL AND DIRECTIONAL SUBSONIC AERODYNAMIC CHARACTERISTICS OF AN AIRPLANE MODEL HAVING A TRIANGULAR WING OF ASPECT RATIO 3. Howard F. Savage and Bruce E. Tinling. April 1955. 82p. diagrs., photo., tabs. (NACA RM A55B11)

The effects of vertical-tail size and length on the lateral and directional stability characteristics of both mid- and high-wing airplane arrangements were evaluated. Also evaluated were the directional-control effectiveness of a rudder, and the lateral-control effectiveness of ailerons and of differential deflection of the horizontal tail surfaces. The tests were conducted at a Reynolds number of 2.5 million at Mach numbers from 0.25 to 0.95.

NACA RM A55B14

WIND-TUNNEL INVESTIGATION AT LOW SPEED OF A WING HAVING 63° SWEEPBACK AND A DROOPED TIP. James R. Blackaby. April 1955. 25p. diagrs., photos., tab. (NACA RM A55B14)

The results of low-speed force tests are presented to show the effects of variations of dihedral (droop) of the outer portion of a 63° sweptback semispan wing on the static longitudinal stability characteristics of the wing. Models with both curved and abruptly drooped tips were investigated, and, in addition, the effects of fences and of a leading-edge flap on the outer portion of the wing were measured.

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NACA RM E50B14

FREE-FLIGHT PERFORMANCE OF 16-INCH-DIAMETER SUPERSONIC RAM-JET UNITS. II - FIVE UNITS DESIGNED FOR COMBUSTION-CHAMBER-INLET MACH NUMBER OF 0.16 AT FREE-STREAM MACH NUMBER OF 1.60 (UNITS B-1, B-2, B-4, AND B-5). Wesley E. Messing and Scott H. Simpkinson. May 5, 1950. 44p. diagrs., photos., tab. (NACA RM E50B14)

Free-flight performance of five 16-inch-diameter ram-jet units was determined over range of free-stream Mach numbers of 0.50 to 1.86 and gas total-temperature ratios between 1.0 and 6.1. Time histories of performance data are presented for each unit. Correlations illustrate effect of free-stream Mach number and gas total-temperature ratio on diffuser total-pressure recovery, net-thrust coefficient, and external drag coefficient. One unit had smooth steady burning throughout the entire flight and encountered a maximum free-stream Mach number of 1.86 with a net acceleration of approximately 4.2 g's.

NACA RM E50D07

FREE-FLIGHT PERFORMANCE OF 16-INCH-DIAMETER SUPERSONIC RAM-JET UNITS. III - FOUR UNITS DESIGNED FOR COMBUSTION-CHAMBER-INLET MACH NUMBER OF 0.245 AT FREE-STREAM MACH NUMBER OF 1.8 (UNITS D-1, D-2, D-3, AND D-4). John H. Disher and Leonard Rabinowitz. June 28, 1950. 41p. diagrs., photos. (NACA RM E50D07)

Performance of four 16-inch-diameter ram-jet units was determined at free-stream Mach numbers of 0.49 to 1.78 over range of gas total-temperature ratios of 1.0 to 6.1. Time histories of each flight and data on thrust, drag, diffuser efficiency, and combustion are presented. A maximum thrust coefficient of 0.88 and a maximum net acceleration of 5.13 g's were observed for the four units.

#NACA RM E50H15, by Rabinowitz and North

NACA RM E50L18

FREE-FLIGHT PERFORMANCE OF 16-INCH-DIAMETER SUPERSONIC RAM-JET UNITS. IV - PERFORMANCE OF RAM-JET UNITS DESIGNED FOR COMBUSTION-CHAMBER-INLET MACH NUMBER OF 0.21 AT FREE-STREAM MACH NUMBER OF 1.6 OVER A RANGE OF FLIGHT CONDITIONS. Leonard Rabb and Warren J. North. February 26, 1951. 46p. diagrs., photos., tab. (NACA RM E50L18)

The performance of four 16-inch-diameter ram-jet units was determined at free-stream Mach numbers of 0.43 to 1.83 for a range of gas total-temperature ratios from 1.0 to 4.8. The effects of free-stream Mach number and gas total-temperature ratio on diffuser pressure recovery, external drag coefficient, and thrust coefficient are correlated. Combustion data with stability limits are also presented.

NACA RM E52B21

AERODYNAMIC INTERFERENCE EFFECTS ON NORMAL AND AXIAL FORCE COEFFICIENTS OF SEVERAL ENGINE-STRUT-BODY CONFIGURATIONS AT MACH NUMBERS OF 1.8 AND 2.0. Emil J. Kremzier and Murray Dryer. April 1952. 35p. diagrs., tab. (NACA RM E52B21)

An investigation to determine aerodynamic interference effects on normal and axial-force characteristics of several engine-strut-body combinations was conducted over range of angles of attack from 0° to 10° at Mach numbers of 1.8 and 2.0. Average Reynolds number based on body length was 28×10^{6}. Data are presented in the form of interference factors and indicate decreases in axial force and normal force curve slope with decreasing strut length. Decreases in axial force were also noted with rearward movement of engines. Theoretical evaluation of aerodynamic interference effects indicated a need for further refinements in the method of evaluation. A short discussion on the configuration lift-drag ratio is also included.

NACA RM E52C17

EXPERIMENTAL INVESTIGATION OF A CONSERVATIVELY DESIGNED TURBINE AT FOUR ROTOR-BLADE SOLIDITIES. Jack A. Heller, Rose L. Whitney, and Richard H. Cavicchi. July 1952. 25p. diagrs., photo., tab. (NACA RM E52C17)

The overall performance of a conservatively designed turbine suitable for the last stage of a multistage turbine is presented. The turbine was investigated at four rotor-blade solidities ranging from 0.85 to 2.27. The 44-blade-rotor turbine, having a solidity of 1.56, yielded the best efficiency over most of the range of investigation. The value of maximum brake internal efficiency was 0.895. The efficiency at the design point was 0.89. A relatively flat curve of maximum brake internal efficiency was found over most of the range of solidities investigated.

NACA RM E52J03

PERFORMANCE OF PURE FUELS IN A SINGLE J33 COMBUSTOR. I - FIVE LIQUID HYDROCARBON FUELS. Jerrold D. Wear and Ralph T. Dittrich. November 1952. 43p. diagrs., tabs. (NACA RM E52J03)

Investigations of several pure hydrocarbon fuels were conducted in a J33 single combustor at several inlet-air conditions to determine possible relations between combustor performance and fuel physical or fundamental combustion properties. The fuels investigated were isooctane, cyclohexane, methylcyclohexane, n-heptane, and benzene. Three combustor performance parameters were used to obtain a performance order among the fuels. Of the several fuel properties considered, maximum burning velocity best correlated with fuel performance, indicating an approximately linear increase in performance of the fuels with an increase in burning velocity.

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NACA RM E53A16

INVESTIGATION OF DISTRIBUTION OF LOSSES IN A CONSERVATIVELY DESIGNED TURBINE. Rose L. Whitney, Jack A. Heller, and Cavour H. Hauser. March 1953. 26p. diagrs., photo. (NACA RM E53A16)

A primary objective of turbine research is to obtain information that will aid in the design of gas turbines for any given application with minimum losses. As part of a program to obtain such information, flow surveys downstream of both the stator and the rotor of an experimental turbine were made in order to obtain detailed information about the flow conditions and the losses within the machine. The single-stage, low-radius-ratio turbine studied is relatively conservative in design, having low rotor-inlet relative Mach number, low turning angle, and high reaction at the rotor-root section. Surveys of the flow conditions and of the losses within the turbine are presented. The measured overall losses are analyzed in order to approximate the magnitudes of the various components of loss. It was found that the major losses in the turbine were in the rotor near the blade extremities. The losses in the tip region were considerably greater than those near the hub. The existence of secondary flows at the exit of both the stator and the rotor was indicated by the presence of low-velocity cores near both the hub and the tip sections. Analysis of the losses by an empirical method indicated that the rotor-profile and the tip-clearance losses are 31 and 9 percent of the adjusted measured total rotor loss, respectively. The remaining 60 percent loss was attributed to secondary flows.

NACA RM L51B05

THE EFFECT OF THICKNESS RATIO ON SECTION THRUST DISTRIBUTION AS DETERMINED FROM A STUDY OF WAKE SURVEYS OF THE NACA 4-(0)(03)-045 AND 4-(0)(08)-045 TWO-BLADE PROPELLERS UP TO FORWARD MACH NUMBERS OF 0.925. Daniel E. Harrison and Joseph R. Milillo. April 5, 1951. 62p. diagrs., photo., tabs. (NACA RM L51B05)

Section-thrust-coefficient data are presented for forward Mach numbers to 0.925 for the NACA 4-(0)(03)-045 propeller for blade angles of 40° to 65° and for the NACA 4-(0)(08)-045 propeller for blade angles of 50° to 65°. The results indicate the effect of blade thickness ratio and forward Mach number on thrust distribution.

NACA RM L53B02

EFFECT OF LEADING-EDGE CHORD-EXTENSIONS ON THE AERODYNAMIC CHARACTERISTICS OF A 45° SWEPTBACK WING-FUSELAGE COMBINATION AT MACH NUMBERS OF 0.40 TO 1.03. F. E. West, Jr., George Liner, and Gladys S. Martz. April 1953. 40p. diagrs., photo. (NACA RM L53B02)

A wind-tunnel investigation has been made to determine the effect of leading-edge chord-extensions on the aerodynamic characteristics of a sting-supported sweptback wing-fuselage combination at Mach numbers from 0.40 to 1.03. The wing had 45° sweep, aspect ratio of 4, taper ratio of 0.6, and NACA 65A006 airfoil sections. The span, chord length, and droop angles of the chord-extensions were varied. In general, the chord-extensions were effective in improving the variation of pitching moment with lift, and the lift characteristics, and lift-drag ratios at lift coefficient above 0.40 or 0.50. The gain in lift-drag ratio decreased with increasing Mach number.

NACA RM L53B04

AN INVESTIGATION AT TRANSONIC SPEEDS OF THE EFFECTS OF FENCES, DROOPED NOSE, AND VORTEX GENERATORS ON THE AERODYNAMIC CHARACTERISTICS OF A WING-FUSELAGE COMBINATION HAVING A 6-PERCENT-THICK, 45° SWEPTBACK WING. Gerald Hieser. March 1953. 26p. diagrs., photos. (NACA RM L53B04)

Lift, drag, and pitching-moment characteristics are presented at Mach numbers from 0.60 to 1.03 for a 45° sweptback wing-fuselage combination with fences at the 0.65 semispan station, drooped nose of the outer 0.35 semispan, and combination fences and drooped nose. Lift and pitching-moment data are given for the model with vortex generators installed at the wing leading edge and at the 0.15 chord station. The results show that an improvement in the pitching-moment characteristics resulted from the fences at Mach numbers from 0.60 to about 0.90 and 1.00. The drooped nose improved the pitch characteristics at Mach numbers of 0.98 and above, and no improvement resulted from the vortex generators.

NACA RM L53B16

EFFECTS OF SLOT SIZE AND GEOMETRY ON THE FLOW IN RECTANGULAR TUNNELS AT MACH NUMBERS UP TO 1.4. William J. Nelson and James M. Cubbage, Jr. April 1953. 43p. diagrs., photos., tab. (NACA RM L53B16)

An investigation has been made of the effects of slot width, depth, shape, and spacing on the center-line pressure distribution in rectangular tunnels of constant cross section with several height-to-width ratios. Results are presented in the form of center-line static-pressure distributions and calculated static-pressure and angle-of-flow distributions along the slotted boundary. The latter was accomplished by the method of characteristics using the center-line pressure distribution as a starting point and assuming isentropic flow throughout the length of the tunnel. The data show that transonic flows with a maximum deviation in Mach number less than ± 0.01 can be generated in a rectangular tunnel with fixed-geometry slots for Mach numbers up to 1.4, the limit of the tests. It is also shown that changes in the effective free area ratio of the boundary and in the length of the tapered slot opening cause large changes in axial pressure distribution. With a given slot configuration more uniform flows were obtained in tunnels of large height-width ratio.

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NACA RM L53B25a

WIND-TUNNEL INVESTIGATION OF THE STATIC LATERAL STABILITY CHARACTERISTICS OF WING-FUSELAGE COMBINATIONS AT HIGH SUBSONIC SPEEDS. TAPER-RATIO SERIES. James W. Wiggins and Paul G. Fournier. April 1953. 25p. diagrs., photos. (NACA RM L53B25a)

This paper presents the aerodynamic characteristics in sideslip of wing-fuselage combinations. The wings have a sweep angle of 45° at the quarter-chord line, aspect ratio of 4, taper ratios of 0.3, 0.6, and 1.0, and an NACA 65A006 airfoil section. The tests covered a Mach number range from 0.4 to 0.95, a Reynolds number range from 1.7×10^6 to 3.2×10^6, and an angle-of-attack range from -3° to 24°.

NACA RM L54B03

A LOW-SPEED INVESTIGATION OF THE AERODYNAMIC, CONTROL, AND HINGE-MOMENT CHARACTERISTICS OF TWO TYPES OF CONTROLS AND BALANCING TABS ON A LARGE-SCALE THIN DELTA-WING—FUSELAGE MODEL. Marvin P. Fink and Bennie W. Cocke. March 1954. 69p. diagrs., photo., tabs. (NACA RM L54B03)

Low-speed longitudinal and lateral control and hinge-moment characteristics of a 60° delta-wing—fuselage combination having an NACA 65A003 airfoil section are presented. Effects of Reynolds number, inboard flap deflection, and control-tip-radius modification are shown for half-delta and horn-balance-type controls. A limited investigation of balancing tabs on the horn-balance-type control was also included.

NACA RM L54B17

LOW-SPEED LONGITUDINAL STABILITY AND LATERAL-CONTROL CHARACTERISTICS OF A MODEL OF A 40° SWEPT-WING FIGHTER-TYPE AIRPLANE AT A REYNOLDS NUMBER OF 9×10^6. Thomas V. Bollech and H. Neale Kelly. February 1956. 149p. diagrs., photo., tabs. (NACA RM L54B17)

An investigation was conducted in the Langley 19-foot pressure tunnel on a model of a 40° swept-wing fighter airplane to determine modifications which would eliminate the pitch-up that occurred near maximum lift during flight tests of the airplane. The effects of high-lift and stall-control devices, horizontal-tail locations, external stores, and various wing-root inlets on the longitudinal stability characteristics of the model were investigated. For the most part, these tests were conducted at a Reynolds number of 9.0×10^6 and a Mach number of 0.19. All tests were made over an angle-of-attack range from -4° to 31°.

NACA RM L54C29

WIND-TUNNEL INVESTIGATION AT HIGH SUBSONIC SPEEDS OF THE STABILITY CHARACTERISTICS OF A COMPLETE MODEL HAVING SWEPTBACK-, M-, W-, AND CRANKED-WING PLAN FORMS AND SEVERAL HORIZONTAL-TAIL LOCATIONS. Kenneth W. Goodson and Robert E. Becht. May 1954. 72p. diagrs., photo. (NACA RM L54C29)

The present paper presents results of an investigation to determine the effect of composite wing plan forms on the high-speed (M = 0.80 to 0.92) longitudinal and lateral stability characteristics of a complete model having various horizontal-tail locations. The composite M-, W-, and cranked-wing plan forms were obtained by modifying the design of the basic wing having an aspect ratio of 4.0, a taper ratio of 0.3, and 45° of sweepback. Some data are also presented for the swept wing with a 10-percent-mean-aerodynamic-chord slat located on the outboard 35 percent of the swept-wing semispan.

NACA RM L54D15a

AERODYNAMIC CHARACTERISTICS AT SMALL SCALE AND A MACH NUMBER OF 1.38 OF UNTAPERED WINGS HAVING M AND W PLAN FORMS. William B. Kemp, Jr. June 1954. 17p. diagrs., tab. (NACA RM L54D15a)

An investigation was made at a Mach number of 1.38 and a Reynolds number of 390,000 to determine the supersonic aerodynamic characteristics of several wings having M and W plan forms. The wings had panel sweep angles of 60°, NACA 65A006 airfoil sections, and a basic aspect ratio of 4 and were untapered. Several tip plan-form modifications were investigated. The results are compared with approximately equivalent results for sweptback wings.

NACA RM L56A10

LOW-SPEED LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A 45° SWEPTBACK WING WITH DOUBLE SLOTTED FLAPS. Rodger L. Naeseth. April 1956. 31p. diagrs., tabs. (NACA RM L56A10)

A low-speed investigation has been made to determine the effect of 0.35-semispan double slotted flaps consisting of a 0.213-wing-chord main flap and either a 0.500-flap-chord vane or a 0.266-flap-chord vane on the aerodynamic characteristics of a 45° sweptback wing. The wing had an aspect ratio of 3.7, a taper ratio of 0.41, and a streamwise thickness ratio of 0.086. The Reynolds number was 1.8×10^6. Lift-coefficient increments for the double slotted flaps at an angle of attack of 0° were 0.67 at a flap deflection of 80° for the flap with 0.500-flap-chord vane and 0.55 at a flap deflection of 66° for the flap with 0.266-flap-chord vane. Maximum lift was about the same for the two flaps. Tests with either or both of the slots blocked were also made.

NACA RM SL54B17, by Bollech and Kelly

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NACA Rept. 1242

TRANSONIC FLOW PAST CONE CYLINDERS. George E. Solomon, California Institute of Technology. 1955. ii, 16p. diagrs., photos. (NACA Rept. 1242. Supersedes TN 3213)

Experimental results are presented for transonic flow past cone-cylinder, axially symmetric bodies. The drag coefficient and surface Mach number are studied as the free-stream Mach number is varied and, wherever possible, the experimental results are compared with theoretical predictions. Interferometric results for several typical flow configurations are shown and an example of shock-free supersonic-to-subsonic compression is experimentally demonstrated. The theoretical problem of transonic flow past finite cones is discussed briefly and an approximate solution of the axially symmetric transonic equations, valid for a semi-infinite cone, is presented.

NACA Rept. 1285

SUMMARY OF DERIVED GUST VELOCITIES OBTAINED FROM MEASUREMENTS WITHIN THUNDERSTORMS. H. B. Tolefson. 1956. ii, 7p. diagrs., tabs. (NACA Rept. 1285. Supersedes TN 3538)

Available measurements of the derived gust velocities within thunderstorms are summarized for altitudes from 5,000 to 34,000 feet. The results indicate that the intensity of the derived gust velocity is essentially constant up to altitudes of 20,000 feet and that an approximate 10-percent reduction in the gust intensity occurs for altitudes from 20,000 to 30,000 feet.

NACA RM 57A30

PROBLEM OF SLIP FLOW IN AERODYNAMICS. Robert E. Street, University of Washington. March 1957. 29p. (NACA RM 57A30)

The present status of theory in the field of slip-flow aerodynamics was investigated and it was concluded that the Navier-Stokes equations of motion together with first-order velocity slip and temperature jump at any boundary are sufficient insofar as experimental confirmation is available. The use of the Burnett terms in the equations of motion as well as second-order terms in boundary conditions does not seem justified, at least for semirarefied gas flows.

NACA RM E56K30

SURVEY OF MICROSTRUCTURES AND MECHANICAL PROPERTIES OF OVERTEMPERATURED S-816 TURBINE BUCKETS FROM J47 ENGINES. S. Floreen and R. A. Signorelli. March 1957. 41p. diagrs., photos., tabs. (NACA RM E56K30)

Most buckets overtemperatured in service had overaged microstructures. Similar microstructures were observed in some new buckets and in new buckets heated to 1500° F for 50 hours. Therefore, an overaged microstructure is not proof of overtemperature. A partially solutioned microstructure is proof of overtemperature. Partially solutioned buckets had longer rupture lives than overaged ones. Examination of new buckets indicates that scatter in bucket performance may be due to fabricating variables.

NACA RM E57A29a

EVALUATION OF THE USE OF ELECTRICAL RESISTANCE FOR DETECTING OVERTEMPERATURED S-816 TURBINE BLADES. Leonard Robins. March 1957. 22p. diagrs., photos., tabs. (NACA RM E57A29a)

The effects of fabrication variables, dimensional tolerances, and time at various overtemperatures on the resistance of S-816 turbine blades were evaluated. The resistance changes caused by overtemperature were within the scatter band of the resistances of new turbine blades and were less than the maximum variation due to dimensional tolerances. As a consequence, overtemperature is impossible to detect without a knowledge of the blade resistance history. Even if the resistance of the blade prior to operation were known, only severe overtemperatures could be detected.

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CURRENT NACA RESEARCH REPORTS

NACA TN 3835

A STUDY OF SPRAYS FORMED BY TWO IMPINGING JETS. Marcus F. Heidmann, Richard J. Priem, and Jack C. Humphrey. March 1957. 32p. diagrs., photos., tab. (NACA TN 3835. Supersedes TN 2349)

The spray pattern developed by two impinging liquid jets over a velocity range of 5 to 100 feet per second is photographically and numerically described. Surface tension and viscosity effects on the spray pattern are presented for low jet velocities. At high velocities the spray consists of waves of drops. For water sprays the frequency of these waves increased with increasing injection velocity and decreasing impingement angle. Jet diameter and jet length before impingement had a negligible effect on wave frequency. Characteristics of the jets prior to impingement were also studied.

NACA TN 3846

EXPERIMENTAL INVESTIGATION OF THE FORCES AND MOMENTS DUE TO SIDESLIP OF A SERIES OF TRIANGULAR VERTICAL- AND HORIZONTAL-TAIL COMBINATIONS AT MACH NUMBERS OF 1.62, 1.93, AND 2.41. Donald E. Coletti. March 1957. 32p. diagrs., photo., tabs. (NACA TN 3846. Supersedes RM L54G01)

An experimental investigation was made at Mach numbers of 1.62, 1.93, and 2.41 of the sideslip derivatives for tail arrangements consisting of a triangular vertical tail attached symmetrically to a triangular horizontal tail. Comparisons are made with the theoretical derivatives presented in NACA TN 3071 and NACA TN 2412.

NACA TN 3869

INVESTIGATION OF SEPARATED FLOWS IN SUPERSONIC AND SUBSONIC STREAMS WITH EMPHASIS ON THE EFFECT OF TRANSITION. Dean R. Chapman, Donald M. Kuehn, and Howard K. Larson. March 1957. 109p. diagrs., photos. (NACA TN 3869)

Experimental and theoretical research has been conducted on flow-separation phenomena associated with steps, bases, compression corners, curved surfaces, shock-wave boundary-layer reflections, and configurations involving leading-edge separation. Results were obtained from pressure-distribution measurements, shadowgraph observations, high-speed motion pictures, and oil-film studies. The maximum scope of measurement encompassed Mach numbers between 0.4 and 3.6 and length Reynolds numbers between 4,000 and 5,000,000. The principal variable controlling pressure distribution in the various separated flows was found to be the location of transition relative to the reattachment and separation positions.

NACA TN 3876

AN INVESTIGATION AT LOW SPEED OF THE FLOW OVER A SIMULATED FLAT PLATE AT SMALL ANGLES OF ATTACK USING PITOT-STATIC AND HOT-WIRE PROBES. Donald E. Gault. March 1957. 58p. diagrs., photos., tabs. (NACA TN 3876)

Results are presented from pitot-static and hot-wire-anemometer surveys of the low-speed flow about a simulated flat plate for angles of attack of 2°, 4°, and 6°. Measurements were obtained for a Reynolds number of 4×10^{6}. The data are presented in graphical as well as tabular form. Methods for correcting the mean velocity measurements for the effects of the exceedingly high levels of turbulence encountered during the investigation are presented in appendixes.

NACA TN 3880

MEASUREMENTS OF LIFT FLUCTUATIONS DUE TO TURBULENCE. P. Lamson, California Institute of Technology. March 1957. 38p. diagrs. (NACA TN 3880)

The power spectra of the fluctuating lift of a rigid wing in turbulent flow were measured, the aerodynamic admittance was obtained, and comparisons were made with existing theory. Aspect ratio and span were varied by means of movable end plates.

NACA TN 3912

FLIGHT TESTS OF A MODEL OF A HIGH-WING TRANSPORT VERTICAL-TAKE-OFF AIRPLANE WITH TILTING WING AND PROPELLERS AND WITH JET CONTROLS AT THE REAR OF THE FUSELAGE FOR PITCH AND YAW CONTROL. Powell M. Lovell, Jr., and Lysle P. Parlett. March 1957. 28p. diagrs., photo., tab. (NACA TN 3912)

An investigation of the stability and control of a high-wing transport vertical-take-off airplane with four engines during constant-altitude transitions from hovering to normal forward flight was conducted with a remotely controlled free-flight model. The model had four propellers distributed along the wing with the thrust axes in the wing chord plane. The wing could be rotated to 90° incidence so that the propeller thrust axes were vertical for hovering flight. An air jet at the rear of the fuselage provided pitch and yaw control for hovering and low-speed flight.

NACA TN 3925

PRELIMINARY METALLOGRAPHIC STUDIES OF BALL FATIGUE UNDER ROLLING-CONTACT CONDITIONS. H. Robert Bear and Robert H. Butler. March 1957. 38p. diagrs., photos. (NACA TN 3925)

The metallurgical results produced on balls tested in the rolling-contact fatigue spin rig were studied by metallographic examination. Origin and progression

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of fatigue failures were observed. These evaluations were made on SAE 52100 and AISI M-1 balls fatigue tested at room temperature (80° F) and 200° to 250° F. Most failures originated subsurface in shear; inclusions, structure changes, and directionalism adversely affected ball fatigue life. Structures in the maximum-shear-stress region of the balls of both materials were stable at room temperature and unstable at 200° to 250° F. Failures were of the same type as those found in full-scale bearings.

NACA TN 3932

AN INVESTIGATION OF HIGH-TEMPERATURE VACUUM AND HYDROGEN FURNACE BRAZING. Walter E. Russell and John P. Wisner. March 1957. 29p. diagrs., photos., tabs. (NACA TN 3932)

The vacuum and the hydrogen brazing of four heat-resistant alloys with two types of high-temperature brazing alloy were investigated. The effect of time at various brazing temperatures on the 1200° F shear strength of joints and on the base-metal tensile strength and elongation was also studied. Brazing techniques for alloys that can be age hardened and that contain titanium and aluminum in a vacuum as well as in dry hydrogen were evaluated.

NACA TN 3936

EXPERIMENTAL INVESTIGATION OF TEMPERATURE FEEDBACK CONTROL SYSTEMS APPLICABLE TO TURBOJET-ENGINE CONTROL. C. E. Hart, L. M. Wenzel, and R. T. Craig. March 1957. 56p. diagrs. (NACA TN 3936)

Temperature - fuel-flow and temperature-area feedback control systems were investigated as means of controlling tailpipe gas temperature of a turbojet engine during transient operation in the high-speed region. Proportional-plus-integral control was used in both systems, but in the temperature-area control system it was necessary to add nonlinear components to the basic proportional-plus-integral control to provide satisfactory transient response to a desired step increase in temperature. Time integrals of temperature-error functions were used as criteria for determining optimum transient response. A description of engine dynamics was obtained from frequency-response data.

NACA TN 3937

A COMPARISON OF TYPICAL NATIONAL GAS TURBINE ESTABLISHMENT AND NACA AXIAL-FLOW COMPRESSOR BLADE SECTIONS IN CASCADE AT LOW SPEED. A. Richard Felix and James C. Emery. March 1957. 46p. diagrs., photo., tabs. (NACA TN 3937. Supersedes RM L53B26a)

Comparative cascade tests of the NGTE (National Gas Turbine Establishment of Great Britain) 10C4/30C50 and NACA 65-($12A_{10}$)10 axial-flow compressor blade sections were conducted in a 5-inch low-speed cascade tunnel at the Langley Laboratory at air-inlet angles of 30°, 45°, and 60° and a solidity of 1.0 by using the porous-wall technique. These NACA data for the NGTE 10C4/30C50 section were also compared with data from NGTE design charts for the same section. British and NACA incompressible cascade force-analysis equations are included.

NACA TN 3939

A THEORETICAL AND EXPERIMENTAL STUDY OF PLANING SURFACES INCLUDING EFFECTS OF CROSS SECTION AND PLAN FORM. Charles L. Shuford, Jr. March 1957. 126p. diagrs., photos., tabs. (NACA TN 3939)

A summary is given of the background and present status of pure-planing theory. Data for models having sharp chines have been obtained for a rectangular flat plate and two V-bottom surfaces having constant angles of dead rise of 20° and 40° and also for rectangular-flat-plate surfaces having very slightly rounded chines. The theory presented in NACA Technical Note 3233 for a rectangular flat plate is revised and extended to include triangular flat plates planing with base forward and V-shaped prismatic surfaces having a constant angle of dead rise, horizontal chine flare, or vertical chine strips. The agreement between the results calculated by the proposed theory and the experimental data is satisfactory for engineering calculations of lift and center-of-pressure location.

NACA TN 3949

EXPERIMENTAL INVESTIGATION OF THE OSCILLATING FORCES AND MOMENTS ON A TWO-DIMENSIONAL WING EQUIPPED WITH AN OSCILLATING CIRCULAR-ARC SPOILER. Sherman A. Clevenson and John E. Tomassoni. March 1957. 20p. diagrs., photos. (NACA TN 3949. Supersedes RM L53K18)

Results of a wind-tunnel investigation of the forces, moments, and phase angles on a two-dimensional wing equipped with an oscillating circular-arc spoiler are presented. Schlieren photographs are presented which show the flow over and behind the spoiler. Data for Reynolds numbers from 1.3×10^6 to 6.3×10^6, Mach numbers from 0.2 to 0.82, and reduced frequencies from 0 to 0.92 on the normal-force and pitching-moment coefficients and their respective phase angles referred to spoiler position are indicated.

NACA TN 3951

INVESTIGATION OF THE PLANING LIFT OF A FLAT PLATE AT SPEEDS UP TO 170 FEET PER SECOND. Kenneth W. Christopher. March 1957. 15p. diagrs., photos., tab. (NACA TN 3951)

An experimental investigation was made in the Langley high-speed hydrodynamics facility to determine whether the planing lift coefficient of a flat-bottom planing surface remains constant with increasing speed at the high towing speeds of this facility. No effect of speed was noted for the range of speeds tested. In addition, the data agreed well with that recently obtained in lower speed towing tanks. A brief description of the facility is included.

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NACA TN 3962

THE EROSION OF METEORS AND HIGH-SPEED VEHICLES IN THE UPPER ATMOSPHERE. C. Frederick Hansen. March 1957. 38p. diagrs., tab. (NACA TN 3962)

Analytic relations for velocity, deceleration, size, and relative magnitude of luminosity of meteors are derived in parametric form. Comparison of the theory with observed meteor behavior indicates that a large fraction of the atmospheric bombardment energy is used in eroding meteor material. Erosion from large, high-speed vehicles in free-molecule flow is calculated and the mass loss is found negligible.

NACA TN 3963

A CORRELATION OF LOW-SPEED, AIRFOIL-SECTION STALLING CHARACTERISTICS WITH REYNOLDS NUMBER AND AIRFOIL GEOMETRY. Donald E. Gault. March 1957. 9p. diagrs., tab. (NACA TN 3963)

Low-speed stalling characteristics of airfoil sections are correlated with Reynolds number and the ordinate at a particular chordwise location. The correlation is appropriate only to airfoils without high-lift devices in flows of very low turbulence and with aerodynamically smooth surfaces.

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N-48151*

Royal Aircraft Establishment (Gt. Brit.)
A VISIT TO SOME AMERICAN RESEARCH ESTABLISHMENTS ENGAGED ON FUNDAMENTAL FATIGUE WORK. P. J. E. Forsyth. July 1956. 11p. RAE Tech.Note Met.245 (Ask for N-48151*)

Nine Research Laboratories were visited during this tour. They were: The Naval Research Laboratories, Washington; The Bureau of Standards, Washington; The Department of Theoretical and Applied Mechanics, University of Illinois, Urbana; The Westinghouse Research Laboratories, East Pittsburgh; The Carnegie Institute of Technology, Pittsburgh; The Alcoa Research Laboratories, New Kensington, Pennsylvania; The Massachusetts Institute of Technology, Boston, Mass.; The General Electric Corporation Research Laboratories, Schenectady, N.Y.; and Columbia University, New York City, N.Y. These laboratories were visited in order to see the type of research work which was going on on the more fundamental aspects of the fatigue of metals, particularly work of a metallographic nature. The work is described in this technical note, and references to work considered to be particularly important are given.

N-48154*

Royal Aircraft Establishment (Gt. Brit.)
A NOTE ON MULTIPLE DIAPHRAGM SHOCK TUBES. G. A. Bird. October 1956. 10p. diagrs. RAE Tech.Note Aero 2469. (Ask for N-48154*)

Attention is drawn to the effects of the secondary waves which are produced by wave interactions in shock tubes having more than one diaphragm. It is shown that these secondary waves can have a serious effect on the uniformity of the shock speed and of the flow behind the shock: the apparent advantages of a multiple diaphragm tube over the conventional type found from the consideration of primary waves alone may be largely nullified when secondary waves are taken into consideration.

N-48156*

Royal Aircraft Establishment (Gt. Brit.)
LOW SPEED WIND TUNNEL TESTS ON PERFORATED SQUARE FLAT PLATES NORMAL TO THE AIRSTREAM: DRAG AND VELOCITY FLUCTUATION MEASUREMENTS. B. G. de Bray. October 1956. 13p. diagrs., tab. RAE Tech.Note Aero 2475. (Ask for N-48156*)

The effects of perforations upon the drag, and velocity fluctuations downstream, of square plates normal to the airstream are described. It is shown that perforations can have a powerful effect upon the level of velocity fluctuations, particularly the low-frequency components, with only a comparatively small reduction in drag coefficient. It is also shown that perforating the central region only of a square plate is as effective in reducing velocity fluctuations as perforating the whole plate while giving a slightly higher drag coefficient than the latter. On the other hand, perforations near the periphery only are less effective.

N-48157*

Royal Aircraft Establishment (Gt. Brit.)
COMPOSITIONS FOR STRIPPING RUBBER SEALANTS FROM INTEGRAL FUEL TANKS. J. H. Sewell. July 1956. 8p. diagrs. RAE Tech.Memo. Chem.138. (Ask for N-48157*)

The development of a liquid and a gelled composition for stripping rubber sealants from integral fuel tanks is described. The liquid is a simple three-component solvent mixture; the gel is a different solvent mixture thickened by addition of sodium palmitate. These mixtures effectively remove typical sealants from test panels under laboratory conditions. Tests in integral tanks have not been made.

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N-48160*

National Gas Turbine Establishment (Gt. Brit.) REGULARITIES IN CREEP AND HOT-FATIGUE DATA. PART I. A. Graham and K. F. A. Walles. December 1956. 25p. diagrs., tabs. NGTE R. 189. (Ask for N-48160*)

Published experimental results are assembled to support a previously given theory of uniaxial deformation, and the theory is then used to analyze published data on the creep ruture and hot fatigue of engineering materials. The theory enables data for different times and temperatures to be classed together, thereby providing information over a much greater range of times than could practicably be covered by experiments at a single temperature. An underlying numerical pattern common to all the widely different Group VIII materials considered then shows through the experimental scatter. Data for further engineering materials are considered in these terms in Part II.

N-48161*

National Gas Turbine Establishment (Gt. Brit.) THE DISTRIBUTION OF IMPACTED PARTICLES OF VARIOUS SIZES ON THE BLADES OF A TURBINE CASCADE. D. L. Martlew. October 1956. 35p. diagrs., photo. NGTE Memo. M. 274. (Ask for N-48161*)

A turbine blade cascade was exposed to an airstream laden with droplets of paraffin wax. Particles in various size groups were counted and the variation of deposition rate with particle size and position on the blade surface estimated. The airflow in the cascade was calculated and the equations of motion of small particles moving initially with the air were integrated to give their paths. The relative deposition rates were calculated and compared with the measurements; good general agreement was obtained. The velocities and directions of impact with the blade were also estimated.

N-48163*

Aeroplane and Armament Experimental Establishment (Gt. Brit.). AN APPROXIMATE METHOD FOR DETERMINING THE LOWER LIMIT OF THE UNSAFE HEIGHT BAND FOR A HOVERING HELICOPTER. D. A. Wilkinson and R. W. Coombes. October 17, 1956. 11p. diagrs. AAEE/Res/295. (Ask for N-48163*)

A simple method has been developed for estimating the lower limit of the unsafe height band for a helicopter in the event of complete power failure while hovering. It has been assumed that no control movements are made by the pilot during the descent and that the vertical landing velocity at touch down may be used as a safety criterion.

N-48164*

Aeroplane and Armament Experimental Establishment (Gt. Brit.). AN ACCOUNT OF SOME LONGITUDINAL STABILITY TESTS ON A DRAGONFLY HELICOPTER. J. D. L. Gregory and R. W. Coombes. September 20, 1956. 12p. diagrs., tabs. AAEE/Res/293. (Ask for N-48164*)

Longitudinal stability tests have been made on a Dragonfly helicopter. Techniques are described for the measurement of static and maneuver margins, and these results are given together with the longitudinal trim curve and the results of pull-up tests. The near-equivalence of the maneuver margin and pull-up tests has been demonstrated, but final assessment of the tests must await results from other helicopters.

N-48165*

Ministry of Supply (Gt. Brit.) A NOTE ON THE THERMAL ANTI-ICING TESTS ON THE VICKERS VIKING VL. 229 1953-1955. H. E. Le Sueur. November 1956. 11p. diagrs., tabs. MOS S&T Memo. 8/56. (Ask for N-48165*)

This note is on flight tests made: (a) to determine, with the aid of water spray equipment, the heat required to prevent the formation of ice on an airfoil; (b) to determine the fraction of water caught that is necessary to be evaporated in order to maintain a clean surface in the same simulated icing conditions; (c) to study the phenomenon of ranback when flying in simulated intermittent maximum conditions; and (d) to study the effect of reduced or insufficient heat for (a).

N-48166*

Ministry of Supply (Gt. Brit.) EXPLORATORY TESTS ON PAINTS CONTAINING LEAD AZELATE INHIBITOR. C. E. Bird. November 1956. 8p. tabs. MOS S & T Memo. 13/56. (Ask for N-48166*)

The experiments described in the present report support the idea that a more porous vehicle might give improved results, and although the actual vehicle used, for example, nitrocellulose, may not always appeal on technological grounds to industry as suitable bases for priming coats for steel, yet the principles emerging may be of value in the development of cheap and effective inhibitive paints.

N-48167*

Royal Aircraft Establishment (Gt. Brit.) THE "WHITE" LIGHT RESPONSE OF FOUR SEMICONDUCTOR PHOTOELECTRIC CELLS. A. K. Walton. June 1956. 20p. diagrs., photos., tabs. RAE Tech. Note MS 28. (Ask for N-48167*)

The static characteristics and response profiles (that is, variation of sensitivity with position) are determined for the Schwarz, the S.T.C. P50A and

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P40A, and the Mullard OCP71 photoelectric cells. The measurements were made for illuminations of about 0.2 millilumen to 10 millilumens, to obtain data for use in the design of position digitizing apparatus. The problem of the detection of small photoelectric signals in the presence of large and variable dark current is discussed and the use of a modulated light source is suggested. The results show that the phototransistor is suitable as a light detector for modulation frequencies up to about 50 kc/s, above which a photodiode is preferable. The amplifier circuitry to be used in conjunction with the phototransistor is mentioned.

N-48169*

Royal Aircraft Establishment (Gt. Brit.)
FRACTIONAL DISTILLATION EQUIPMENT: THE CONSTRUCTION AND OPERATION OF A STEDMAN-TYPE COLUMN. I. M. White. August 1956. 30p. diagrs., photos. RAE Tech.Note Chem.1283. (Ask for N-48169*)

The construction and mode of operation of a Stedman-type fractionating column are described in this note. Efficiency tests using a n-heptane/methylcyclohexane mixture, at various boil-up rates are presented. Some observations are made on the use of a small, commercial, fractionating column.

N-48171*

National Gas Turbine Establishment (Gt. Brit.)
MULTI-CHANNEL DRUM CAMERA RECORDING OF DYNAMIC PHENOMENA. H. Taylor and T. W. Armstrong. August 1956. 60p. diagrs., photos. NGTE Memo.M.279. (Ask for N-48171*)

The design of two cameras each employing rotating drums is described, together with a description of the ancillary equipment. The cameras were designed to meet the need for a moving-film camera capable of making a number of exposures at high film speeds, and in rapid succession.

N-48173*

Royal Aircraft Establishment (Gt. Brit.)
THE STRUCTURE AND LOW TEMPERATURE EMBRITTLEMENT OF TITANIUM-ALUMINIUM ALLOYS. K. S. Jepson, G. I. Lewis, and D. Clark. June 1956. 31p. diagrs., photos., tabs. RAE Tech. Note Met.241. (Ask for N-48173*)

In the titanium-aluminum system, solid solutions based on the hexagonal close packed allotropic form of titanium may contain up to 24 percent Al at room temperature; they are of interest because they have higher specific moduli than pure titanium. The limiting composition of commercially useful alloys is set at about 6 percent Al, by a progressive deterioration in working properties, with increasing aluminum content. In the present work alloys containing 5, 10, and 15 percent Al were made and all but the higher alloy were successfully fabricated to sheet. Attention was then primarily directed toward understanding the abnormal mechanical properties and microstructure found on examining the Ti 10-percent Al sheet. Specimens of rolled sheet given a recrystallization anneal high in the single-phase field and quenched were ductile, but if slower cooling was employed or if the quenched specimens were subsequently given a low temperature treatment they were rendered brittle. The microstructures of this supposedly single-phase alloy showed anomalous line markings similar to those on strained polished surfaces. X-ray diffraction, resistometric, and metallographic studies failed to show any connection between these two anomalous phenomena, nor has any evidence yet been found that the present phase diagram is wrong. It is suggested that anisotropic thermal contraction strains cause the microstructural abnormalities while the embrittlement is due to a rise in the critical stress for plastic deformation of the solid solution.

N-48176*

Royal Aircraft Establishment (Gt. Brit.)
PROPOSALS FOR A FAST, ACCURATE VOLTAGE ANALOGUE TO DIGITAL CONVERTER. W. G. Hughes. August 1956. 21p. diagrs. RAE Tech. Note GW 425. (Ask for N-48176*)

This note describes a proposed scheme for converting a voltage into an equivalent binary-digital representation with an accuracy of 0.2 to 0.3 percent of full scale, and with a speed of response such that a step input from zero to full scale would be followed in about 0.01 sec.

N-48177*

National Gas Turbine Establishment (Gt. Brit.)
FLAME RADIATION IN AN INDUSTRIAL GAS TURBINE COMBUSTION CHAMBER. D. Reeves. October 1956. 65p. diagrs., tabs. NGTE Memo. M.285. (Ask for N-48177*)

Radiation properties of the flame were measured in a large combustion chamber; flame temperatures were deduced and the experimental results are presented in tables and graphically. The observations were made using four fuels, over a range of pressures, velocities, and fuel/air ratios, at four positions along the flame. Analysis of the results was approached by developing an expression for nonluminous emissivity in terms of the combustion variables and comparing the values so obtained with the observed total emissivities; the ratio of total emissivity to ideal nonluminous emissivity varied between 0.5 and 5. A general expression for total emissivity was thereby obtained but included a term, the luminous emission coefficient, which could not be correlated satisfactorily; its values are shown graphically for a range of combustion conditions. In the special case of gas oil flames, the coefficient of average luminous emission along a flame could be expressed empirically in terms of pressure and fuel/air ratio.

BRITISH REPORTS

N-48178*

National Gas Turbine Establishment (Gt. Brit.)
REGULARITIES IN CREEP AND HOT FATIGUE DATA. PART II. K. F. A. Walles and A. Graham. December 1956. 144p. diagrs., tabs. NGTE R.190. (Ask for N-48178*)

A previously-given theory suggests that (for a single form of loading) strain ε is related to stress σ, time t, and temperature T by a sum of terms of the form $C_{\sigma\beta\phi k}$ where $\phi = t(T' - T)^{-A}$, that the constant A is the same for all terms and a range of materials, and that the ratios β/k take values from the sequence 2^n. In the present report, the theory is compared with 103 sets of published creep-rupture, creep-rate, and hot-fatigue data relating mainly to alloys of the Fe, Ni, Cr, Co, system of 44 different compositions. The results of all analyses are given in detail in the figures and tables. A statistical assessment of the extent of agreement of the theory with the data is given with reference to the number of free constants used.

N-48182*

Royal Aircraft Establishment (Gt. Brit.)
A NOTE ON TEST FACTORS. N. I. Bullen. September 1956. 18p. diagrs., tabs. RAE Structures 215. (Ask for N-48182*)

The calculation of test factors is reviewed. The distribution of the population from which the test sample is taken is assumed to be Gaussian. Three cases are discussed in which: (i) there is no prior knowledge of the mean or standard deviation, (ii) there is no prior knowledge of the mean but the standard deviation is a given fraction of the mean (that is, coefficient of variation known), and (iii) there is no prior knowledge of the mean but the standard deviation is known. In each case an estimate is made of the average proportion of items under strength which go into service as a result of the continued application of a given test factor. The distributions of the statistics used in the solution of cases (i) and (iii) can be found from published tables. The corresponding distributions for case (ii) for the appropriate ranges are given in this paper.

N-48183*

Royal Aircraft Establishment (Gt. Brit.)
THERMODYNAMIC PROPERTIES OF AIR AT HIGH TEMPERATURES. R. L. Dommett. August 1956. 39p. diagrs., tabs. RAE Tech. Note GW 429. (Ask for N-48183*)

This note proposes values for the thermodynamic and transport properties of air both undissociated and in dissociation equilibrium for temperatures up to 12,000° K. These proposals are compared with other sources where available. Some discussion is made of the effects ignored in the derivation of the proposed data.

N-48184*

Ministry of Supply (Gt. Brit.)
DEVELOPMENT OF PLANT, EQUIPMENT AND WELDING TECHNIQUES FOR FUSION WELDING THIN GAUGE AIRCRAFT MATERIALS WITH 'CRATER FREE' FINISHED WELDS TO AIRCRAFT STANDARDS. J. V. Thomas. October 1956. 25p. diagrs., photos., tabs. MOS S & T Memo. 6/56. (Ask for N-48184*)

Development work was started at Luton on stainless steel and Nimonic 75 in 20 S.W.G., 16 S.W.G., and 10 S.W.G. sheet materials. Arrangements had to be made to modify the existing prototype plant to accommodate the thinner gage materials, enabling sample welds to be produced of the length and diameters commonly used in aircraft industry. When fusion welding thin gage materials the current and voltage valves are usually small (20/70 amperes at 8/10 volts). To avoid even the slightest arc blow due to magnetic fields the clamps were made of non-magnetic materials.

N-48185*

National Gas Turbine Establishment (Gt. Brit.)
METHODS FOR REDUCTION OF HIGH TEMPERATURE DATA IN TERMS OF A THEORY OF DEFORMATION. K. F. A. Walles. December 1956. 41p. diagrs., tabs. NGTE Memo. M. 242. (Ask for N-48185*)

Procedures are described for analysis of creep curves, creep-rupture data, and hot-fatigue data in terms of the theory of NGTE Reports Nos. R. 94 and R. 137 which are summarized. Rapid graphical methods have been developed whose accuracy is fully adequate for data presently available. In addition to providing values of the constants in the theory they coordinate and summarize experimental data upon convenient graphs of stress versus a time-temperature variable from which values of e.g. strain for any combination of stress, time, and temperature within the experimental range may be immediately read by means of a sliding scale. The analysis of an extensive set of data takes only a short while and detailed study of data for a range of materials becomes practicable.

N-48189*

Royal Aircraft Establishment (Gt. Brit.)
ON THE MINIMISATION AND NUMERICAL EVALUATION OF WAVE DRAG. E. Eminton. November 1955. 23p. diagrs., tabs. RAE Aero 2564. (Ask for N-48189*)

A Fourier analysis of the linearized theory expression for the zero-lift wave drag of a smooth, slender body in terms of its cross-sectional area distribution is used to derive the area distribution which minimizes the expression for given length, volume, nose area, base area, and n intermediate areas. Another minimal deduced from this by relaxing the restriction on volume is used to evolve a method for the numerical evaluation of the original expression. Two practical applications of these results are discussed. The first is in the design of wing-body combinations to have small drag rise at transonic speeds.

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The second is in the calculation of the wave drag of wing-body combinations at zero lift; an example is constructed to illustrate the method and to give an indication of its accuracy.

N-48190*

Royal Aircraft Establishment (Gt. Brit.)
ANALYSIS OF A LOADED CANTILEVER PLATE BY FINITE DIFFERENCE METHODS. R. K. Livesley and P. C. Birchall. June 1956. 24p. RAE Tech. Note MS 26. (Ask for N-48190*)

The various difference patterns necessary for finite difference solution of rectangular plate problems, with various boundary conditions and under various transverse loads, are developed. The solution of one particular problem on DEUCE is also described.

N-48249*

Aeronautical Research Council (Gt. Brit.)
A CONSTRUCTIONAL METHOD FOR MINIMISING THE HAZARD OF CATASTROPHIC FAILURE IN A PRESSURE-CABIN. D. Williams. 1956. 13p. diagrs. ARC CP 286. (Ask for N-48249*)

A method is put forward for substantially reducing the chances of a local failure in the shell of a pressure cabin from developing into catastrophic failure of the cabin. The increased safety is achieved without weight penalty, and consists essentially in using closely spaced (10 inches or thereabouts) transverse flat bands, the material for which is obtained by reducing the sheet thickness normally available for the shell walls.

MISCELLANEOUS

Errata on NACA TN 3941. By John L. Crigler. January 1957.

N-35894, v.4*

Advisory Group for Aeronautical Research and Development. FLIGHT TEST MANUAL, VOLUME IV - INSTRUMENTATION SYSTEMS. Edited by Courtland D. Perkins and Enoch J. Durbin, Princeton University. 1956. Loose-leaf. Advisory Group for Aeronautical Research and Development. (Ask for N-35894, v.4*)

Contents: Part I - THE SYSTEMS CONCEPT IN PLANNING FLIGHT TEST INSTRUMENTATION. Enoch J. Durbin, Princeton U. THE FUNCTIONAL ORGANIZATION OF THE COMPONENT PARTS OF AN INSTRUMENTATION SYSTEM. Enoch J. Durbin, Princeton U. Part II - CHARACTERISTICS OF MEASURING INSTRUMENTS. J. Idrac, Centre d'Essais en Vol, France. DYNAMIC RESPONSE OF INSTRUMENT SYSTEMS. A. Pool, National Aeronautical Research Inst., Amsterdam. DISPLACEMENT MEASUREMENT AS THE BASIS OF TRANSDUCING TECHNIQUES. A. Pool, National Aeronautical Research Inst., Amsterdam. TEMPERATURE SENSING TECHNIQUES. A. Pool, National Aeronautical Research Inst., Amsterdam. PRESSURE SENSING TECHNIQUES. A. Pool, National Aeronautical Research Inst., Amsterdam. ACCELERATION AND VIBRATION SENSING TECHNIQUE. A. Pool, National Aeronautical Research Inst., Amsterdam. FORCE AND STRAIN SENSING TECHNIQUES. Niels Y. Andersen, Cornell Aeronautical Laboratory. FLUID FLOW SENSING TECHNIQUES. Jerry Grey, Princeton U. ATMOSPHERIC WATER VAPOR AND ICING SENSING TECHNIQUES. K. G. Pettit, National Aeronautical Establishment, Canada. AIRFLOW DIRECTION AND CHARACTER SENSING TECHNIQUES. A. Pool, National Aeronautical Research Inst., Amsterdam. SIGNAL MODIFIERS. G. E. Bennett, Royal Aircraft Establishment. TELEMETRY. C. A. Taylor, Burroughs Corp. FRENCH TELEMETERING SYSTEMS. J. Desportes, Centre d'Essais en Vol, France. RECORDERS. A. Toudic, A. Botrel, G. Petit, and B. Galonka, Centre d'Essais en Vol, France. GROUND TRACKING SYSTEMS FOR DETERMINING POSITION AND VELOCITY. H. J. Keyes, Aircraft & Armament Experimental Establishment. Part III - INTRODUCTION TO DATA REDUCTION SYSTEMS. Jerome J. Dover and Jack Ridley, Edwards Air Force Base. Part IV - SYSTEMATIC ERRORS. Edward Seckel, Princeton U. POWER SPECTRAL METHODS OF ANALYSIS AND THEIR APPLICATION TO PROBLEMS IN AIRPLANE DYNAMICS. Harry Press, National Advisory Committee for Aeronautics and John W. Tukey, Bell Telephone Labs., Inc.

UNPUBLISHED PAPERS

N-51356*

ON THE FORMATION OF SUPERCOOLED WATERDROPS AND ICE CRYSTALS IN THE ATMOSPHERE. (Über die Bildung der unterkühlten Wassertropfen und der Eiskristalle in der freien Atmosphäre). L. Krastanow. (1957). 30p. diagrs., tab. Translation from Meteorologische Zeitschrift, v. 57, no. 10, October 1940, p. 357-371. (Ask for N-51356*)

The formation of undercooled waterdrops and ice crystals under atmospheric conditions is treated quantitatively by using the Gibbs-Volmer theory of nucleation. Based on this theory, a method is developed which makes it possible to determine the rate of aggregation of the first condensation products at temperatures below 0° C and under atmospheric conditions, provided that the properties of condensation nuclei are known.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification March 19, 1957.

NACA MR L6B27, by Bartlett (1214 - 7)

NACA RM A8J04

AERODYNAMIC STUDY OF A WING-FUSELAGE COMBINATION EMPLOYING A WING SWEPT BACK 63°. - CHARACTERISTICS AT A MACH NUMBER OF 1.53 INCLUDING EFFECT OF SMALL VARIATIONS OF SWEEP. Robert T. Madden. January 26, 1949. 71p. diagrs., photos., tabs. (NACA RM A8J04)

Measured values of lift, drag, and pitching moment at a Mach number of 1.53 and Reynolds numbers of 0.31, 0.62, and 0.84 million are presented for a wing-fuselage combination having a wing leading-edge sweep angle of 63°, an aspect ratio of 3.42, a taper ratio of 0.25, and an NACA 64A006 section in the stream direction. Data are also presented for sweep angles of 57.0°, 60.4°, 67.0°, and 69.9°. The experimentally determined characteristics were less favorable than indicated by the linear theory but the experimental and theoretical trends with sweep were in good agreement. Boundary-layer-flow tests showed that laminar boundary-layer separation was the primary cause of the differences between experiment and theory.

NACA RM A9C07

AERODYNAMIC STUDY OF A WING-FUSELAGE COMBINATION EMPLOYING A WING SWEPT BACK 63°. - INVESTIGATION AT A MACH NUMBER OF 1.53 TO DETERMINE THE EFFECTS OF CAMBERING AND TWISTING THE WING FOR UNIFORM LOAD AT A LIFT COEFFICIENT OF 0.25. Robert T. Madden. May 6, 1949. 33p. diagrs., photo., tabs. (NACA RM A9C07)

Measured values of lift, drag, and pitching moment at a Mach number of 1.53 are presented for wing-fuselage combinations having cambered and twisted wings with leading-edge sweep angles of 63°, 67°, and 70°. The results obtained with the 63° configuration when compared with those of an earlier investigation using a thicker uncambered, untwisted wing showed an increase in maximum lift-drag ratio from 7.2 to 8.3 at a Reynolds number of 0.84 million. The maximum lift-drag ratio increased with increased Reynolds number, a value of 9.0 being obtained at a Reynolds number of 0.95 million with the 67° configuration.

NACA RM A9C16

A COMPARISON OF THEORETICAL AND EXPERIMENTAL LOADING ON A 63° SWEPT-BACK WING AT SUPERSONIC SPEEDS. Victor I. Stevens and John W. Boyd. September 14, 1949. 21p. diagrs., photos. (NACA RM A9C16)

Results are presented for an investigation of the loading over a wing having 63° of sweepback, an aspect ratio of 3.5, and a taper ratio of 0.25 for Mach numbers from 1.15 to 1.7 and a Reynolds number of 4.5 million. The measured loading as a function of angle of attack is compared with that predicted by use of supersonic lifting-surface theory.

NACA RM A9C21

AERODYNAMIC STUDY OF A WING-FUSELAGE COMBINATION EMPLOYING A WING SWEPT BACK 63°. - EFFECTS OF SPLIT FLAPS, ELEVONS, AND LEADING-EDGE DEVICES AT LOW SPEED. Edward J. Hopkins. May 19, 1949. 46p. diagrs., photos. (NACA RM A9C21)

Measurements were made of the effects of a fuselage, split flaps, elevons, sharp leading edges, drooped-nose flaps, and extended-nose flaps on the lift, drag, and pitching-moment characteristics of a wing having the leading edge swept back 63° and having an aspect ratio of 3.5. Rolling moments produced by the elevons were also measured. Most of the tests were conducted at a Reynolds number of 4.2×10^6.

NACA RM A52C07

AERODYNAMIC CHARACTERISTICS OF TWO PLANE, UNSWEPT TAPERED WINGS OF ASPECT RATIO 3 AND 3-PERCENT THICKNESS FROM TESTS ON TRANSONIC BUMP. Horace F. Emerson and Bernard M. Gale. May 1952. 23p. diagrs., photo. (NACA RM A52C07)

An experimental investigation was conducted, using the transonic-bump technique, to determine the aerodynamic characteristics of two unswept tapered wing models, one having the NACA 0003-63 section and the other a 3-percent-thick circular-arc section, both in streamwise planes. The models had an aspect ratio of 3.0, taper ratio of 0.39, and the 60-percent-chord line unswept. Lift, drag, and pitching-moment coefficients are presented for a Mach number range from 0.60 to 1.10. The Reynolds number for the tests varied from 1.9 to 2.5 million.

NACA RM A52C10a

LIFT, DRAG, AND PITCHING MOMENT OF LOW-ASPECT-RATIO WINGS AT SUBSONIC AND SUPERSONIC SPEEDS - PLANE TRIANGULAR WING OF ASPECT RATIO 3 WITH AIR-TO-AIR MISSILE MODELS MOUNTED EXTERNALLY. Donald Conrard. June 1952. 28p. diagrs., photo. (NACA RM A52C10a)

This report presents the results of an investigation to ascertain the effects of externally mounted missile models on the lift, drag, and pitching moment of a

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wing-fuselage model having a triangular wing of aspect ratio 3 with an NACA 0003-63 section in streamwise planes. Results are shown for Mach numbers of 0.6, 0.9, 1.2, 1.4, and 1.7 at a constant Reynolds number of 4.8 million.

NACA RM A53A09

BUFFETING OF A VERTICAL TAIL ON AN INCLINED BODY AT SUPERSONIC MACH NUMBERS. Forrest E. Gowen. March 1953. 35p. diagrs., photos., tab. (NACA RM A53A09)

Time histories of the rolling moments on a body of revolution with a single vertical-tail fin were obtained in wind-tunnel tests. Data were taken at Mach numbers of 1.45, 1.98, and 2.90 in the range of Reynolds numbers (based on body diameter) from 0.2 million to 1.3 million. Models were tested with three longitudinal positions of the vertical fin and two nose shapes at angles of attack up to about 31°. At Mach numbers of 1.45 and 1.98, visual-flow studies and time histories of surface pressure were also made near the base of the bodies without the tail fin installed. Large aperiodic fluctuations in rolling moment and surface pressure were found to accompany the unsteadiness in the cross flow at large angles of attack.

NACA RM A54C30, by Rogallo, McCloud, and Yaggy

NACA RM A55C02

THE UNSTEADY NORMAL-FORCE CHARACTERISTICS OF SELECTED NACA PROFILES AT HIGH SUBSONIC MACH NUMBERS. Perry P. Polentz, William A. Page, and Lionel L. Levy, Jr. May 1955. 110p. diagrs., photos., tab. (NACA RM A55C02)

The magnitudes of normal-force fluctuations (unsteady normal force) are reported for 27 NACA profiles for angles of attack generally extending up to those corresponding to maximum lift, and Mach numbers from 0.5 to 0.9 at Reynolds numbers between 1 and 2 million. The variations of unsteady normal force with maximum thickness, camber, position of minimum pressure, and leading-edge radius are presented. Unsteady normal force was found to be a stationary random function of time; the principal defining variables, including the first probability density and the spectral density, are presented for some of the profiles at selected test points.

NACA RM A55C08

A CORRELATION OF AIRFOIL SECTION DATA WITH THE AERODYNAMIC LOADS MEASURED ON A 45° SWEPTBACK WING MODEL AT SUBSONIC MACH NUMBERS. Harold J. Walker and William C. Maillard. May 1955. 78p. diagrs., photo., tabs. (NACA RM A55C08)

A study is made at Mach numbers from 0.50 to 0.95 of the correlation between the experimental chordwise pressure distributions for various stations on a 45° sweptback-wing and body combination of aspect ratio 5.5 and those for the corresponding two-dimensional airfoil corrected for sweep. The applicability of airfoil section data, in conjunction with span-loading theory, for predicting the wing loading is also studied. The characteristics of the flow within and beyond the limiting conditions for good correlation are discussed.

NACA RM A55C23

A STUDY OF THE APPLICATION OF AIRFOIL SECTION DATA TO THE ESTIMATION OF THE HIGH SUBSONIC SPEED CHARACTERISTICS OF SWEPT WINGS. Lynn W. Hunton. June 1955. 37p. diagrs., tab. (NACA RM A55C23)

Estimates of the variation with Mach number of the aerodynamic characteristics of swept wings are made on the basis of airfoil section data combined with span-loading theory. The analysis deals with examinations of the lift, drag, and pitching moment of 26 wings and wing-body combinations ranging in sweep angle from 35° to 60° and for Mach numbers between 0.6 and 1.0.

NACA RM A55K14

EFFECT OF AREA-SUCTION-TYPE BOUNDARY-LAYER CONTROL ON THE LANDING-APPROACH CHARACTERISTICS OF A 35° SWEPT-WING FIGHTER. George E. Cooper and Robert C. Innis. February 1956. 35p. diagrs., photos., tabs. (NACA RM A55K14)

A flight evaluation of porous area-suction boundary-layer control applied to the wing flap of one 35° swept-wing fighter airplane and to the wing leading edge of another has been made. Pilots' opinions of the effects of these applications of porous area suction with respect to the landing-approach characteristics of the test airplanes are presented for 16 NACA, Navy, Air Force, and contractor pilots. Lift and thrust-required data are presented for each configuration and related to the pilots' opinions.

NACA RM A55K29

FLIGHT MEASUREMENTS OF THE LOW-SPEED CHARACTERISTICS OF A 35° SWEPT-WING AIRPLANE WITH AREA-SUCTION BOUNDARY-LAYER CONTROL ON THE FLAPS. Seth B. Anderson and Hervey C. Quigley. February 1956. 35p. diagrs., photos., tab. (NACA RM A55K29)

Tests were conducted to determine the flight characteristics of an F-86A airplane equipped with an area-suction boundary-layer-control system on the flaps. The effectiveness and suction requirements of the flap were determined and compared with wind-tunnel results. Take-off and landing performance data are presented as calculated from lift and drag measurements. Improvements in flap lift increment with suction are reflected in decreases in landing-approach speeds over the normal airplane.

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NACA RM A56G30

FLIGHT MEASUREMENTS OF THE LOW-SPEED CHARACTERISTICS OF A 35° SWEPT-WING AIRPLANE WITH BLOWING-TYPE BOUNDARY-LAYER CONTROL ON THE TRAILING-EDGE FLAPS. Seth B. Anderson, Hervey C. Quigley, and Robert C. Innis. October 1956. 52p. diagrs., photos., tabs. (NACA RM A56G30)

Tests were conducted to determine the flight characteristics of an F-86F airplane equipped with a blowing-type boundary-layer control system on the trailing-edge flaps. The effectiveness and flow requirements of the flap were determined and compared with other boundary-layer control applications. Take-off and landing performance data are presented as calculated from lift and drag measurements. Pilot evaluation of the blowing flap is included.

NACA RM E8L13

ALTITUDE-WIND-TUNNEL INVESTIGATION OF AN-F-58 FUEL IN EXPERIMENTAL VERSION OF J47 TURBOJET ENGINE. Carl L. Meyer. May 2, 1949. 16p. diagrs., tab. (NACA RM E8L13)

An altitude-wind-tunnel investigation of the performance of AN-F-58 and AN-F-32 fuels in an experimental turbojet engine was conducted over a range of simulated altitudes and flight Mach numbers. Combustion efficiencies obtained with AN-F-58 and AN-F-32 fuels were approximately equal. The minimum-speed altitude operational limit was essentially the same with either AN-F-58 or AN-F-32 fuel. Starting characteristics of the two fuels were approximately the same at low windmilling speeds. Visual observation showed no apparent differences in the carbon-deposition rates of AN-F-58 and AN-F-32 fuels.

NACA RM E9C11

EXPERIMENTAL INVESTIGATION OF LIQUID DIBORANE - LIQUID OXYGEN PROPELLANT COMBINATION IN 100-POUND-THRUST ROCKET ENGINE. William H. Rowe, Paul M. Ordin, and John M. Diehl. May 9, 1949. 25p. diagrs., photos., tab. (NACA RM E9C11)

Values of specific impulse were determined over a range of mixture ratios using a liquid diborane - liquid oxygen propellant combination in a 100-pound-thrust rocket engine. The maximum value of 274 pound-seconds per pound (correlated for heat rejection) occurred at a ratio of fuel weight to total propellant weight of 0.36. A few runs were made with an engine having a smaller characteristic length and also with an engine having another type of injection. A limited number of shock- and temperature-sensitivity determinations made with diborane produced no explosions nor detonations.

NACA RM E9G09, by Conrad and Sobolewski
NACA RM E9G28, by Prince and Jansen
NACA RM E9I26, by Bloomer
NACA RM E9K10, by Thorman and McAulay
NACA RM E9L02, by Campbell
NACA RM E50G07, by Golladay and Bloomer
NACA RM E50J12, by Farley and Prince
NACA RM E50K24, by Jansen and McAulay

NACA RM E51A04

ALTITUDE OPERATION OF GAS-TURBINE ENGINE WITH VARIABLE-AREA FUEL-NOZZLE SYSTEM. H. Gold and S. Rosenzweig. April 2, 1951. 41p. diagrs., photos. (NACA RM E51A04)

The fuel consumption and combustion efficiency of a gas-turbine engine alternately equipped with variable- and with fixed-area fuel nozzles were investigated at altitudes up to 40,000 feet. At 40,000 feet, the engine when equipped with variable-area fuel nozzles operated with reduced fuel consumption and increased combustion efficiency. At lower altitudes, these gains, which are attributed to improved atomization, occurred at progressively lower engine-speed ranges. A correlation is presented between the percentage reduction in fuel consumption and the fuel consumption of the engine equipped with fixed-area fuel nozzles. This percentage reduction is a function of fuel-flow rate through the nozzles.

#NACA RM E51B06, by Saari and Wintler
#NACA RM E51B07, by Wilsted and Grey
#NACA RM E51G25, by Campbell

NACA RM E51H13

AERODYNAMICS OF SLENDER BODIES AT MACH NUMBER OF 3.12 AND REYNOLDS NUMBERS FROM 2×10^6 TO 15×10^6. I - BODY OF REVOLUTION WITH NEAR-PARABOLIC FOREBODY AND CYLINDRICAL AFTERBODY. John R. Jack and Warren C. Burgess. November 1951. 47p. diagrs., photos. (NACA RM E51H13)

An experimental investigation of the aerodynamic characteristics of a slender, square-based body of revolution was conducted at a Mach number of 3.12 for angles of attack from 0° to 10° and for Reynolds numbers from 2×10^6 to 15×10^6. Boundary-layer measurements at zero angle of attack are compared with several compressible flow formulations for predicting boundary-layer characteristics. Comparison of experimental pressure and force values with theoretical values showed good agreement for low angles of attack. The measured mean skin-friction coefficients agreed well with those predicted by Mangler's transformation for laminar flow over cones.

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NACA RM E51H30

PRELIMINARY RESULTS OF TURBOJET-ENGINE ALTITUDE-STARTING INVESTIGATION. H. D. Wilsted and J. C. Armstrong. November 1951. 25p. diagrs. (NACA RM E51H30)

A spark energy of 2.13 joules per spark at 1 spark per second produced ignition to an altitude of 50,000 feet at a flight Mach number of 0.6. The minimum power requirements for ignition were obtained from a combination of low spark repetition rates and high spark energy. The altitude-ignition limit was also increased by increasing spark-gap immersion, fuel temperature, inlet-air temperature, and fuel volatility, and by decreasing flight Mach number. The maximum altitude at which flame propagation was accomplished from combustors with spark plugs to combustors without spark plugs was increased about 5000 feet by increasing fuel volatility.

#NACA RM E51I14, by Meyer and Johnson
#NACA RM E51J15, by Fleming
#NACA RM E51J26, by Useller, Harp, and Barson
#NACA RM E51K19, by Delio and Rosenzweig
#NACA RM E52F18, by Harp, Useller, and Auble
#NACA RM E52F20, by Useller, Auble, and Harvey

NACA RM E52H04

SOME DYNAMIC CHARACTERISTICS OF A TURBOJET ENGINE FOR LARGE ACCELERATIONS. Herbert Heppler, David Novik, and Marcel Dandois. August 1952. 20p. diagrs., photos. (NACA RM E52H04)

Dynamics of an axial-flow turbojet engine with a fixed area exhaust nozzle were obtained from successively larger transients including successful accelerations through surge. In the low-speed range, appreciable changes in thrust were obtainable only as a result of changes in speed. Beyond an optimum step increase in fuel flow at each engine speed, further increases in the size of the fuel step did not result in further increases in acceleration and thrust, and a curve of maximum acceleration was obtained. Maximum acceleration and thrust appeared obtainable through the use of a proposed fuel schedule that required only small initial steps in fuel flow.

NACA RM E53J15

A METHOD OF MEASURING JET THRUST OF TURBOJET ENGINES IN FLIGHT INSTALLATIONS. Joseph N. Sivo and David B. Fenn. January 1954. 19p. diagrs., photo. (NACA RM E53J15)

Measurement of the jet thrust of a turbojet engine in flight becomes more difficult as the number and complexity of the engine components increase. It is desirable, therefore, that a general correlation of jet thrust be developed which is applicable to a simple direct reading thrustmeter. In view of this need a correlation is presented which is independent of flight conditions and applicable to both nonafterburning and afterburning engines equipped with nonejector type fixed- and variable-area convergent exhaust nozzles. The general equation used in this correlation was derived from the theoretical jet-thrust equation for a choked convergent nozzle. The data used to verify the correlation were obtained over a range of altitudes from 10,000 to 54,000 feet and a range of flight Mach numbers from 0.4 to 1.1. A thrustmeter based on this equation was installed on an afterburning turbojet engine equipped with a fixed-area convergent exhaust nozzle. The results indicated that a meter based on this correlation would be applicable to a flight installation and that probable error in thrust measurement would be approximately ±1.5 percent provided the exhaust-nozzle thrust coefficient is known.

NACA RM E54C11

EXPERIMENTAL INVESTIGATION OF THE EFFECT OF A SHROUDED ROTOR ON THE PERFORMANCE OF A CONSERVATIVELY DESIGNED TURBINE. Cavour H. Hauser and Henry W. Plohr. May 1954. 14p. diagrs., photo. (NACA RM E54C11)

In order to determine the effect of shrouding the rotor blades of a particular turbine design on the overall turbine performance, a conservatively designed experimental cold-air turbine was investigated both with and without a shroud band on the rotor blades. The tip of the rotor blade was oriented toward the tangential direction so that the adverse effect of blade-tip scraping would not be appreciable. It was found that the addition of a shroud to the turbine rotor blades had only a slight effect and did not improve the turbine performance. The efficiency for the unshrouded-rotor configuration was about one point higher than for the shrouded rotor.

NACA RM E54C18

EXPERIMENTAL INVESTIGATION OF EFFECT OF HIGH-ASPECT-RATIO ROTOR BLADES ON PERFORMANCE OF CONSERVATIVELY DESIGNED TURBINE. Cavour H. Hauser and William J. Nusbaum. May 1954. 13p. diagrs., photo. (NACA RM E54C18)

A considerable weight reduction in the turbine wheel of an aircraft gas turbine is attained through the use of high-aspect-ratio rotor blading. An experimental investigation was made to compare the performance of a turbine of conservative aerodynamic design having shrouded rotor blades with an aspect ratio of 4.48 with that obtained from both a shrouded and an unshrouded rotor design with aspect ratio of 2.24. The use of high-aspect-ratio rotor blades had a negligible effect on the turbine efficiency.

UNPUBLISHED PAPERS

NACA RM E55C22

INJECTION PRINCIPLES FROM COMBUSTION STUDIES IN A 200-POUND-THRUST ROCKET ENGINE USING LIQUID OXYGEN AND HEPTANE. M. F. Heidmann and C. M. Auble. June 1955. 55p. diagrs., photos., tabs. (NACA RM E55C22)

Ten injectors were tested in a 200-pound-thrust rocket engine with liquid oxygen and heptane. The injectors were designed to evaluate the relative importance of atomizing and mixing the propellants. Characteristic velocity, chamber gas velocity, and combustion photographs were compared. The results showed that atomizing the fuel controlled the combustion rate to a much larger extent than atomizing the oxygen. Induced mixing, however, completed combustion in the smallest volume. For stable, high-efficiency combustion and smooth engine starts, mixing after atomization was most promising.

NACA RM E55D28

CORRELATION OF TURBOJET COMBUSTOR CARBON FORMATION WITH SMOKE-VOLATILITY INDEX, SMOKE POINT, AND NACA K FACTOR. Edmund R. Jonash, Helmut F. Butze, and William P. Cook. June 1955. 28p. diagrs., photos., tabs. (NACA RM E55D28)

Carbon-forming characteristics of MIL-F-5624 grades JP-3 and JP-4 jet fuels were determined in a single-tubular combustor. While three empirical fuel factors satisfactorily correlated combustor deposit and exhauxt-gas smoke data obtained at one operating condition, none was satisfacotry at a higher pressure and temperature. Further, only deposit data obtained at the first condition correlated with full-scale engine results obtained with the same fuels.

NACA RM E55J31

EFFECT OF FUEL ADDITIVES ON CARBON DEPOSITION IN A J33 SINGLE COMBUSTOR. IV - NINE OXYGEN-BEARING COMPOUNDS. Edmund R. Jonash, William P. Cook, and Jerrold D. Wear. February 1956. 12p. diagrs., photos., tabs. (NACA RM E55J31)

The effectiveness of nine oxygen-bearing additives in reducing carbon formation of No. 2 furnace oil was studied in a single turbojet combustor. Among the additives tested only four, three alkyl nitrates, and diethyl ether, reduced carbon deposits significantly; the largest reduction, 30 percent, was obtained with a 1.0 percent by weight concentration of iso-octyl nitrate. None of the additives had a significant effect on exhaust-gas-smoke concentration.

NACA RM L8A05a

RESULTS OBTAINED DURING ACCELERATED TRANSONIC TESTS OF THE BELL XS-1 AIRPLANE IN FLIGHTS TO A MACH NUMBER OF 0.92. Hubert M. Drake, Milton D. McLaughlin, and Harold R. Goodman. April 19, 1948. 22p. diagrs., tab. (NACA RM L8A05a)

Results are presented of tests up to a Mach number of 0.92 at altitudes around 30,000 feet. The data obtained show that the airplane can be flown to this Mach number above 30,000 feet. Longitudinal trim changes have been experienced but the forces involved have been small. The elevator effectiveness decreased about one-half with increase of Mach number from 0.70 to 0.87. Buffeting has been experienced in level flight but it has been mild and the associated tail loads have been small. No aileron buzz or other flutter phenomena have been noted.

NACA RM L8A23a

RESULTS OF PRELIMINARY FLIGHT TESTS OF THE XS-1 AIRPLANE (8-PERCENT WING) TO A MACH NUMBER OF 1.25. W. C. Williams and De E. Beeler. April 6, 1948. 14p. diagrs. (NACA RM L8A23a)

Presents results of the U.S. Air Forces' accelerated transonic flight tests of the XS-1 No. 1 airplane for the Mach number range from 0.70 to 1.25 at altitudes from 30,000 to 49,000 feet. Data are included on horizontal-tail loads and buffeting, longitudinal trim changes, elevator effectiveness and control forces, and lateral trim characteristics.

NACA RM L8C23a

RESULTS OBTAINED DURING A DIVE RECOVERY OF THE BELL XS-1 AIRPLANE TO HIGH LIFT COEFFICIENTS AT A MACH NUMBER GREATER THAN 1.0. Milton D. McLaughlin and Dorothy C. Clift. April 6, 1948. 6p. diagrs. (NACA RM L8C23a)

Measured quantities are presented which were obtained on the Bell XS-1 airplane with an 8-percent-thick wing and a 6-percent-thick horizontal tail during a dive recovery at a Mach number greater than 1.0. The data obtained show that it is possible to obtain fairly high load factors with the airplane at Mach numbers greater than 1.0 if the stabilizer is used for longitudinal control. Lift coefficients approaching low-speed maximum-lift values have been obtained at a Mach number of 1.1 with no indication that these values are the maximum obtainable for the airplane. At the Mach number and lift coefficient reported, there was little or no buffeting.

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NACA RM L51A12

FREE-FLIGHT-TUNNEL INVESTIGATION OF THE DYNAMIC LATERAL STABILITY AND CONTROL CHARACTERISTICS OF A TIP-TO-TIP BOMBER-FIGHTER COUPLED AIRPLANE CONFIGURATION. Charles V. Bennett and Robert B. Cadman. April 4, 1951. 16p. diagrs., tab. (NACA RM L51A12)

The results are presented of an experimental investigation conducted in the Langley free-flight tunnel to determine the dynamic stability and control characteristics of a coupled airplane configuration consisting of a simplified fighter model attached to each wing tip of a simplified bomber model. The fighter models could be attached either rigidly, or with freedom in roll, freedom in roll and pitch, or freedom in roll, pitch, and yaw with respect to the bombers.

NACA RM L52C26

FLIGHT INVESTIGATION FROM MACH NUMBER 0.8 TO MACH NUMBER 2.0 TO DETERMINE SOME EFFECTS OF WING-TO-TAIL DISTANCE ON THE LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A 60° DELTA-WING-CANARD MISSILE. Clarence A. Brown, Jr., and Reginald R. Lundstrom. June 1952. 42p. diagrs., photos. (NACA RM L52C26)

A flight test was conducted on a 60° delta wing and canard missile configuration with a long fuselage. Stability derivatives, control hinge moment, and drag characteristics are presented throughout a Mach number range of 0.80 to 2.0. Comparison is made with data from a similar model having a shorter fuselage.

NACA RM L52E05a

FLOW SEPARATION FROM RODS AHEAD OF BLUNT NOSES AT MACH NUMBER 2.72. Jim J. Jones. July 1952. 18p. diagrs., photos. (NACA RM L52E05a)

An experimental investigation has been made of the flow separation from slender rods mounted to extend forward along the axes of symmetry of blunt-nosed bodies. The mechanism of the separation and its governing criteria are discussed. Drag data at a Mach number of 2.72 for various rod lengths and nose radii at an angle of attack of 0° are presented.

NACA RM L54C02

THREE-DEGREE-OF-FREEDOM EVALUATION OF THE LONGITUDINAL TRANSFER FUNCTIONS OF A SUPERSONIC CANARD MISSILE CONFIGURATION INCLUDING CHANGES IN FORWARD SPEED. Ernest C. Seaberg. April 1954. 29p. diagrs., photo., tabs. (NACA RM L54C02)

The three-degree-of-freedom longitudinal equations of motion including changes in forward speed are applied to a supersonic canard missile of the boost-glide type to determine the longitudinal transfer functions. These transfer functions are presented in the form of frequency-response plots for several flight conditions. For a constant Mach number, the frequency response is shown to vary with angle of attack, mainly in the region of low-frequency airframe operation. A comparison of the frequency responses thus obtained with those in which the forward speed change is neglected also shows significant variation in the low-frequency region. The additional derivatives necessary for this study (namely C_{D_α}, C_{D_u}, C_{L_u}, and C_{m_u}) were obtained from a reevaluation of existing flight data and are evaluated for a Mach number range from transonic to approximately 1.8.

NACA RM L54C08

MEASUREMENTS AND PREDICTIONS OF FLOW CONDITIONS ON A TWO-DIMENSIONAL BASE SEPARATING A MACH NUMBER 3.36 JET AND A MACH NUMBER 1.55 OUTER STREAM. Donald E. Coletti. May 1954. 56p. diagrs., photos. (NACA RM L54C08)

Results are presented of an investigation made in a mixing-zone apparatus of the effects of jet flow on two-dimensional base pressure, including a prediction of the base pressure. The development of supersonic-channel flow about a two-dimensional base, with and without splitter plates of different thicknesses was also investigated. The Mach number of the outer stream was 1.55 and the center-jet Mach number was 3.36. Pressure measurements and observations of the flow are presented.

NACA RM L54C10

ROCKET-POWERED-MODEL INVESTIGATION OF THE HINGE-MOMENT AND NORMAL-FORCE CHARACTERISTICS OF A HALF-DIAMOND TIP CONTROL ON A 60° SWEPTBACK DIAMOND WING BETWEEN MACH NUMBERS OF 0.5 AND 1.3. James D. Church. April 1954. 30p. diagrs., photos., tab. (NACA RM L54C10)

Control-force and hinge-moment characteristics were obtained from a free-flight investigation of a rocket-powered research model equipped with 60° sweptback diamond wings having 30° sweptforward trailing edges featuring half-diamond tip controls. Data were obtained for control deflections up to ±13° and for angles of attack from ±3° to ±14° between Mach numbers of 0.5 and 1.3. Comparisons are made with other rocket-powered-model test results.

NACA RM L54C26

WIND-TUNNEL INVESTIGATION OF EFFECT OF SWEEP ON ROLLING DERIVATIVES AT ANGLES OF ATTACK UP TO 13° AND AT HIGH SUBSONIC MACH NUMBERS, INCLUDING A SEMIEMPIRICAL METHOD OF ESTIMATING THE ROLLING DERIVATIVES. James W. Wiggins. April 1954. 47p. diagrs., tab. (NACA RM L54C26)

Results are presented of an investigation to determine the rolling derivatives for swept-wing—body configurations. The wing had sweep angles at the quarter-chord line of 3.6°, 32.6°, 45°, and 60°, an aspect ratio of 4, a taper ratio of 0.6, and an NACA

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65A006 airfoil section parallel to the free stream. The angle-of-attack range was from 0° to 13° and the Mach number range was from 0.50 to 0.95, corresponding to a Reynolds number range from 1.8×10^{6} to 3.0×10^{6}. Tests at selected angles of attack were repeated for the 45° swept wing with fences located at the 65-percent-semispan station. Included is a semiempirical method for estimating the rolling derivatives.

NACA RM L55G05

A THEORETICAL ANALYSIS OF THE EFFECT OF ENGINE ANGULAR MOMENTUM ON LONGITUDINAL AND DIRECTIONAL STABILITY IN STEADY ROLLING MANEUVERS. Ordway B. Gates, Jr., and C. H. Woodling. October 1955. 20p. diagrs., tab. (NACA RM L55G05)

The effect of engine momentum on the longitudinal and directional stability of aircraft in steady rolling maneuvers has been investigated. The results presented indicate that the gyroscopic moments produced on the aircraft by the rotating engine in rolling maneuvers can have an appreciable effect on the range of rolling velocities for which longitudinal or directional instability might occur.

NACA RM L56F04

A SIMPLIFIED METHOD FOR APPROXIMATING THE TRANSIENT MOTION IN ANGLES OF ATTACK AND SIDESLIP DURING A CONSTANT ROLLING MANEUVER. Leonard Sternfield. August 1956. 38p. diagrs., tabs. (NACA RM L56F04)

A simplified method for approximating the transient motion in angles of attack and sideslip during a constant rolling maneuver is presented. From the expressions presented in the paper, the pertinent modes of motion as well as the modal coefficient corresponding to each mode can be determined. Calculations made with and without the derivatives $C_{Y_{\beta}}$ (side force due to sideslip) and $C_{L_{\alpha}}$ (lift-curve slope) indicate that although these derivatives increase the total damping of the system, they do not markedly affect the transient motion.

#NACA RM SL51A12, by Bennett and Cadman

#NACA RM SL54C19a, by Smith and Lovell

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NACA Rept. 1268

THEORETICAL CALCULATIONS OF THE PRESSURES, FORCES, AND MOMENTS AT SUPERSONIC SPEEDS DUE TO VARIOUS LATERAL MOTIONS ACTING ON THIN ISOLATED VERTICAL TAILS. Kenneth Margolis and Percy J. Bobbitt. 1956. ii, 44p. diagrs., tabs. (NACA Rept. 1268. Supersedes TN 3373; TN 3240)

Velocity potentials, pressure distributions, and stability derivatives have been derived by use of supersonic linearized theory for families of thin isolated vertical tails performing steady rolling, steady yawing, constant sideslip, and constant-lateral-acceleration motions. Vertical-tail families (half-delta and rectangular plan forms) are considered for a broad Mach number range. Also considered are the vertical tail with arbitrary sweepback and taper ratio at Mach numbers for which both the leading edge and trailing edge of the tail are supersonic and the triangular vertical tail with a subsonic leading edge and a supersonic trailing edge. End-plate effects for several of the derivatives are included.

NACA Rept. 1270

REVIEW OF EXPERIMENTAL INVESTIGATIONS OF LIQUID-METAL HEAT TRANSFER. Bernard Lubarsky and Samuel J. Kaufman. 1956. ii, 33p. diagrs., tab. (NACA Rept. 1270. Supersedes TN 3336)

Experimental data of various investigators of liquid-metal heat-transfer characteristics were reevaluated using as consistent assumptions and methods as possible and then compared with each other and with theoretical results. The reevaluated data for both local fully developed and average Nusselt numbers in the turbulent flow region were found still to have considerable spread, with the bulk of the data being lower than predicted by existing analysis. An equation based on empirical grounds which represents most of the fully developed heat-transfer data is $Nu = 0.625\ Pe^{0.4}$ where Nu represents the Nusselt number and Pe the Peclet number. The theoretical prediction of the heat transfer in the entrance region was found to give lower values, in most cases, than those found in the experimental work.

NACA Rept. 1272

A REEVALUATION OF DATA ON ATMOSPHERIC TURBULENCE AND AIRPLANE GUST LOADS FOR APPLICATION IN SPECTRAL CALCULATIONS. Harry Press, May T. Meadows, and Ivan Hadlock. 1956. ii, 29p. diagrs., tabs. (NACA Rept. 1272. Supersedes TN 3362; TN 3540)

The available information on the spectrum of atmospheric turbulence is first briefly reviewed. On the basis of these results, methods are developed for the conversion of available gust statistics normally given in terms of counts of gusts or acceleration peaks into a form appropriate for use in spectral calculations. The fundamental quantity for this purpose appears to be the probability distribution of the root-mean-square gust velocity. Estimates of this distribution are derived from data for a number of load histories of transport operations; also, estimates of the variation of this distribution with altitude and weather condition are derived from available data and the method of applying these results to the calculation of airplane gust-response histories in operations is also outlined.

NACA Rept. 1275

THE PROPER COMBINATION OF LIFT LOADINGS FOR LEAST DRAG ON A SUPERSONIC WING. Frederick C. Grant. 1956. ii, 9p. diagrs., tab. (NACA Rept. 1275. Supersedes TN 3533)

Lagrange's method of undetermined multipliers is applied to the problem of properly combining lift loadings for the least drag at a given lift on supersonic wings. The interference drag between the optimum loading and any loading at the same lift coefficient is found to be constant on a given plan form. This is an integral form of a criterion established by Robert T. Jones for optimum loadings. The best combination of four loadings on a delta wing with subsonic leading edges is calculated as a numerical example.

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NACA Rept. 1276

WIND-TUNNEL AND FLIGHT INVESTIGATIONS OF THE USE OF LEADING-EDGE AREA SUCTION FOR THE PURPOSE OF INCREASING THE MAXIMUM LIFT COEFFICIENT OF A 35° SWEPT-WING AIRPLANE. Curt A. Holzhauser and Richard S. Bray. 1956. ii, 24p. diagrs., photos., tabs. (NACA Rept. 1276. Supersedes RM A52G17; RM A55C07)

Wind tunnel and flight tests were made to evaluate the lift characteristics and suction requirements of a 35° swept-wing airplane with a leading edge area-suction boundary-layer-control installation. Large gains in maximum lift coefficients were obtained, and the resulting stalling characteristics of the airplane were tolerable to good. The porous leading edge had no marked detrimental effect on the operational performance of the airplane.

NACA Rept. 1281

FLIGHT DETERMINATION OF DRAG OF NORMAL-SHOCK NOSE INLETS WITH VARIOUS COWLING PROFILES AT MACH NUMBERS FROM 0.9 TO 1.5. R. I. Sears, C. F. Merlet, and L. W. Putland. 1956. ii, 19p. diagrs., photos., tabs. (NACA Rept. 1281. Supersedes RM L53I25a)

External-drag data are presented for normal-shock nose inlets with NACA 1-series, parabolic, and conic cowling profiles. The tests were made at an angle of attack of 0° by using rocket-propelled models in free flight at Mach numbers from 0.9 to 1.5. The Reynolds number based on body maximum diameter varied from 2.5×10^6 to 5.5×10^6. At maximum flow rate, the inlet models had about the same external drag at a Mach number of approximately 1.1, but at higher Mach numbers the sharp-lip conic cowling had the least drag. Blunting or beveling the lip of the conic cowling while keeping the fineness ratio constant resulted in drag coefficients slightly higher than for the sharp-lip conic cowling at maximum flow rate. At a mass-flow ratio of about 0.8, the conic cowlings with sharp, blunt, or beveled lips and the parabolic cowling all gave about the same drag.

NACA RM L57A11

PRELIMINARY MEASUREMENTS OF ATMOSPHERIC TURBULENCE AT HIGH ALTITUDE AS DETERMINED FROM ACCELERATION MEASUREMENTS ON LOCKHEED U-2 AIRPLANE. Thomas L. Coleman and Jack Funk. March 1957. 14p. diagrs., tab. (NACA RM L57A11)

An analysis of turbulence data obtained from VGH records covering approximately 22,000 flight miles taken on Lockheed U-2 airplanes during research flights up to 55,000 feet over England and Western Europe is presented. Substantial reductions in the number and intensity of gusts with increasing altitude are indicated. The results on the variation of the amount and intensity of turbulence with altitude are compared with turbulence data previously obtained from airplane- and balloon-borne instruments over the United States.

NACA TM 1405

STEADY NUCLEAR COMBUSTION IN ROCKETS. (Stationäre Kernverbrennung in Raketen). E. Sänger. April 1957. 39p. diagrs., tab. (NACA TM 1405. Translation from Astronautica Acta, v.1, pt.2, 1955, p.61-88)

Astrophysical theory is applied to study possibilities for thermonuclear reactions to be used as an energy source for the propulsion of atomic rockets, photon rockets, turbojets, and ram jets. Results indicate maximum heat production at 10^8 °K for the hydrogen isotopes. For chamber pressures of 100 atm the energy release 10^4 kcal/(cu m)(sec) is comparable to that of the chemical fuels. The effect of burnup time and of the degree of complete ionization on the balance between energy release and energy radiated is determined.

NACA TM 1430

THE EFFECT OF SOLID ADMIXTURES ON THE VELOCITY OF MOTION OF A FREE DUSTY AIR JET. (K Voprosu o Vliyanii Tverdykh Primecei na Skorost' Dvizheniya Svobodnoi Pylevozdushnoi Strui). A. P. Chernov. April 1957. 7p. diagr. (NACA TM 1430. Translation from Zhurnal Tekhnicheskoi Fiziki, v.26, no.5, 1956, p.1060-1063)

The presence of solid pulverized particles suspended in air in concentrations of up to 1 kg particles/1 kg air and velocities less than 30 m/sec has no significant effect on the aerodynamics of air jet. For velocities greater than 30 m/sec and concentrations different than 1 the effect can be calculated.

NACA TN 3780

INCOMPRESSIBLE FLUTTER CHARACTERISTICS OF REPRESENTATIVE AIRCRAFT WINGS. C. H. Wilts, California Institute of Technology. April 1957. 121p. diagrs., tabs. (NACA TN 3780)

The present report gives the results of a detailed study of the flutter characteristics of four representative aircraft wings. This study was made using the electric analog computer at the California Institute of Technology. During the course of this investigation, eight important parameters of each wing were varied and, in addition, the effects of mass, inertia, pitching spring, and location of a concentrated mass were investigated for all four wings and several sweepback angles.

NACA TN 3824

EFFECT OF AN INTERFACE ON TRANSIENT TEMPERATURE DISTRIBUTION IN COMPOSITE AIRCRAFT JOINTS. Martin E. Barzelay and George F. Holloway, Syracuse University. April 1957. 51p. diagrs., photo., tabs. (NACA TN 3824)

Geometrically related structural joints representing typical skin-stringer cross sections were tested under radiant heating to simulate the effects of aerodynamic heating. Temperature histories for 15 2024-T fabricated specimens and an equal number of integral control specimens were recorded for two

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different constant heat inputs, ranging from approximately 5 to 40 Btu/(sq ft)(sec). Interface conductance values were computed for each of the 15 fabricated specimens. A maximum temperature rise of 450° F was attained in the specimens in 8 to 40 seconds of heating. There was no restraint or external loading applied.

NACA TN 3826

INVESTIGATION OF A NONLINEAR CONTROL SYSTEM. I. Flügge-Lotz and C. F. Taylor, Stanford University. April 1957. 92p. diagrs., tabs. (NACA TN 3826)

A discontinuous variation of coefficients of the differential equation describing the linear control system before nonlinear elements are added is studied in detail. The nonlinear feedback is applied to a second-order system. Simulation techniques are used to study performance of the nonlinear control system and to compare it with the linear system for a wide variety of inputs. A preliminary extension of this type of system to higher order systems is presented.

NACA TN 3845

INVESTIGATION OF THE EFFECTS OF LEADING-EDGE CHORD-EXTENSIONS AND FENCES IN COMBINATION WITH LEADING-EDGE FLAPS ON THE AERODYNAMIC CHARACTERISTICS AT MACH NUMBERS FROM 0.40 TO 0.93 OF A 45° SWEPT-BACK WING OF ASPECT RATIO 4. Kenneth P. Spreemann and William J. Alford, Jr. April 1957. 45p. diagrs., photo., tabs. (NACA TN 3845. Supersedes RM L53A09a)

An investigation was conducted in the Langley high-speed 7- by 10-foot tunnel over a Mach number range of 0.40 to 0.93 to determine the effects of a number of wing leading-edge modifications and fences on the aerodynamic characteristics in pitch of a wing-fuselage combination with the wing quarter-chord line swept back 45°, aspect ratio 4.0, taper ratio 0.3, and an NACA 65A006 airfoil section. Lift, drag, and pitching moment were obtained for all configurations over an angle-of-attack range of about -2° to 24°.

NACA TN 3908

HYDRODYNAMIC CHARACTERISTICS OVER A RANGE OF SPEEDS UP TO 80 FEET PER SECOND OF A RECTANGULAR MODIFIED FLAT PLATE HAVING AN ASPECT RATIO OF 0.25 AND OPERATING AT SEVERAL DEPTHS OF SUBMERSION. Victor L. Vaughan, Jr., and John A. Ramsen. April 1957. 23p. diagrs. (NACA TN 3908)

Results of an investigation of the hydrodynamic characteristics over an extended speed range of a rectangular modified flat plate having an aspect ratio of 0.25 and operating at several depths of submersion are presented. Comparisons between these data and data over a lower speed range on a similar aspect-ratio-0.25 flat plate but having one-half the thickness are presented. These comparisons show no significant differences at the low speeds. At high speeds and high angles of attack, where extensive cavitation was present, the lift coefficients were lower than would have been indicated by the results of the previous investigations and the present investigation at the lower angles of attack. A brief discussion and comparison of ventilation are presented which shows two types of planing bubble formation and the effect of increasing the thickness of the model on the ventilation boundary.

NACA TN 3910

THE RESPONSE OF AN AIRPLANE TO RANDOM ATMOSPHERIC DISTURBANCES. Franklin W. Diederich, California Institute of Technology. April 1957. ii, 95p. diagrs., tab. (NACA TN 3910)

The statistical approach to the gust-load problem which consists in considering flight through turbulent air to be a stationary random process is extended by including the effect of lateral variation of the instantaneous gust intensity on the aerodynamic forces. The forces obtained in this manner are used in dynamic analyses of rigid and flexible airplanes free to move vertically, in pitch, and in roll. The effect of the interaction of longitudinal, vertical, and lateral gusts on the wing stresses is also considered.

NACA TN 3953

A LIMITED CORRELATION OF ATMOSPHERIC SOUNDING DATA AND TURBULENCE EXPERIENCED BY ROCKET-POWERED MODELS. Homer P. Mason and William N. Gardner. April 1957. 51p. diagrs., tab. (NACA TN 3953)

Atmospheric turbulence as experienced by rocket-powered models and temperature lapse-rate data obtained from rawinsonde soundings have been analyzed and compared in 38 cases by using an assumed lapse-rate stability boundary. A limited correlation has been obtained which shows that a large percentage of turbulent conditions can be avoided by making rocket-model flight tests only during marginal or stable lapse-rate conditions.

NACA TN 3955

A COLLECTION OF DATA FOR ZERO-LIFT DAMPING IN ROLL OF WING-BODY COMBINATIONS AS DETERMINED WITH ROCKET-POWERED MODELS EQUIPPED WITH ROLL-TORQUE NOZZLES. David G. Stone. April 1957. 23p. diagrs., tab. (NACA TN 3955. Supersedes RM L53E26)

Zero-lift damping-in-roll data have been collected from experimentally determined results through high subsonic, transonic, and low supersonic speeds by a torque-nozzle forced-roll technique utilizing rocket-propelled models. These collections of data show the effects of wing plan form and airfoil section and, qualitatively, the effects of wing aeroelasticity. These collections also show all wings tested to have damping in roll in this speed range at 0° angle of attack.

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NACA TN 3958

ANALYSIS OF STATIC AEROELASTIC BEHAVIOR OF LOW-ASPECT-RATIO RECTANGULAR WINGS. John M. Hedgepeth and Paul G. Waner, Jr. April 1957. 21p. diagrs. (NACA TN 3958)

Slender-body theory is used in conjunction with plate theory to analyze the static aeroelastic-divergence behavior of low-aspect-ratio rectangular wings of constant thickness when chordwise deformations are considered. In the analysis, the spanwise variation of the deflection is restricted to a parabola but the chordwise variation is allowed complete freedom. Results show the variation of the divergence speed and mode shape with the aspect ratio. Comparisons are made with results obtained by using approximate (linear, parabolic, and cubic) chordwise deflection shapes.

NACA TN 3960

EXPECTED NUMBER OF MAXIMA AND MINIMA OF A STATIONARY RANDOM PROCESS WITH NON-GAUSSIAN FREQUENCY DISTRIBUTION. Franklin W. Diederich. April 1957. 21p. tabs. (NACA TN 3960)

A method is presented for correcting the known results for the expected number of maxima and minima of a random process with Gaussian frequency distribution for cases in which the joint frequency-distribution function of the process and its first two derivatives is non-Gaussian. This correction is based on the statistical moments of the process and its first two derivatives and involves certain given functions.

NACA TN 3974

FULL-SCALE INVESTIGATION OF SEVERAL JET-ENGINE NOISE-REDUCTION NOZZLES. Willard D. Coles and Edmund E. Callaghan. April 1957. 45p. diagrs., photos., tabs. (NACA TN 3974)

A number of nozzles which use the mixing interference of adjacent jets for noise suppression were investigated. Reductions in sound power of nearly 70 percent (5 db) with thrust losses of 1 percent were achieved. A method of calculating the limiting frequency affected by this type of suppression nozzle, that is, multiple-slot nozzles, is presented. Data are shown which indicate that further large reductions in sound power are not likely with mixing-interference nozzles.

NACA TN 3976

RUPTURE STRENGTH OF SEVERAL NICKEL-BASE ALLOYS IN SHEET FORM. James H. Dance and Francis J. Clauss. April 1957. 24p. diagrs., photos., tabs. (NACA TN 3976)

The 100-hour rupture strengths of Inconel X, Inconel 700, Incoloy 901, Refractaloy 26, and R-235 at 1200° and 1350° F in both the annealed and heat-treated conditions were determined. Inconel 700 had the highest rupture strength at both temperatures; Incoloy 901 was second strongest at 1200° F, and R-235 second strongest at 1350° F. With the exception of Incoloy 901, ductility was low. Photomicrographs show that fractures are through the grain boundaries. Results are compared with published data for other sheet alloys and bar stock.

NACA TN 3977

FURTHER EXPERIMENTS ON THE STABILITY OF LAMINAR AND TURBULENT HYDROGEN-AIR FLAMES AT REDUCED PRESSURES. Burton Fine. April 1957. 31p. diagrs., tabs. (NACA TN 3977)

Stability limits for laminar and turbulent hydrogen-air burner flames were measured as a function of pressure, burner diameter, and composition. On the basis of a simple flame model, turbulent flashback involved a smaller effective penetration distance than laminar flashback. No current theoretical treatment predicts the observed pressure and diameter dependence of laminar and turbulent blowoff.

NACA TN 3994

STATIC STRENGTH OF CROSS-GRAIN 7075-T6 ALUMINUM-ALLOY EXTRUDED BAR CONTAINING FATIGUE CRACKS. Walter Illg and Arthur J. McEvily, Jr. April 1957. 25p. diagrs., photos., tabs. (NACA TN 3994)

Cross-grain specimens of 7075-T6 aluminum-alloy extrusion containing fatigue cracks of various lengths were subjected to static tests to determine residual static strength. Small cracks resulted in disproportionately large reductions of static strength. Comparison of the results with those for the with-grain direction revealed no significant difference. However, it is cautioned that cases may arise for 7075-T6 or for other materials where the cross-grain residual static strength is substantially inferior. The effects of biaxiality and ductility on notch sensitivity under static loading are discussed in appendixes.

BRITISH REPORTS

N-48164*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) AN ACCOUNT OF SOME LONGITUDINAL STABILITY TESTS ON A DRAGONFLY HELICOPTER. J. D. L. Gregory, G. F. Langdon, and R. W. Coombes. January 7, 1957. 15p. diagrs., tabs. AAEE/Res/293 (revised). (Ask for N-48164*)

Longitudinal stability tests have been made on a Dragonfly helicopter. Techniques are described for the measurement of static and maneuver margins, and these results are given together with the longitudinal trim curve and the results of pull-up tests. The near-equivalence of the maneuver margin and pull-up tests has been demonstrated, but final assessment of the tests must await results from other helicopters.

N-48302*

Aeronautical Research Council (Gt. Brit.) BASE PRESSURES IN SUPERSONIC FLOW. G. E. Gadd, D. W. Holder, and J. D. Regan. 1956. 26p. diagrs., photos. ARC CP 271. (Ask for N-48302*)

The aim of the work is to throw light on the fundamental processes of the flow rather than to accumulate ad hoc data. Hence, only simple model shapes were investigated. These shapes are: two-dimensional wedges with base to chord ratios of one-fourth and one-eighth, cones of 10° semiangle, and cone-cylinder bodies of revolution with 30° semi-angle heads and lengths of 3 and 7 diameters. The base pressure behind a shallow two-dimensional step was measured at $M = 3$, and that behind a wedge on a plate at $M = 3$ and 4.

N-48355*

Aeronautical Research Council (Gt. Brit.) THE USE OF MULTIPLE DIAPHRAGMS IN SHOCK TUBES. B. D. Henshall. 1956. 43p. diagrs., tabs. ARC CP 291. (Ask for N-48355*)

Calculations are presented which illustrate the advantages of various types of multiple-diaphragm shock tubes over the single-diaphragm conventional shock tube. Shock tubes having a discontinuous change of cross section at a diaphragm station or at any other position along the tube are also considered.

N-48356*

Aeronautical Research Council (Gt. Brit.) AN INDEX OF MATHEMATICAL TABLES FOR SHOCK-TUBE FLOW. B. D. Henshall. 1956. 7p. diagr. ARC CP 292. (Ask for N-48356*)

A classified index of tables for use in calculations of the flow in shock tubes is presented in this note. Consistent nomenclature in accordance with general usage is adopted.

N-48357*

Aeronautical Research Council (Gt. Brit.) FACTORS AFFECTING THE PERFORMANCE OF THE NOZZLE OF A HYPERSONIC SHOCK TUBE. B. D. Henshall and G. E. Gadd. 1956. 29p. diagrs., tab. ARC CP 293. (Ask for N-48357*)

An analysis of the starting process of a hypersonic shock tube is made and the subsequent flow conditions in the working section are evaluated for various static temperatures and Mach numbers of the flow. A discussion of the simulation of free-flight conditions leads to recommendations for the optimum operation of hypersonic shock tubes; performance charts are given.

N-48412*

Ministry of Supply (Gt. Brit.) TURNING TESTS ON TITANIUM ALLOY Ti.155A. 25p. diagrs., photos. MOS S&T Memo.11/56. (Ask for N-48412*)

The objective of this report is to determine the effects of various cutting fluids, tool angles, cutting speeds, and feed rates on tool life when rough turning, and on workpiece surface finish when finish turning using carbide-tipped tools.

N-48413*

Ministry of Supply (Gt. Brit.) THE SKID-WHEEL. E. R. Stables. (1957). 18p. photos., tabs. MOS S&T Memo. 1/57. (Ask for N-48413*)

This memorandum describes a projected method of moving heavy loads on soft ground, with particular reference to aircraft. It records the origin, theoretical analysis, and development of a skid-wheel aircraft transporter up to the completion of a series of tests on a full-scale experimental model. The device may perhaps be of interest in fields of engineering other than the one in which it arose.

N-48415*

Royal Aircraft Establishment (Gt. Brit.) THE RELATIVE REACTIVITIES OF BIFUNCTIONAL MONOMERS. PART V. SWELLING STUDIES OF POLYMERS OF VARIOUS ALLYLIC METHACRYLATES. G. M. Bristow. November 1956. 31p. diagrs., tabs. RAE Tech.Note Chem.1286. (Ask for N-48415*)

Cross-linked polymers have been prepared from the following methacrylates; α-methallyl, β-methallyl, β-chloroallyl, crotyl (γ-methallyl), and allyl carbinyl. Swelling measurements in toluene have been used to determine degrees of cross-linking, and hence the relative reactivities of the various allylic groups with respect to the methacryl group.

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N-48418*

Royal Aircraft Establishment (Gt. Brit.)
THE DETERMINATION OF PHOSPHORUS IN ORGANIC COMPOUNDS. J. R. Webb. November 1956. 9p. tabs. RAE Tech.Note Chem.1290. (Ask for N-48418*)

Published methods for the determination of phosphorus have been modified and applied to the semimicro determination of phosphorus in organic materials. Some sources of interference have been eliminated.

N-48419*

Royal Aircraft Establishment (Gt. Brit.)
THE HARDNESS OF WROUGHT TITANIUM.
A. R. G. Brown and P. M. R. Gates. July 1956. 14p. diagrs., tabs. RAE Tech.Note Met.243. (Ask for N-48419*)

Forged, rolled, and swaged bars of commercially pure titanium were annealed for various times at 550, 650, 700, and 750° C in air and in vacuo. The hardnesses of the annealed bars were compared to indicate the extent of oxygen contamination and suitable annealing procedures. It was found that annealing at 700° C for one hour gave an almost fully softened product even after extensive cold working, and that this treatment does not lead to undesirable pick-up of oxygen.

N-48420*

Ministry of Supply (Gt. Brit.)
MILLING TESTS ON TITANIUM ALLOY Ti.155A. 19p. diagrs., photos. MOS S&T Memo.10/56. (Ask for N-48420*)

The objective of this report is to determine the effects of cutting speed, feed rate, and cutter tooth shape on cutter life, and workpiece surface finish when milling titanium alloy Ti 155A, with face cutters and side and face milling cutters.

N-48421*

Royal Aircraft Establishment (Gt. Brit.)
CALCULATED AERODYNAMIC FORCES ON A SWEPTBACK UNTAPERED WING OSCILLATING IN INCOMPRESSIBLE FLOW. D. L. Woodcock. December 1956. 21p. diagr., tabs. RAE Structures 217. (Ask for N-48421*)

The air forces are given for an untapered wing of aspect ratio 2 and sweepback 40° oscillating with symmetric distortion modes in incompressible flow. The results are for frequency parameters of 0(0.6)1.8. These are presented both as influence matrixes based on the displacement at a particular set of points and also as overall derivatives for modes of the form η^n for $n = 0(1)4$ where η is a nondimensional spanwise coordinate. The method used was the vortex lattice method. The standard lattice was modified by making the mesh size (in a chordwise direction) adjacent to the leading edge smaller than that over the main part of the wing. Comparison is made with some values obtained by a variant of the Multhopp method and the agreement is good. An appendix shows how the vortex lattice method is modified to obtain the virtual inertias.

N-48422*

Royal Aircraft Establishment (Gt. Brit.)
SUPPORTS FOR VIBRATION ISOLATION. W. G. Molyneux. November 1956. 20p. diagrs. RAE Tech.Note Structures 211. (Ask for N-48422*)

Spring arrangements are described that provide flexible supports of very low stiffness for a limited range of movement. They are suitable as supports for vibration isolation provided the levels of vibration are not too large. Some particular applications of the arrangements for vibration isolation and in other fields are discussed.

N-48423*

Ministry of Supply (Gt. Brit.)
DRILLING AND TAPPING TITANIUM ALLOY Ti.155A. 9p. diagrs., photos. MOS S&T Memo. 12/56. (Ask for N-48423*)

The objective of this report is to determine whether recommendations for drilling and tapping titanium alloy Ti 150A can be used satisfactorily when machining titanium alloy Ti 155A.

N-48426*

National Gas Turbine Establishment (Gt. Brit.)
MULTI-CHANNEL SLIP RINGS FOR STRESS AND TEMPERATURE MEASUREMENT. R. Chaplin. December 1956. 19p. diagrs., photo. NGTE Memo. M.289. (Ask for N-48426*)

The development of the various types of slipring is outlined in the text and the design of a brush and ring type of slipring is discussed in detail. It is shown that a slipring unit of this type can be made sufficiently robust to be a permanent part of the instrumentation of any rig. A highly stable contact potential is obtained in this design making possible stress measurements below 1/2 ton/sq in. in steel and temperature measurements with errors of less than 1° C using chromel-alumel thermocouples.

N-48427*

Royal Aircraft Establishment (Gt. Brit.)
AN APPROXIMATE MEANS OF DETERMINING THE AXIAL FLAME TEMPERATURE PATTERN WITHIN A ROCKET ENGINE COMBUSTION CHAMBER.
L. J. Purchase and H. Walder. November 1956. 15p. diagrs., photo., tabs. RAE Tech.Note RPD 149. (Ask for N-48427*)

A knowledge of the position and temperature of the flame front in a combustion chamber is of value in the development of rocket engines. This note describes a method of obtaining the approximate position of the flame front in a combustion chamber.

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Metal rods of differing melting points are encastred at one end to the injector plate so that they lie parallel and close to the axis of the combustion chamber. The length of each rod remaining after a test gives an indication of the temperature at particular points within the chamber.

N-48428*

Royal Aircraft Establishment (Gt. Brit.)
LOW SPEED FLOW STUDIES OF THE VORTEX PATTERNS ABOVE INCLINED SLENDER BODIES USING A NEW SMOKE TECHNIQUE. R. L. Maltby and D. H. Peckham. November 1956. 12p. diagrs., photos. RAE Tech.Note Aero 2482.
(Ask for N-48428*)

A simple method of making visible the vortex flow pattern above an inclined body in a low-speed tunnel is described. Examples of such flow are given and two main types of vortex pattern are identified at high incidence.

N-48429*

Royal Aircraft Establishment (Gt. Brit.)
FATIGUE STRENGTH OF ALUMINIUM ALLOY LUGS (UNBUSHED) WITH AND WITHOUT INTERFERENCE FIT PINS. ALLOYS D.T.D.364 AND D.T.D.363. W. A. P. Fisher and H. Yeomans. November 1956. 21p. diagrs., photo., tabs. RAE Tech.Note Structures 209. (Ask for N-48429*)

The results of fatigue tests in pulsating tension are given for lug specimens in D.T.D.364 and D.T.D. 363 materials. Tests were done at mean stresses of 5.0 and 7.5 tons/in.^{2} and, in the case of D.T.D. 364 only, also at zero mean stress. With a few exceptions, the lugs with interference fit pins had a much longer endurance than those with push fit pins; the improvement was less at a mean stress of 7.5 tons/in.^{2} than at 5 tons/in.^{2} and was more consistent for the D.T.D.364 than for the D.T.D.363 lugs. The use of tapered pins is considered to be a more reliable method of controlling the desired amount of interference.

N-48431*

Royal Aircraft Establishment (Gt. Brit.)
AN ANALOGUE COMPUTER FOR CONVECTIVE HEATING PROBLEMS. H. G. R. Robinson. October 1956. 24p. diagrs., photo., tabs. RAE Tech.Note GW 434. (Ask for N-48431*)

The computer was designed to assist in the solutions of kinetic heating problems which occur in guided weapon design. Its flexibility allows it to be used for a number of problems involving one-dimensional convective heating in a wall of finite thickness, providing the basic data such as the source temperature of the convective medium and the heat transfer coefficient in the region of interest are known. Completely arbitrary time varying functions of source temperatures and heat transfer coefficient are acceptable. This note describes the design and construction of the computer.

N-48432*

Marine Aircraft Experimental Establishment
(Gt. Brit.) THE FULL SCALE AIR DRAG OF SOME FLYING BOAT SEAPLANES. A. G. Smith. February 1956. 71p. diagrs., photos., tabs. MAEE F/Res/265. (Ask for N-48432*)

An analysis has been made of the full-scale lift and drag characteristics of a number of British seaplanes. It is found that the drag coefficient and profile drag per 100 lb A.U.W. show progressive decreases, the best aircraft being the Princess. This is caused by improvement in hull design, reduction of drag with changeover to turbojet and turbopropeller propulsion units, and increase in aircraft size. The hull drag is of the order of 0.22 of the total profile drag for all the aircraft but the ratio of the turbulent skin friction drag of the idealized wing, hull, and tail unit to the actual profile drag increases to 0.73 for the Princess from 0.4 for the Sunderland. Further drag reductions would be possible if full use were made of recent methods of reducing hull air drag still further by detail fairing and increase of length-to-beam ratio.

N-48433*

Royal Aircraft Establishment (Gt. Brit.)
THE MECHANICAL PROPERTIES AND POROSITY OF PARACHUTE FABRICS. A. Baker. September 1956. 61p. diagrs., photos., tabs. RAE Chem.507.
(Ask for N-48433*)

The various parachute textiles are described, and the effects of weave and construction on the porosity of fabrics are discussed. Their mechanical properties are assessed in relation to temperature, humidity, and rate of stressing; data are presented for yarns as well as fabrics. The hysteresis occurring in cyclic stressing is considered as an aspect of creep and recovery. The nature of porosity is clarified by means of light transmission and bubble pressure measurements; the latter are related to the threshold pressures for the commencement of airflow through wet fabrics. The repeated stressing of fabrics produces transient and permanent changes of porosity which may be explained in terms of the recoverable and residual components of deformation. The relative advantages of nylon, Terylene, and other fibers are discussed, for various conditions of use. The trends of future research are indicated.

N-48434*

Royal Aircraft Establishment (Gt. Brit.)
AN INVESTIGATION INTO THE SUITABILITY OF SHOCK TESTING AS A MEANS OF THERMIONIC VALVE SELECTION FOR PULSE MODULATION TELEMETRY SENDERS. J. S. Whitall and P. C. Dench. November 1956. 13p. diagrs., photo., tabs. RAE Tech.Note TD 9. (Ask for N-48434*)

When CV 467's used as phantastrons in pulse telemetry senders are subjected to a sweep type vibration test there is a wide variation in the magnitude of microphony (approx. 100:1). It is therefore desirable that some simple and nondestructive method of valve selection should be possible prior to fitting to the sender. To make the test equipment as simple

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as possible, the valves were tested in an amplifier circuit and were excited by a shock produced by a light ebonite hammer falling, through a fixed angle, onto a duralumin block in which the valves were mounted. The peak microphony was observed on a cathode ray oscilloscope with a long persistence screen. Valves of different manufacturers and of different batches from the same manufacturer were tested and the results compared with the microphony obtained when the same valves were incorporated in pulse telemetry sender circuit and were subjected to a sweep-type vibration test.

N-48435*

Royal Aircraft Establishment (Gt. Brit.)
THE DETERMINATION OF EXCESS ZINC IN NON-STOICHIOMETRIC ZINC OXIDE. H. J. Allsopp. November 1956. 19p. diagrs., tabs. RAE Met.92. (Ask for N-48435*)

This paper describes a hydrogen evolution technique whereby excess zinc in zinc oxide is determined. Under vacuum, the sample to be analyzed is dissolved in previously distilled hydrochloric acid. After solution, the acid is evaporated to insure that all the evolved gas is released. The gases are then analyzed for hydrogen content from the amount of which the excess metal is calculated. The method was standardized radiochemically and although the values obtained showed only about a 70-percent recovery, the method is believed to be absolute. The influence of grinding on the specimens has been studied. The sensitivity is estimated to be 0.1 p.p.m. $\frac{\text{excess zinc}}{\text{zinc oxide}}$ by weight. The zinc oxide specimens analyzed so far have been found to contain excess zinc within the range 0.2 - 18 p.p.m. $\frac{\text{excess zinc}}{\text{zinc oxide}}$ by weight. Reproducibility is good.

N-48436*

Aeronautical Inspection Directorate (Gt. Brit.)
AN EXTENSOMETER WITH CAMERA ATTACHMENT FOR HIGH SENSITIVITY CREEP TESTS. A. E. Walmsley and F. J. Tranter. July 1956. 15p. diagrs., photos. AID Met/28. (Ask for N-48436*)

A method of recording creep extensometer readings using an automatic camera with a slightly modified Marten's type extensometer is described.

N-48437*

Royal Aircraft Establishment (Gt. Brit.)
THE EXTENSIBILITY OF NYLON AND TERYLENE FABRICS UNDER CYCLIC STRESS. J. E. Swallow. November 1956. 17p. diagrs., tabs. RAE Tech. Note Chem.1289. (Ask for N-48437*)

The effect of cyclic uniaxial and biaxial stressing on the extension of several nylon and Terylene fabrics in plain and mock-leno weaves has been studied. Terylene has a greater strain hysteresis than nylon and its subsequent recovery is slower. Porosity changes in parachute fabrics under cyclic stressing are closely related to the extension under load and to the residual deformation after removal of stress.

N-48438*

Royal Aircraft Establishment (Gt. Brit.)
A NEW D.C. AMPLIFIER FOR GENERAL USE IN ELECTRONIC ANALOGUE COMPUTERS. P. R. Benyon. August 1956. 44p. diagrs., photo. RAE Tech.Note GW 426. (Ask for N-48438*)

An account is given of the design of a simple and compact direct-coupled amplifier, suitable for general use in electronic analog computers.

N-48439*

Royal Aircraft Establishment (Gt. Brit.)
THE VARIATION OF GUST FREQUENCY WITH GUST VELOCITY AND ALTITUDE. N. I. Bullen. October 1956. 14p. diagrs. RAE Structures 216. (Ask for N-48439*)

Information on atmospheric turbulence obtained from counting accelerometer records is examined and relations giving the variation of gust frequency with gust velocity and altitude are obtained. The results are summarized in a form convenient for use in estimating the fatigue life of an aircraft.

N-48440*

Royal Aircraft Establishment (Gt. Brit.)
SOME CONSIDERATIONS IN THE DESIGN OF SMALL AIRBORNE MIRROR-GALVANOMETER RECORDERS. B. S. Crawshaw and C. R. Hunt. October 1956. 32p. diagrs., photos. RAE Tech. Note Instn. 153. (Ask for N-48440*)

The recording medium and the means of driving it demand more space in a recorder than any other single component and provide the greatest scope for size reduction. The record and the drive can be made smaller without sacrifice of measuring performance if the width of the trace is reduced, and the optical system is studied to this end. The characteristics required in a small recorder for general use in small aircraft are considered and particulars are given of a trial batch of instruments designed and made to demonstrate the conclusions.

N-48441*

Royal Aircraft Establishment (Gt. Brit.)
AN ASSESSMENT OF THE ACCURACY OF A PRESSURE AND THRUST RECORDING SYSTEM EMPLOYING STRAIN GAUGE TRANSDUCERS, CARRIER AMPLIFIERS AND GALVANOMETER RECORDING. D. S. Dean and D. Young. November 1956. 34p. diagrs., tabs. RAE Tech.Note RPD 148. (Ask for N-48441*)

Tests to determine the accuracy of a recording system prior to installation in a rocket engine test bed are described. The system comprised strain gage

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pressure and thrust transducers, 2 kc/s carrier amplifiers with a frequency response linear to 100 c/s, and mirror galvanometers recording on photographic paper. Each element of the recording system was checked individually for stability and reproducibility of results. Where relevant, the accuracy of setting up the equipment and reading the results was determined. An estimate was then made of the accuracy to be expected with the complete equipment. During the tests, shortcomings became apparent in some of the instruments, and modifications are described to improve their performance. The complete equipment should have an accuracy of ±1/2 percent of full range when measuring pressure and ±1 percent when measuring thrust. All percentage errors quoted are related to the full usuable scale of the instrument or system, and unless otherwise stated are the maximum errors measured during tests and equivalent to about three standard deviations.

N-51108*

Australian Aeronautical Research Committee. A CRITICAL REVIEW OF THE MECHANISM OF AGEING IN ALLOYS BASED ON THE ALUMINIUM-ZINC-MAGNESIUM SYSTEM. I. J. Polmear. August 1955. 22p. diagrs., tabs. Australian Aeronautical Research Committee ACA-59. (Ask for N-51108*)

The object of this report is to survey critically the available information pertaining to structural and property changes accompanying precipitation in alloys based on the aluminium-zinc-magnesium system. From this it is hoped that a clearer understanding of the mechanism of age hardening may be achieved. The significance of aging, particularly in relation to the resistance of the alloys to corrosion under stress, is discussed in detail.

MISCELLANEOUS

Errata on NACA Rept. 1276. By Curt A. Holzhauser and Richard S. Bray. 1956.

Errata on NACA TN 3162. By Louis S. Stivers, Jr. March 1954.

Errata on NACA TN 3230. By K. R. Czarnecki, Ross B. Robinson, and John H. Hilton, Jr. June 1954.

N-40046*

Advisory Group for Aeronautical Research and Development. A NEW STANDARD FOR THE PREDICTION OF FULL SCALE SPIN AND RECOVERY CHARACTERISTICS FROM MODEL TESTS. T. H. Kerr, Royal Aircraft Establishment. (Presented at Joint Session Flight Test Panel & Wind Tunnel & Model Testing Panel, AGARD, Rome, February 20-25, 1956). February 1956. 19p. diagrs., tab. AGARD Report 25. (Ask for N-40046*)

The important features of a model, which affect the scale effect in the spin and recovery are discussed in the light of several models to full-scale comparisons and the general background of spinning experience. These features have been shown to be the nondimensional rate of rotation (λ) of the spin, the thickness/chord ratio of the wing, and the inertia ratio B/A of the model. Using these parameters, a new standard for the prediction of the full-scale spin and recovery from the model test has been presented.

N-42773*

Advisory Group for Aeronautical Research and Development. MEASUREMENT OF THE AERODYNAMIC FORCES ON OSCILLATING AEROFOILS. W. G. Molyneux, Royal Aircraft Establishment. (Presented at 3rd meeting of the Structures & Materials Panel, AGARD, Washington, D. C., April 17-23, 1956). April 1956. 39p. diagrs., tab. AGARD Report 35. (Ask for N-42773*)

Considers various techniques for oscillatory force measurements in relation to their application to the measurement of the aerodynamic coefficients for a rectangular wing oscillating in modes of vertical translation and uniform pitch. Discusses also the corrections which must be applied to such measurements.

N-42808*

Advisory Group for Aeronautical Research and Development. FLUTTER PREDICTION IN PRACTICE. E. G. Broadbent, Royal Aircraft Establishment. (Presented at 3rd meeting of Structures & Materials Panel, AGARD, Washington, D.C., April 17-23, 1956). April 1956. 29p. diagrs., tabs. AGARD Report 44. (Ask for N-42808*)

Gives a brief summary of the resources available for flutter prediction, both experimental and theoretical. Specific flutter investigations are described for four actual recent flutter incidents, in all of which good agreement is eventually obtained between calculations and full scale experience. Conclusions for future guidance are drawn from all the examples, and a few points are given from a more general statistical survey of recent incidents.

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N-48142*

Royal Aircraft Establishment (Gt. Brit.)
AN OPTICAL APPARATUS FOR CONTINUOUS MEASUREMENT OF SHRINKAGE AT HIGH TEMPERATURE. J. Hutchings and J. P. Roberts. August 1956. 11p. diagrs., photo. RAE Tech. Note Met. 253. (Request N-48142*)

The apparatus works on the principle of the optical lever and is suitable for use in small furnaces up to at least 1300° C. It is made of sintered alumina, apart from the high-temperature mirrors of (i) fused silica sputtered with platinum, or (ii) corundum crystal. The magnification of the change of thickness of the rectangular specimen is 70 times. The shrinkage of specimens approximately 1 cm thick can be determined to within 10μ, so that shrinkages greater than 5 percent are accurate to one part in 50 or better. The apparatus has been used to measure the shrinkage occurring during sintering of powder pressings.

N-48143*

Royal Aircraft Establishment (Gt. Brit.)
A LOW POWER UNIVERSAL JOINT FOR USE AT X BAND. V. Russell and G. H. Peter. October 1956. 30p. diagrs., photos. RAE Tech. Note GW 431. (Request N-48143*)

A universal joint in a 50Ω coaxial feeder was developed for an application of microwave equipment, where miniaturization and low friction were important. Satisfactory operation was obtained over a 5-percent band with a voltage standing wave ratio of better than 0.72 and less than 0.5 db loss. The design is suitable for azimuth and elevation movements of ±45° and it allows continuous rotation of one of the feeders. Normally the joint is intended for operation with a receiver, but preliminary power tests suggest that it should be satisfactory at 10 kw peak and 10 w mean.

N-48144*

Royal Aircraft Establishment (Gt. Brit.)
SOME DATA ON THE NOISE FACTOR OF 3 CM. RECEIVERS USING SILICON MIXERS. M. G. B. Weedon and R. G. Guttridge. September 1956. 32p. diagrs., tab. RAE Tech. Note GW 433. (Request N-48144*)

A series of measurements is reported on the noise factor of X band superheterodyne receivers using silicon mixers. The valves used were CV154, CV155, CV253, CV2226, CV2258, and CV4141. The effects of receiver intermediate frequency, crystal current, and the use of balanced, or single-ended mixers were investigated. Values of mean noise factor are presented for various valves in a variety of conditions including low frequency I. F's suitable for simple CW receivers combining the Doppler and intermediate frequency.

N-48145*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF KLYSTRON PRIMING UPON THE NOISE SPECTRUM OF THE C.W. MAGNETRON VX8114. M. G. B. Weedon and R. G. Guttridge. September 1956. 26p. diagrs. RAE Tech. Note GW 432. (Request N-48145*)

An account is given of measurements upon the VX8114 C.W. magnetron to determine the spectrum due to amplitude and frequency modulation by noise. The level of the noise spectrum found was too high for the valve to be useful in C.W. radars. When primed by power from a CV.129 klystron isolated from the magnetron by "Uniline" ferrite isolators, there was a reduction in the frequency modulation noise but it was insufficient to make the valve useful in C.W. radar applications.

N-48146*

National Gas Turbine Establishment (Gt. Brit.)
THE ηq METER, A RAPID INSTRUMENTAL METHOD OF COMBUSTION GAS ANALYSIS. F. H. Holderness. November 1956. 52p. diagrs., photos. NGTE R. 194. (Request N-48146*)

An account is given of the operating principles of an apparatus for rapid instrumental gas analytical measurements on combustion gases. An analysis can be completed with the apparatus in 6 to 10 minutes, using a stream of sample taken directly from a combustion chamber. The measurements made are of net carbon dioxide concentration, carbon monoxide, hydrogen, and total carbon dioxide. The last quantity is estimated after all carbon compounds in the sample have been fully oxidized to carbon dioxide in a furnace system. The direct indicating instruments which are incorporated into the meter are two infrared gas analyzers, for carbon dioxide and carbon monoxide measurements, and a sonic gas analyzer for hydrogen measurement. These instruments are described in a section of the report which gives complete constructional details of the meter. The measurements made can be used to derive values of combustion efficiency and fuel/air mixture strength. The calculations involved are included in an appendix. The meter is capable of handling gases from zones where combustion efficiency is in the range 0 to 100 percent and the mixture strength is in the range 0.0125 to 0.125.

N-48149*

National Gas Turbine Establishment (Gt. Brit.)
BUBBLE-POINTS, FLAMMABILITY LIMITS AND FLASH POINTS OF PETROLEUM PRODUCTS. B. P. Mullins. November 1956. 34p. diagrs., tabs. NGTE R. 200. (Request N-48149*)

Relationships between the bubble points, flammability limits, and flash points of a fuel have been demonstrated numerically for four hydrocarbon fuels ranging from aviation spirit to gas oil. The mean molecular weights of the fuel vapors at the bubble points

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have been computed and several nomographic methods of presenting corrected bubble-point data are outlined with examples. Weak and rich flammability limits in air of the four fuels were calculated over a range of static pressures. The weak limit curve represents the conditions of the closed flash point test and so by differentiation of this curve a flash point pressure correction factor was obtained for each fuel. Excellent agreement between theoretical and measured values was found in all cases and a simple general rule for estimating flash points is given.

MISCELLANEOUS

Errata on NACA Rept. 1245. By Morris Morduchow. 1955.

Errata on NACA Rept. 1254. By Edmond E. Bisson, Robert L. Johnson, Max A. Swikert, and Douglas Godfrey. 1956.

Errata on NACA RM E56D23. By Vearl N. Huff, Anthony Fortini, and Sanford Gordon. September 7, 1956.

Errata on NACA TN 3747. By Alfred Gessow. October 1956.

Errata on NACA TN 3760. By William R. Michelsen and Lionel V. Baldwin. August 1956.

N-41416, 1956

FORTY-SECOND ANNUAL REPORT OF THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS. ADMINISTRATIVE REPORTS WITHOUT TECHNICAL REPORTS. 1956. ix, 89p. NACA. (Request N-41416, 1956)

N-49802*

Advisory Group for Aeronautical Research and Development. THE USE OF RHEOELECTRICAL ANALOGIES IN AERODYNAMICS. L. C. Malavard, Faculté des Sciences de Paris. Wilbur C. Nelson, editor, University of Michigan. August 1956. (vi), 175p. diagrs., photos. AGARDograph 18. (Request N-49802*)

The study describes the equipment and experimental technique used in model construction, in the physical realization of the given problem data, in the exploration of the potential fields, and in carrying out the necessary adjustments and measurements. Next the different aerodynamic applications are examined: representations of plane flows, studies of airfoil sections and turbine blade lattices, practical accomplishment of conformal mappings, and studies of axially symmetric and three-dimensional flows. Detailed descriptions are given of the analog methods and setups used for the solution of lifting line, propeller, lifting surface, and compressible flow problems.

UNPUBLISHED PAPERS

N-38324*

COMPARISON OF THE RESISTANCE TO SHOCK OF LUBRICATING FILMS. (Comparaison de la résistance au choc des films lubrifiants). F. Charron. January 1957. 19p. diagrs., photos., tabs. Translation of Ministere de l'Air Publications Scientifiques et Techniques No. 298, 1955. (Request N-38324*)

The purpose of this paper is to compare the protective properties of lubricating films with regard to continuous or suddenly applied forces. First, a test apparatus is described which has been especially constructed to take care of this double program. The result of steady-state tests shows that the viscosity under atmospheric pressure is a predominant factor whereas the coefficient of the increase of viscosity with pressure appears to be without interest, contrary to expectations. Tests under shock-loading conditions confirm these conclusions. In order to classify lubricants, we form the ratio of breaking-load of the film to the viscosity. This ratio is not constant; it is seen to be higher for certain oils which are particularly suitable for resisting large forces, due to properties little known or even unknown.

N-49857*

Georgia Institute of Technology, Engineering Experiment Station. HEAT TRANSFER TO VIBRATING AIR COLUMNS. W. B. Harrison, W. C. Boteler, T. W. Jackson, A. Lowi, Jr., and F. A. Thomas, Jr. December 1955. iv, 38p. diagrs., photo., tabs. Georgia Inst. of Tech. (State) Engineering Experiment Station. (Request N-49857*)

Experimental studies of the effects of acoustic vibrations on convective heat transfer have been made in a vertical steam-heated tube, with air as the heat transfer medium. The studies were made in the range of superposed free and forced convection, and the runs without acoustic vibrations were correlated by predictions of Martinelli and Boelter (and a modified equation based on their predictions).

N-49902*

SECOND ANNUAL REPORT OF THE DIRECTORATE OF THE INSTITUTE ON THE WORK OF THE RESEARCH INSTITUTE FOR PHYSICS OF JET PROPULSION, STUTTGART, AT THE THIRD REGULAR CONFERENCE OF THE MEMBERS ON JULY 20, 1956. Eugen Sänger and Irene Sänger-Bredt. December 1956. 18p. diagr. Translation of Zweiter Jahresbericht der Institutsleitung über die Arbeiten des Forschungsinstituts Für Physik Der Strahlantriebe E.V., Stuttgart, anlässlich der dritten ordentlichen Mitgliederversammlung am July 20, 1956. (Request N-49902*)

Includes sections on size, membership, and scope of work of the institute. Reports on booster rockets, ram jets, chemical liquid-fuel rockets, thermonuclear rockets, and photon-jets are listed with abstracts.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM A50K21

LIFT, DRAG, AND PITCHING MOMENT OF LOW-ASPECT-RATIO WINGS AT SUBSONIC AND SUPERSONIC SPEEDS - PLANE TRIANGULAR WING OF ASPECT RATIO 2 WITH NACA 0005-63 SECTION. Donald W. Smith and John C. Heitmeyer. February 1, 1951. 23p. diagrs., photo. (NACA RM A50K21)

This paper contains the results of an investigation to ascertain the lift, drag, and pitching moment of a wing-body combination having a plane triangular wing of aspect ratio 2 and having NACA 0005-63 sections in streamwise planes. Results are shown for Mach numbers from 0.24 to 1.70 at a Reynolds number of 3.0 million. The variations of the characteristics with Reynolds number are also shown for several Mach numbers.

NACA RM A50K24

LIFT, DRAG, AND PITCHING MOMENT OF LOW-ASPECT-RATIO WINGS AT SUBSONIC AND SUPERSONIC SPEEDS - PLANE TRIANGULAR WING OF ASPECT RATIO 4 WITH NACA 0005-63 SECTION. John C. Heitmeyer and Jack D. Stephenson. February 2, 1951. 21p. diagrs., photo. (NACA RM A50K24)

This paper contains the results of an investigation to ascertain the lift, drag, and pitching moment of a wing-body combination having a plane triangular wing of aspect ratio 4 and NACA 0005-63 sections in streamwise planes. Results are shown for Mach numbers from 0.25 to 0.96 and from 1.2 to 1.7 at a Reynolds number of 1.5 million. The variations of the characteristics with Reynolds number are also shown for several Mach numbers.

NACA RM A50K24a

LIFT, DRAG, AND PITCHING MOMENT OF LOW-ASPECT-RATIO WINGS AT SUBSONIC AND SUPERSONIC SPEEDS - PLANE TRIANGULAR WING OF ASPECT RATIO 2 WITH NACA 0003-63 SECTION. John C. Heitmeyer and Willard G. Smith. February 2, 1951. 22p. diagrs., photo. (NACA RM A50K24a)

This paper contains the results of an investigation to ascertain the lift, drag, and pitching moment of a wing-body combination having a plane triangular wing of aspect ratio 2 and NACA 0003-63 sections in streamwise planes. Results are shown for Mach numbers from 0.60 to 0.90 and from 1.3 to 1.7 at a Reynolds number of 5.0 million. The variations of the characteristics with Reynolds number are also shown for several Mach numbers.

NACA RM A50K24b

LIFT, DRAG, AND PITCHING MOMENT OF LOW-ASPECT-RATIO WINGS AT SUBSONIC AND SUPERSONIC SPEEDS - TRIANGULAR WING OF ASPECT RATIO 4 WITH NACA 0005-63 THICKNESS DISTRIBUTION, CAMBERED AND TWISTED FOR TRAPEZOIDAL SPAN LOAD DISTRIBUTION. E. Ray Phelps and Willard G. Smith. February 2, 1951. 23p. diagrs., photo., tab. (NACA RM A50K24b)

This paper contains the results of an investigation to ascertain the lift, drag, and pitching moment of a wing-body combination having a triangular wing of aspect ratio 4 and NACA 0005-63 thickness distribution in streamwise planes and cambered and twisted for trapezoidal span load distribution. Results are shown for Mach numbers from 0.25 to 0.96 and from 1.2 to 1.7 at a Reynolds number of 1.5 million. The variations of the characteristics with Reynolds number are also shown for several Mach numbers.

NACA RM A50K27a

LIFT, DRAG, AND PITCHING MOMENT OF LOW-ASPECT-RATIO WINGS AT SUBSONIC AND SUPERSONIC SPEEDS - TRIANGULAR WING OF ASPECT RATIO 2 WITH NACA 0005-63 THICKNESS DISTRIBUTION, CAMBERED AND TWISTED FOR A TRAPEZOIDAL SPAN LOAD DISTRIBUTION. Willard G. Smith and E. Ray Phelps. February 5, 1951. 21p. diagrs., photo., tab. (NACA RM A50K27a)

This paper contains the results of an investigation to ascertain the lift, drag, and pitching moment of a wing-body combination having a triangular wing of aspect ratio 2 with NACA 0005-63 thickness distribution in streamwise planes and twisted and cambered for a trapezoidal span load distribution. Results are shown for Mach numbers from 0.60 to 0.90 and from 1.3 to 1.7 at a Reynolds number of 3.0 million. The variations of the characteristics with Reynolds number are also shown for several Mach numbers.

NACA RM A50K28

LIFT, DRAG, AND PITCHING MOMENT OF LOW-ASPECT-RATIO WINGS AT SUBSONIC AND SUPERSONIC SPEEDS - PLANE TAPERED WING OF ASPECT RATIO 3.1 WITH 3-PERCENT-THICK, BICONVEX SECTION. David E. Reese and E. Ray Phelps. January 30, 1951. 26p. diagrs., photo. (NACA RM A50K28)

This paper contains the results of an investigation to ascertain the lift, drag, and pitching moment of a wing-body combination having a plane tapered wing of aspect ratio 3.1 and 3-percent-thick biconvex sections in streamwise planes. Results are shown for Mach numbers from 0.60 to 0.925 and from 1.2 to 1.9 at a Reynolds number of 2.4 million.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM A51D25

LOW-SPEED CHARACTERISTICS OF A WING HAVING 63° SWEEPBACK AND UNIFORM CAMBER. Leonard M. Rose. June 26, 1951. 18p. diagrs., photo., tabs. (NACA RM A51D25)

Low-speed wind-tunnel tests were made of a semispan wing with the leading edge swept back 63° and having the NACA 0010 airfoil section cambered for a lift coefficient of 1.0 perpendicular to the leading edge. The data, obtained at a Reynolds number of 3.7×10^6 based on the mean aerodynamic chord, include pressure distributions, lift, drag, and pitching-moment characteristics of the wing with and without a fuselage.

NACA RM A51D30

LIFT, DRAG, AND PITCHING MOMENT OF LOW-ASPECT-RATIO WINGS AT SUBSONIC AND SUPERSONIC SPEEDS - PLANE TRIANGULAR WING OF ASPECT RATIO 4 WITH 3-PERCENT-THICK, BICONVEX SECTION. John C. Heitmeyer. June 8, 1951. 26p. diagrs., photo. (NACA RM A51D30)

This report presents the results of an investigation to ascertain the lift, drag, and pitching moment of a wing-body combination having a triangular wing of aspect ratio 4 with 3-percent-thick, biconvex sections in streamwise planes. Results are shown for Mach numbers from 0.60 to 0.92 and from 1.20 to 1.70 at Reynolds numbers of 1.66 million and 2.91 million. Results are also shown for a Reynolds number of 4.15 million at Mach numbers up to 1.60.

NACA RM A51F21

LIFT, DRAG, AND PITCHING MOMENT OF LOW-ASPECT-RATIO WINGS AT SUBSONIC AND SUPERSONIC SPEEDS - PLANE TRIANGULAR WING OF ASPECT RATIO 4 WITH 3-PERCENT-THICK ROUNDED NOSE SECTION. John C. Heitmeyer and Ronald C. Hightower. August 1951. 17p. diagrs. (NACA RM A51F21)

This report presents the results of an investigation to ascertain the lift, drag, and pitching moment of a wing-body combination having a triangular wing of aspect ratio 4 with 3-percent-thick rounded nose sections in streamwise planes. Results are shown for Mach numbers from 0.60 to 0.92 and from 1.20 to 1.70 at Reynolds numbers of 2.91 million and 4.15 million.

NACA RM A51I18

AERODYNAMIC STUDY OF A WING-FUSELAGE COMBINATION EMPLOYING A WING SWEPT BACK 63° - EFFECTIVENESS OF AN INBOARD ELEVON AS A LONGITUDINAL- AND LATERAL-CONTROL DEVICE AT SUBSONIC AND SUPERSONIC SPEEDS. Frank A. Pfyl. December 1951. 38p. diagrs., photo., tabs. (NACA RM A51I18)

This reports presents the results of an experimental investigation of the effectiveness of a constant percent chord inboard elevon as a longitudinal- and lateral-control device for a wing-fuselage combination employing a wing swept back 63°. The investigation was made at Mach numbers of 0.6, 0.9, 1.2, 1.4, and 1.7 at a Reynolds number of 1.5 million. The results were compared with the experimental values obtained from tests at supersonic speeds, NACA RM A50A31a, 1950, and NACA RM A50K07, 1951, and at subsonic Mach numbers, NACA RM A8D20, 1948.

NACA RM A51K05

OBSERVATIONS OF UNSTEADY FLOW PHENOMENA FOR AN INCLINED BODY FITTED WITH STABILIZING FINS. Merrill H. Mead. January 1952. 23p. diagrs., photos. (NACA RM A51K05)

The dynamic rolling-moment characteristics of a slender inclined body of revolution in combination with a triangular cruciform tail have been investigated in the Ames 6- by 6-foot supersonic wind tunnel through a Mach number range of 0.9 to 1.7 at a free-stream Reynolds number of 0.84×10^6 based on maximum body diameter. Approximate measurements of the oscillating rolling moments of the model were obtained through an angle-of-attack range of 0° to 27°, and are presented for a series of Mach numbers. Photographs of the cross-flow field at the tail of the model, obtained by the use of the vapor-screen technique, are presented for several test conditions.

NACA RM A51K28

LIFT, DRAG, AND PITCHING MOMENT OF LOW-ASPECT-RATIO WINGS AT SUBSONIC AND SUPERSONIC SPEEDS - AN INVESTIGATION AT LARGE REYNOLDS NUMBERS OF THE LOW-SPEED CHARACTERISTICS OF SEVERAL WING-BODY COMBINATIONS. Donald W. Smith, Harry H. Shibata, and Ralph Selan. February 1952. 56p. diagrs., photos., tab. (NACA RM A51K28)

This paper contains the results of an investigation to ascertain the lift, drag, and pitching moment of nine wing-body combinations at large Reynolds numbers and low speeds. Results are presented for a range of Reynolds number from 4.9 million to 16.6 million at a constant Mach number of 0.25 for the models having wings of aspect ratio 2. The results for the models having wings of aspect ratios 3 and 4 are presented for a range of Reynolds number from approximately 2.4 million to 10.6 million at a constant Mach number of 0.25. The characteristics are also presented for a Mach number of 0.60 at a Reynolds number of 4.9 million for the models having wings of aspect ratio 2 and approximately 2.4 million for the models having wings of aspect ratios 3 and 4.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM A52D01c

AERODYNAMIC CHARACTERISTICS OF TWO 25-PERCENT-AREA TRAILING-EDGE FLAPS ON AN ASPECT RATIO 2 TRIANGULAR WING AT SUBSONIC AND SUPERSONIC SPEEDS. John W. Boyd. July 1952. 82p. diagrs., photos., tabs. (NACA RM A52D01c)

The results of an experimental investigation of flap-type controls on a low-aspect-ratio triangular wing are presented for a constant-chord and a constant-percent-chord control surface. Two flap profiles were investigated, one of which had a ratio of trailing edge to hinge-line thickness of zero and the other of 0.50. The lift, drag, pitching moment, hinge moment, and rolling moments were obtained for Mach numbers of 0.60, 0.80, 0.90, 1.30, 1.53, and 1.70 at a constant Reynolds number of 3.0 million and for angles of attack from -4° to 16°.

NACA RM A52D21

TRANSONIC AERODYNAMIC CHARACTERISTICS OF THREE THIN TRIANGULAR WINGS AND A TRAPEZOIDAL WING, ALL OF LOW ASPECT RATIO. Horace F. Emerson and Bernard M. Gale. July 1952. 35p. diagrs., photos. (NACA RM A52D21)

An experimental investigation was conducted, using the transonic-bump technique, to determine the aerodynamic characteristics of the following three triangular wing models: two of aspect ratio 2 with the NACA 0005-63 and 0003-63 wing sections, respectively, and one of aspect ratio 3 with the NACA 0003-63 wing section. In addition an aspect-ratio-2 trapezoidal wing, obtained by removing the wing tip from the aspect-ratio-3 model, was investigated. Lift, drag, and pitching-moment coefficients are presented for Mach numbers ranging from 0.60 to 1.10. The Reynolds number for the tests varied from 2.1 to 2.8 million.

NACA RM A52D23

LIFT, DRAG, AND PITCHING MOMENT OF LOW-ASPECT-RATIO WINGS AT SUBSONIC AND SUPERSONIC SPEEDS - PLANE TAPERED WING OF ASPECT RATIO 3.1 WITH 3-PERCENT-THICK ROUNDED-NOSE SECTION. John C. Heitmeyer. July 1952. 25p. diagrs., tabs. (NACA RM A52D23)

This report presents the results of an investigation to ascertain the lift, drag, and pitching moment of a wing-body combination having a plane tapered wing of aspect ratio 3.1, taper ratio of 0.39 with 3-percent-thick, rounded-nose sections in streamwise planes. Results are shown for Mach numbers from 0.60 to 0.92 and from 1.20 to 1.90 at Reynolds numbers of 1.5 million and comparisons made with similar results for sharp-nose biconvex sections.

NACA RM A52E01

EFFECTS OF THREE TYPES OF BLUNT TRAILING EDGES ON THE AERODYNAMIC CHARACTERISTICS OF A PLANE TAPERED WING OF ASPECT RATIO 3.1, WITH A 3-PERCENT-THICK BICONVEX SECTION. Duane W. Dugan. July 1952. 34p. diagrs. (NACA RM A52E01)

Results of an experimental investigation of the effects of trailing-edge bluntness on the aerodynamic characteristics of a wing-body combination are given for Mach numbers both subsonic (0.6 to 0.925) and supersonic (1.2 to 1.7) and Reynolds numbers of 1.5 and 3.8 million. Three types of blunt-trailing-edge wings were investigated, each obtained by modifying a basic plane tapered wing of aspect ratio 3.1 having a 3-percent-thick, circular-arc, biconvex section.

NACA RM A52K14

EXPERIMENTAL INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS OF AN AIR-TO-AIR MISSILE EMPLOYING CRUCIFORM WINGS AND TAIL OF RECTANGULAR PLAN FORM AT MACH NUMBERS OF 1.4 AND 1.9. Merrill H. Mead. February 1953. 31p. diagrs. (NACA RM A52K14)

The aerodynamic characteristics of a model of an air-to-air missile employing variable-incidence cruciform wings of rectangular plan form and a fixed cruciform tail of rectangular plan form, and the characteristics of its body-wing and body-tail components have been obtained, from a wind-tunnel investigation, for Mach numbers of 1.4 and 1.9. The results presented include normal-force, pitching-moment, and axial-force data for the body-wing-tail, body-wing, and body-tail combinations, and normal-force, hinge-moment, and axial-force data for the individual wing panels. The investigation was conducted at a constant Reynolds number of 1.51 million based on the wing chord. All of the results are presented in coefficient form plotted against angle of attack. No discussion of the results is included.

NACA RM A52L02

LIFT, DRAG, AND PITCHING MOMENT OF LOW-ASPECT-RATIO WINGS AT SUBSONIC AND SUPERSONIC SPEEDS - COMPARISON OF THREE WINGS OF ASPECT RATIO 2 OF RECTANGULAR, SWEPTBACK, AND TRIANGULAR PLAN FORM, INCLUDING EFFECTS OF THICKNESS DISTRIBUTION. Ronald C. Hightower. February 1953. 30p. diagrs., tabs. (NACA RM A52L02)

Three wing-body combinations of aspect ratio 2, of rectangular, sweptback, and triangular plan form, are compared at subsonic and supersonic Mach numbers. The effects of thickness distribution on the characteristics of the rectangular and sweptback wings are also shown. Data are presented in tabulated form for the rectangular wing at Reynolds numbers of 1.8 million and 4.4 million, the sweptback wing at Reynolds numbers of 1.9 million and 4.8 million, and the triangular wing at Reynolds numbers of 3.0 million and 7.5 million. A summary of the aerodynamic characteristics of the models at the highest Reynolds numbers is presented.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM A52L15a

EFFECT OF VERTICAL POSITION OF THE WING ON THE AERODYNAMIC CHARACTERISTICS OF THREE WING-BODY COMBINATIONS. John C. Heitmeyer. February 1953. 56p. diagrs., photo., tabs. (NACA RM A52L15a)

An experimental wind-tunnel investigation has been made of three plane wings of aspect ratio 3, with 3-percent-thick sections each in combination with a body modified for off-the-center-line locations of the wing. The three wings were of the following plan forms: tapered unswept, tapered swept, and triangular. The lift, drag, and pitching-moment characteristics of each configuration were obtained for a range of Mach numbers from 0.61 to 0.91 and from 1.20 to 1.90. The data were obtained at constant Reynolds numbers per foot of 2.57 million and 4.00 million for all Mach numbers except 1.90. At this Mach number the maximum test Reynolds number per foot was limited to 2.57 million. The results at a Reynolds number per foot of 4.0 million are compared with results of the same wings mounted in a midwing position on a body of revolution of the same axial distribution of cross-sectional area as the body of the present investigation.

NACA RM A53C20

SUBSONIC STATIC LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A WING-BODY COMBINATION HAVING A POINTED WING OF ASPECT RATIO 2 WITH CONSTANT-PERCENT-CHORD TRAILING-EDGE ELEVONS. Donald W. Smith and Verlin D. Reed. May 1953. 143p. diagrs., photos., tab. (NACA RM A53C20)

Results of tests made to determine the static longitudinal stability of a pointed wing with an aspect ratio 2 and the effectiveness of trailing-edge elevons as a longitudinal control are presented in this report. The effectiveness of tabs in reducing elevon hinge moments is also included. The data were obtained for a range of Mach numbers from 0.24 to 0.95 at a constant Reynolds number of 3.0 million and for Reynolds numbers up to 15.0 million at a constant Mach number of 0.24.

NACA RM A53D28

A STUDY OF THE MOTION AND AERODYNAMIC HEATING OF MISSILES ENTERING THE EARTH'S ATMOSPHERE AT HIGH SUPERSONIC SPEEDS. H. Julian Allen and A. J. Eggers, Jr. August 1953. 62p. diagrs., photo. (NACA RM A53D28)

A simplified analysis of the velocity and deceleration history of missiles entering the earth's atmosphere at high supersonic speeds is presented. The results of this motion analysis are employed to indicate means available to the designer for minimizing aerodynamic heating. The heating problem considered involves not only the total heat transferred to a missile by convection, but also the maximum average and local time rates of convective heat transfer.

NACA RM A53D29

PERFORMANCE OF A NORMAL-SHOCK SCOOP INLET WITH BOUNDARY-LAYER CONTROL. Alson C. Frazer and Warren E. Anderson. June 1953. 31p. diagrs., photos. (NACA RM A53D29)

An experimental investigation was conducted with a normal-shock scoop inlet mounted on a flat plate and employing a boundary-layer-removal scoop. The performance of the main scoop and the boundary-layer scoop was determined for varying amounts of boundary-layer removal over a Mach number range from 1.35 to 1.75. The maximum net thrust was approximately equal to that for an ideal normal-shock inlet and occurred for a value of scoop height to boundary-layer thickness of about 70 percent. Extending the boundary-layer scoop forward of the main inlet was found to increase the stable range of subcritical mass-flow ratio.

NACA RM A55D07

ESTIMATION OF INCREMENTAL PITCHING MOMENTS DUE TO TRAILING-EDGE FLAPS ON SWEPT AND TRIANGULAR WINGS. Harry A. James and Lynn W. Hunton. June 1955. 31p. diagrs., tab. (NACA RM A55D07)

A method is shown by which the incremental pitching moment of swept and triangular wings due to flaps at low speeds can be estimated by using two-dimensional data in conjunction with span-loading theory. Comparisons of estimated and experimental values of flap pitching-moment increments for some 58 cases indicate a mean deviation of about 0.02 C_m. Some two-dimensional flap parameters pertinent to the application of the method are summarized in graphical form.

NACA RM A55D18

A FLIGHT INVESTIGATION AT TRANSONIC SPEEDS OF A MODEL HAVING A TRIANGULAR WING OF ASPECT RATIO 3. Maurice D. White. June 1955. 39p. diagrs., photos., tabs. (NACA RM A55D18)

The longitudinal aerodynamic characteristics of a model having a triangular wing of aspect ratio 3 and a 45° sweptback horizontal tail located in the extended wing chord plane were investigated at transonic speeds by the free-falling recoverable-model technique. Static and dynamic longitudinal-stability data, and force and moment data for the major components of the model are presented for Mach numbers from 0.80 to 1.12 and angles of attack up to 16° to 22°, depending on the Mach number.

NACA RM E52D16, by Barson.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM E55D04

STATIC INVESTIGATION OF SEVERAL JET DEFLECTORS FOR LONGITUDINAL CONTROL OF AN AIRCRAFT. Alfred S. Valerino. June 1955. 19p. diagrs., photos. (NACA RM E55D04)

Results of a static investigation of several radially curved jet deflectors mounted at the exit of a shrouded iris-flap ejector indicate that, when the deflectors were alined with the trailing edge of the afterbody shroud (deflector removed from jet boundary), the lowest lifts per unit deflector area were obtained with the deflector having the shortest length. When the deflectors were alined with the trailing edge of the ejector shrouded iris flap (deflector at jet boundary), the highest lifts per unit deflector area were obtained with the deflector having the shortest length.

NACA RM L7D11, by Kuhn and Polhamus.

NACA RM L51D30

AN INVESTIGATION OF FLOW CHARACTERISTICS AT MACH NUMBER 4.04 OVER 6- AND 9-PERCENT-THICK SYMMETRICAL CIRCULAR-ARC AIRFOILS HAVING 30-PERCENT-CHORD TRAILING-EDGE FLAPS. Edward F. Ulmann and Douglas R. Lord. July 1951. 67p. diagrs., photos., tab. (NACA RM L51D30)

Section data obtained from wind-tunnel tests at Mach number 4.04 and Reynolds numbers of about 5.0×10^6 and 8.4×10^6 are presented for 6- and 9-percent-thick symmetrical circular-arc airfoils with 30-percent-chord trailing-edge flaps. Pressure distributions, schlieren photographs, and force and moment coefficients are included.

NACA RM L52D15a

SOME EFFECTS OF FIN PLAN FORM ON THE STATIC STABILITY OF FIN-BODY COMBINATIONS AT MACH NUMBER 4.06. Edward F. Ulmann and Robert W. Dunning. July 1952. 20p. diagrs., photos. (NACA RM L52D15a)

The results of an investigation in the Langley 9- by 9-inch Mach number 4 blowdown tunnel into the effects of fin plan form on the static stability of fin-body configurations at Mach number 4.06 are presented. Fins of three plan forms were tested as pairs of tail fins on fineness-ratio-9 and -12 ogive-cylinder bodies of revolution. Plan forms were rectangular, delta, and the trapezoidal plan form of the vertical tail of the Bell X-2 airplane. The results were compared with some existing fin-body interaction theories and an alteration to these theories is presented which improves their predictions for blunt bodies at high Mach numbers.

NACA RM L52D29

FREE-FLIGHT INVESTIGATION OF THE ZERO-LIFT DRAG OF SEVERAL WINGS AT SUPERSONIC MACH NUMBERS EXTENDING TO 2.6. Russell N. Hopko and Carl A. Sandahl. December 1952. 19p. diagrs., photos., tabs. (NACA RM L52D29)

The zero-lift drag of some delta and swept wings of current interest was obtained at Mach numbers extending to 2.6. The 60° delta wings had the lowest drag. At Mach numbers above 2.1, the drag coefficients of the 4.5-percent-thick, 10° swept wing and the 5.8-percent-thick, 63° swept tapered wing were about equal.

NACA RM L52L30

EFFECTS OF WING ELASTICITY ON THE AERODYNAMIC CHARACTERISTICS OF AN AIRPLANE CONFIGURATION HAVING 45° SWEPTBACK WINGS AS OBTAINED FROM FREE-FLIGHT ROCKET-MODEL TESTS AT TRANSONIC SPEEDS. A. James Vitale. January 1953. 49p. diagrs., photos., tab. (NACA RM L52L30)

Flight tests were conducted on two rocket-propelled models of an airplane configuration with 45° sweptback wings of aspect ratio 4 and having different stiffnesses. The longitudinal stability, lift, and drag characteristics were determined over a Mach number range of 0.95 to 1.3. A comparison was made between calculated and experimental aeroelastic effects on lift and longitudinal stability.

NACA RM L53D03

AERODYNAMIC CHARACTERISTICS AT MACH NUMBER 4.04 OF A RECTANGULAR WING OF ASPECT RATIO 1.33 HAVING A 6-PERCENT-THICK CIRCULAR-ARC PROFILE AND A 30-PERCENT-CHORD FULL-SPAN TRAILING-EDGE FLAP. Robert W. Dunning and Edward F. Ulmann. May 1953. 26p. diagrs., tab. (NACA RM L53D03)

The results of force tests at a Mach number of 4.04 and a Reynolds number of 8×10^6 of a rectangular-plan-form wing of aspect ratio 1.33 having a 6-percent-thick circular-arc profile and a 30-percent-chord full-span trailing-edge flap are presented and compared with previously obtained two-dimensional data and the predictions of an existing theoretical method. Data presented included lift, drag, pitching-moment, rolling-moment, and wing-root bending-moment coefficients for the wing and flap-hinge-moment coefficients and are presented through an angle-of-attack range of 0° to 10° and a flap-deflection range of $\pm 12^\circ$.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM L53D10

A TRANSONIC INVESTIGATION BY THE FREE-FALL METHOD OF AN AIRPLANE CONFIGURATION HAVING 45° SWEPTBACK WING AND TAIL SURFACES. Stanley Faber and John M. Eggleston. June 1953. 41p. diagrs., photos., tabs. (NACA RM L53D10)

As part of a general investigation to obtain the characteristics of airplanes in the transonic range, the Langley Laboratory, by using the free-fall technique, has tested an airplane configuration having 45° sweptback wing and tail surfaces. The model was equipped with an all-movable horizontal tail that was stepped cyclically during the drop in order to vary the angle of attack. In this manner, the lift, drag, and longitudinal static and dynamic stability and control characteristics were obtained at various operating lift coefficients (up to 0.26) over a Mach number range of 0.5 to 1.21.

NACA RM L53D24

AN EXPERIMENTAL INVESTIGATION OF THE EFFECT OF VARIOUS PARAMETERS INCLUDING TIP MACH NUMBER ON THE FLUTTER OF SOME MODEL HELICOPTER ROTOR BLADES. George W. Brooks and John E. Baker. June 1953. 68p. diagrs., photos., tabs. (NACA RM L53D24)

Experimental studies have been made to evaluate the effects of parameters such as Mach number, blade angle, and structural damping on the flutter of model helicopter rotor blades in the hovering condition. The model blades had NACA 23012 and 23018 airfoil sections and each was tested at chordwise center-of-gravity locations of approximately 27.5 and 37 percent. Data were obtained at test-medium densities ranging from 0.0012 to 0.0030 slug per cubic foot and at various pitch angles up into the stall. Mixtures of air and Freon-12 were used for the test medium in order to extend the tip Mach number range of the tests to slightly above unity.

NACA RM L53D27

EFFECT OF VARIATIONS IN REYNOLDS NUMBER ON THE AERODYNAMIC CHARACTERISTICS OF THREE BOMB OR STORE SHAPES AT A MACH NUMBER OF 1.62 WITH AND WITHOUT FINS. Robert W. Rainey. June 1953. 40p. diagrs., photos., tab. (NACA RM L53D27)

Results of tests made in the Langley 9-inch supersonic tunnel of three bomb shapes with two sets of cruciform fins as well as without fins are presented. These investigations were made at a Mach number of 1.62 and at Reynolds numbers of from 0.40×10^6 to 9.70×10^6 based upon the closed body lengths. The maximum angle-of-attack range was from -4° to 10°. The results are presented in the form of normal forces, chord forces, and pitching moments with analyses made of the effects of variations of angle of attack and Reynolds number upon the measured characteristics as well as upon the center-of-pressure position and fin effectiveness.

NACA RM L54D01

A WIND-TUNNEL INVESTIGATION AT HIGH SUBSONIC SPEEDS OF THE LATERAL CONTROL CHARACTERISTICS OF VARIOUS PLAIN SPOILER CONFIGURATIONS ON A 3-PERCENT-THICK 60° DELTA WING. Harleth G. Wiley. May 1954. 45p. diagrs., tabs. (NACA RM L54D01)

Results are presented of wind-tunnel investigations at Mach numbers of 0.60 to 0.94 and angles of attack of -2° to about 24° to determine the lateral control characteristics of spoilers with various wing chordwise and spanwise locations and spoiler spans and deflections on a thin 60° delta wing of NACA 65A003 airfoil section parallel to free stream.

NACA RM L54D09

SUBSONIC FLIGHT INVESTIGATION OF METHODS TO IMPROVE THE DAMPING OF LATERAL OSCILLATIONS BY MEANS OF A VISCOUS DAMPER IN THE RUDDER SYSTEM IN CONJUNCTION WITH ADJUSTED HINGE-MOMENT PARAMETERS. Harold L. Crane, George J. Hurt, Jr., and John M. Elliott. June 1954. 46p. diagrs., photos., tab. (NACA RM L54D09)

Results are presented of a flight investigation at subsonic speeds of a method to improve the damping of lateral oscillations by means of a viscous damping cylinder used in the rudder system in conjunction with adjusted hinge-moment parameters. The single-degree-of-freedom analysis used as a guide to adjust the parameters is included. A brief discussion of related problems which may result from the application of such a viscous damping device is given. The results of rudder trailing-edge strips to control rudder floating tendency are presented.

NACA RM L54D12a

SUPERSONIC FLUTTER OF A 60° DELTA WING ENCOUNTERED DURING THE FLIGHT TEST OF A ROCKET-PROPELLED MODEL. William T. Lauten, Jr., and Joseph H. Judd. June 1954. 20p. diagrs., photos., tabs. (NACA RM L54D12a)

Results of a flight test of a 60° delta-wing airplane configuration indicated wing flutter at a Mach number of about 1.7, continuing through the maximum Mach number of 2.08 to telemeter failure at a Mach number of 1.4. The ratio of flutter frequency to torsional frequency was approximately 1.0 from start to peak speed and gradually decreased as the model speed decreased. The flight time history, natural frequencies of vibration, and structural influence coefficients of the wing, and the mass, moment of inertia, and center of gravity of streamwise strips of the wing are presented. Also presented are calculated mode shapes and frequencies. A comparison is made with results obtained from a flight test of a wing similar in plan form but weaker structurally which fluttered over the same speed range.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM L54D15

EXPERIMENTAL EVIDENCE OF SUSTAINED COUPLED LONGITUDINAL AND LATERAL OSCILLATIONS FROM A ROCKET-PROPELLED MODEL OF A 35° SWEPT WING AIRPLANE CONFIGURATION. James H. Parks. May 1954. 28p. diagrs., photos., tab. (NACA RM L54D15)

Flight tests of a rocket-propelled model of a representative 35° sweptback airplane design indicate the existence of coupled longitudinal and lateral oscillations. The flight time history is presented and the primary sources of the cross-coupling moments are shown.

NACA RM L54D26a

FLIGHT INVESTIGATION OF AN AILERON AND A SPOILER ON A WING OF THE X-3 AIRPLANE PLAN FORM AT MACH NUMBERS FROM 0.5 TO 1.6. Roland D. English. June 1954. 16p. diagrs., photos. (NACA RM L54D26a)

A free-flight investigation has been made of the rolling effectiveness and drag of two types of controls on a wing of the X-3 airplane plan form. The controls investigated include a 25-percent-chord aileron deflected 5° and a 2-percent-chord trailing-edge spoiler. The tests were made at essentially zero angle of attack and zero angle of yaw over a Mach number range from 0.5 to 1.6.

NACA RM L54D28

FLIGHT INVESTIGATION TO DETERMINE LIFT AND DRAG CHARACTERISTICS OF A CANARD RAM-JET MISSILE CONFIGURATION IN THE MACH NUMBER RANGE OF 0.8 TO 2.0. Abraham A. Gammal and Thomas L. Kennedy. June 1954. 20p. diagrs., photos. (NACA RM L54D28)

A flight investigation, employing two rocket-boosted models, has been conducted on a canard ram-jet missile configuration consisting of two ram jets mounted on a composite wing of 0° and 60° leading-edge sweepback and a delta-type canard of 60° sweepback. Lift and drag data were obtained at low values of lift in the Mach number range of 0.8 to 2.0.

NACA RM L54L15

TURBULENT CONVECTIVE HEAT-TRANSFER COEFFICIENTS MEASURED FROM FLIGHT TESTS OF FOUR RESEARCH MODELS (NACA RM-10) AT MACH NUMBERS FROM 1.0 TO 3.6. Leo T. Chauvin and Joseph P. Maloney. March 1955. 30p. diagrs., photo., tabs. (NACA RM L54L15)

Free-flight tests at supersonic speeds have been made to determine the heat-transfer coefficient evaluated from measured skin temperatures along a parabolic body of revolution. The Mach number ranged from 1.0 to 3.6 and the Reynolds number ranged from 6×10^6 to 150×10^6. The experimental heat-transfer data from four flight tests are in agreement with previous measurement made on the NACA RM-10 research model. The measured recovery factors were lower than those predicted by theory for turbulent boundary layers. The experimental data were also in agreement with the theory of NACA RM L52H04 for heat transfer in a compressible flow. When a modified Reynolds analogy was used, the measured heat transfer was in agreement with the average measured skin friction.

NACA RM L55D27

EFFECTS OF WING-MOUNTED TANK-TYPE STORES ON THE LOW-LIFT BUFFETING AND DRAG OF A SWEPT-WING AIRPLANE CONFIGURATION BETWEEN MACH NUMBERS OF 0.8 AND 1.3. Homer P. Mason. October 1955. 34p. diagrs., photos., tabs. (NACA RM L55D27)

Results of rocket-powered model tests of a 45° swept-wing airplane configuration with two different underwing fuel-tank installations are presented and compared with previously reported data to show the effect of fuel-tank installations on the buffeting and drag, including an evaluation of interference effects, of the configuration.

NACA RM L55D29

INVESTIGATION OF THE EFFECTS OF MODEL SCALE AND STREAM REYNOLDS NUMBER ON THE AERODYNAMIC CHARACTERISTICS OF TWO RECTANGULAR WINGS AT SUPERSONIC SPEEDS IN THE LANGLEY 9-INCH SUPERSONIC TUNNEL. Donald E. Coletti. June 1955. 32p. diagrs. (NACA RM L55D29)

Results of an investigation made in the Langley 9-inch supersonic tunnel are presented to determine the effect of model scale and stream Reynolds number on the aerodynamic characteristics of two aspect-ratio 1.80 rectangular wings having thickness ratios of 0.059. The tests were conducted at Reynolds numbers varying between 0.13×10^6 and 2.96×10^6 and at Mach numbers of 1.62, 1.94, and 2.41. The angle of attack was varied between 7° and -6°. Comparisons are made with theory.

NACA RM SL53F26, by Sleeman and Byrnes.
NACA RM SL53G10, by Sleeman and Morrison.

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1282

A SPECIAL METHOD FOR FINDING BODY DISTORTIONS THAT REDUCE THE WAVE DRAG OF WING AND BODY COMBINATIONS AT SUPERSONIC SPEEDS. Harvard Lomax and Max. A. Heaslet. 1956. ii, 38p. diagrs., tabs. (NACA Rept. 1282. Supersedes RM A55B16)

For a given wing and supersonic Mach number, the problem of shaping an adjoining fuselage so that the combination will have a low wave drag is considered. Only fuselages that can be simulated by singularities (multipoles) distributed along the body axis are studied. However, the optimum variations of such singularities are completely specified in terms of the wing geometry.

NACA Rept. 1283

EXTRAPOLATION TECHNIQUES APPLIED TO MATRIX METHODS IN NEUTRON DIFFUSION PROBLEMS. Robert R. McCready. 1956. ii, 10p. diagrs. (NACA Rept. 1283. Supersedes TN 3511)

An iterative scheme is developed for the matrix solution of the type of characteristic-value problem arising from homogeneous linear equations. The scheme is shown to minimize a suitable form at each step. Extrapolation techniques for speeding convergence are developed and refined. An example from nuclear-reactor theory is presented.

NACA Rept. 1292

INTENSITY, SCALE, AND SPECTRA OF TURBULENCE IN MIXING REGION OF FREE SUBSONIC JET. James C. Laurence. 1956. ii, 27p. diagrs., photo., tab. (NACA Rept. 1292. Supersedes TN 3561; TN 3576)

The intensity of turbulence, the longitudinal and lateral correlation coefficients, and the spectra of turbulence in a 3.5-inch-diameter free jet were measured with hot-wire anemometers at exit Mach numbers from 0.2 to 0.7 and Reynolds numbers from 192,000 to 725,000. The results of these measurements show the following: (1) Near the nozzle (distances less than 4 or 5 jet diameters downstream of the nozzle) the intensity of turbulence, expressed as percent of core velocity, is a maximum at a distance of approximately 1 jet radius from the center line and decreases slightly with increasing Mach and/or Reynolds number. At distances greater than 8 jet diameters downstream of the nozzle, however, the maximum intensity moves out and decreases in magnitude until the turbulence-intensity profiles are quite flat and approaching similarity. (2) The lateral and longitudinal scales of turbulence are nearly independent of Mach and/or Reynolds number and in the mixing zone near the jet vary proportionally with distance from the jet nozzle. (3) Farther downstream of the jet the longitudinal scale reaches a maximum and then decreases approximately linearly with distance. (4) Near the nozzle the lateral scale is much smaller than the longitudinal and does not vary with distance from the center line, while the longitudinal scale is a maximum at a distance from the center line of about 0.7 to 0.8 of the jet radius. (5) Farther downstream this maximum moves out from the center line. (6) A statistical analysis of the correlograms and spectra yields a "scale" which, although different in magnitude from the conventional, varies similarly to the ordinary scale and is easier to evaluate.

NACA RM 57B25

PROPAGATION OF SOUND INTO A WIND-CREATED SHADOW ZONE. David C. Pridmore-Brown, Massachusetts Institute of Technology. April 1957. 25p. diagrs. (NACA RM 57B25)

The general wave equation is derived governing the propagation of sound in a stratified moving medium, the velocity of which varies only along one coordinate. Under the assumption that the flow velocity is small and slowly varying, a simplified equation is adopted which is satisfactory for the present application. A solution is found to this equation corresponding to the pressure field around a spherical source located above a plane ground in a horizontal wind whose velocity increases with altitude. It is shown that within the acoustic shadow that forms on the upwind side of such a source the pressure field is similar to that which is obtained in the corresponding problem of a sound source in a temperature gradient. An expression is derived for the rate of attenuation within a shadow which is brought about by the presence of both a wind and a temperature gradient.

CURRENT NACA RESEARCH REPORTS

NACA RM E57B14

A REVIEW OF THE PHYSICAL AND THERMODYNAMIC PROPERTIES OF BORIC OXIDE. Paul C. Setze. April 1957. 25p. diagrs., photo., tabs. (NACA RM E57B14)

The properties of boric oxide (B_2O_3) are presented in tabular and graphical form and include specific heat, sensible enthalpy, total enthalpy, entropy, latent heat of vaporization, and vapor pressure, (for the crystal, liquid, and vapor states) and specific gravity, surface tension, viscosity, and electrical resistivity. In addition, basic molecular and structural data are included. The data presented are discussed, and the reasons are given for choosing one set of data in preference to another.

NACA TM 1429

WALL INTERFERENCE IN A PERFORATED WIND TUNNEL. (Studio dell'Interferenza delle Gallerie Aerodinamiche con Pareti a Fessure). Riccardo Brescia. May 1957. 28p. diagrs. (NACA TM 1429. Translation from Accademia delle Scienze di Torino, Atti, v. 87, 1952-1953)

The interference of perforated walls on sources and doublets is treated by showing that as the dimensions of a cascade wall become small, the cascade wall approximates a vortex sheet. Special singularities called "reflected" and "transmitted" are developed to simulate the interference of the vortex sheet on the original singularities. Equations are given for the interference of two perforated walls on the flow fields of two-dimensional sources and doublets.

NACA TN 3878

THEORETICAL AND EXPERIMENTAL INVESTIGATION OF RANDOM GUST LOADS. PART I - AERODYNAMIC TRANSFER FUNCTION OF A SIMPLE WING CONFIGURATION IN INCOMPRESSIBLE FLOW. Raimo J. Hakkinen and A. S. Richardson, Jr., Massachusetts Institute of Technology. May 1957. 64p. diagrs., photos. (NACA TN 3878)

Sinusoidally oscillating downwash and lift produced on a simple rigid airfoil were measured and compared with calculated values. Statistically stationary random downwash and the corresponding lift on a simple rigid airfoil were also measured and the transfer functions between their power spectra determined. The random experimental values are compared with theoretically approximated values. Limitations of the experimental technique and the need for more extensive experimental data are discussed.

NACA TN 3879

THEORETICAL AND EXPERIMENTAL INVESTIGATION OF RANDOM GUST LOADS. PART II - THEORETICAL FORMULATION OF ATMOSPHERIC GUST RESPONSE PROBLEM. A. S. Richardson, Jr., Massachusetts Institute of Technology. May 1957. 50p. diagrs., tab. (NACA TN 3879)

Equations of motion are derived for the dynamic response of an aircraft to random atmospheric gust loads. These equations include the degrees of freedom of plunging, pitching, rolling, and an arbitrary number of elastic normal modes. Solutions are obtained by use of the Dirac delta function and certain cross correlations and autocorrelations enter the analysis. Several simplified cases are analyzed. Comparisons are made with results of the sharp-edged-gust formula.

NACA TN 3903

AN EXPERIMENTAL HYDRODYNAMIC INVESTIGATION OF THE INCEPTION OF VORTEX VENTILATION. John A. Ramsen. April 1957. 31p. diagrs., photos. (NACA TN 3903)

Results are presented from a hydrodynamic investigation of the inception of vortex ventilation on modified-flat-plate rectangular lifting surfaces of aspect ratio 0.25 differing in scale and thickness ratio. Two types of bubble-formation processes are described. Inception speeds were correlated for bubble formation in the high angle-of-attack range by using the Froude number and for that in the low angle-of-attack range by expressing the speed as a function of the thickness ratio.

NACA TN 3920

EFFECT OF SPANWISE VARIATIONS IN GUST INTENSITY ON THE LIFT DUE TO ATMOSPHERIC TURBULENCE. Franklin W. Diederich and Joseph A. Drischler. April 1957. 56p. diagrs., tabs. (NACA TN 3920)

The effect of spanwise variations in gust intensity on the power spectrum directly due to atmospheric turbulence is calculated for several analytic approximations to the correlation function or power spectra of atmospheric turbulence, for several spanwise weighting functions (span loadings), and for various angles of sweepback.

NACA TN 3934

EXPERIMENTAL STUDY OF HEAT TRANSFER TO SMALL CYLINDERS IN A SUBSONIC, HIGH-TEMPERATURE GAS STREAM. George E. Glawe and Robert C. Johnson. APPENDIX C: METHOD USED TO COMPUTE VISCOSITY AND THERMAL CONDUCTIVITY OF COMBUSTION GAS MIXTURES. Richard S. Brokaw and Robert C. Johnson. May 1957. 21p. diagrs., photo. (NACA TN 3934)

A Nusselt-Reynolds number relation for cylindrical thermocouple wires in crossflow was obtained from the experimental determination of time constants. Tests were conducted in exhaust gas over a temperature range of 2000° to 3400° R, a Mach number range of 0.3 to 0.8, and a static-pressure range from 2/3 to 1-1/3 atmospheres, yielding a Reynolds number range of 450 to 3000. The correlation obtained is $Nu = (0.428 \pm 0.003)\sqrt{Re^*}$ with average deviations of a single observation of 8.5 percent. This relation is the same as one previously reported for room-temperature conditions.

CURRENT NACA RESEARCH REPORTS

NACA TN 3935

HYDROGEN-OXYGEN EXPLOSIONS IN EXHAUST DUCTING. Paul M. Ordin. April 1957. 31p. diagrs., photos., tab. (NACA TN 3935)

An investigation was undertaken to determine the detonation combustion pressure of hydrogen-oxygen mixtures at a pressure of 1 atmosphere in a 2-foot-diameter duct. Detonation pressures of about 315 lb/sq in. abs were obtained at oxidant-fuel mole ratios of 0.82. Water sprays distributed through sections of the duct did not prevent a detonation but did reduce the peak pressures. The total pressures obtained on various designs of 90° steel elbows by the detonation were about 900 lb/sq in. abs. A design stress of 38,400 psi and suitable supporting members for the duct elbows contained the detonation without any damage to the structure.

NACA TN 3950

CHARTS FOR THE ANALYSIS OF FLOW IN A WHIRLING DUCT. Robert A. Makofski. May 1957. 21p. diagrs. (NACA TN 3950)

Charts are developed for the analysis of flow in a whirling constant-diameter duct. These charts permit the determination of the duct-exit Mach number, or the Mach number at any point along the duct, for practical ranges of duct-inlet Mach number, duct-tip Mach number, friction factor, ratio of ambient temperature to duct-flow total temperature, ratio of duct-tip radius to duct hydraulic diameter, and heat conductivity through the duct wall and surrounding material. The method of using the charts is illustrated through the computation of a sample problem.

NACA TN 3956

LIFT AND MOMENT RESPONSES TO PENETRATION OF SHARP-EDGED TRAVELING GUSTS, WITH APPLICATION TO PENETRATION OF WEAK BLAST WAVES. Joseph A. Drischler and Franklin W. Diederich. May 1957. 85p. diagrs., tabs. (NACA TN 3956)

The lift and moment responses to penetration of sharp-edged traveling gusts are calculated for wings in incompressible and supersonic two-dimensional flow, for wide delta and rectangular wings in supersonic flow, and for very narrow delta wings. By using the two-dimensional indicial-lift functions, some calculations of normal-acceleration response are made for two mass ratios. The relation between gusts traveling at supersonic speeds and blast waves is indicated.

NACA TN 3959

CASCADE INVESTIGATION OF A RELATED SERIES OF 6-PERCENT-THICK GUIDE-VANE PROFILES AND DESIGN CHARTS. James C. Dunavant. May 1957. 48p. diagrs., tabs. (NACA TN 3959. Supersedes RM L54I02)

A new guide-vane blade series for high critical speeds of improved section characteristics has been derived. Low-speed cascade tests were made of four blade sections of this series at solidities of 0.75, 1.00, and 1.50. From these tests, design angles of attack were selected and are presented as a method of determining camber for guide-vane turning angles as high as 50°. The results of a number of simple computations made to estimate the high-speed characteristics of the blade series are presented.

NACA TN 3961

EFFECTS OF FUSELAGE NOSE LENGTH AND A CANOPY ON THE STATIC LONGITUDINAL AND LATERAL STABILITY CHARACTERISTICS OF 45° SWEPTBACK AIRPLANE MODELS HAVING FUSELAGES WITH SQUARE CROSS SECTIONS. Byron M. Jaquet and H. S. Fletcher. April 1957. 47p. diagrs., photos., tabs. (NACA TN 3961)

Results are presented of an investigation made in the Langley stability tunnel to determine the effect of fuselage nose length and canopy on the static longitudinal and lateral characteristics of complete models (fuselage fineness ratio varied from 7.41 to 10.18) over an angle-of-attack range of -10° to 32°. The effects of the canopy and wing on the tail contribution to the static longitudinal and static directional stability characteristics were determined for a fuselage of fineness ratio 9.26. Data were also obtained with the fuselage nose blunted for a complete model originally having the pointed-nose fuselage of fineness ratio 9.26. Data through a sideslip-angle range of -24° to 24° were obtained at a few angles of attack. The test Mach number was 0.13 and the Reynolds number, based on the wing mean aerodynamic chord, was 0.83×10^6.

NACA TN 3964

THE LINEARIZED SUBSONIC FLOW ABOUT SYMMETRICAL NONLIFTING WING-BODY COMBINATIONS. John B. McDevitt. April 1957. 67p. diagrs. (NACA TN 3964)

A theory is presented for calculating the linearized subsonic flow about symmetrical, nonlifting wing-body combinations. The wing is represented by a planar distribution of sources and the required boundary condition of tangential flow at the body surface is satisfied by placing along the body center line axial distributions of sources and multipoles.

CURRENT NACA RESEARCH REPORTS

NACA TN 3965

MEASUREMENTS OF THE NONLINEAR VARIATION WITH TEMPERATURE OF HEAT-TRANSFER RATE FROM HOT WIRES IN TRANSONIC AND SUPERSONIC FLOW. Warren Winovich and Howard A. Stine. April 1957. 33p. diagrs., photo., tab. (NACA TN 3965)

An experimental investigation was undertaken to determine heat-loss characteristics of hot wires operating at Mach numbers between 0.5 and 2.5. At constant temperature potential, the Nusselt number is given as a function of the Reynolds number and Mach number. The influence of Mach number on nonlinearity between temperature and heat-transfer rate was determined at various Reynolds numbers.

NACA TN 3966

THEORETICAL INVESTIGATION OF THE EFFECTS OF CONFIGURATION CHANGES ON THE CENTER-OF-PRESSURE SHIFT OF A BODY-WING-TAIL COMBINATION DUE TO ANGLE OF ATTACK AND MACH NUMBER AT TRANSONIC AND SUPERSONIC SPEEDS. J. Richard Spahr. May 1957. 43p. diagrs. (NACA TN 3966. Supersedes RM A55F02)

A theoretical investigation was made to determine the effects of systematic configuration changes on the center-of-pressure shift of an unbanked canard missile configuration having coplanar triangular-wing and -tail surfaces due to angle of attack and Mach number in the transonic and supersonic ranges. The following geometric variables were investigated independently of the others: ratio of wing semispan to tail semispan, ratio of body radius to wing semispan, ratio of tail length to body length, wing aspect ratio, tail aspect ratio, wing taper ratio, tail taper ratio, wing sweep, tail sweep, ratio of tail height to body radius, and wing-tail interdigitation.

NACA TN 3967

CHARACTERISTICS OF A 40° CONE FOR MEASURING MACH NUMBER, TOTAL PRESSURE, AND FLOW ANGLES AT SUPERSONIC SPEEDS. Frank J. Centolanzi. May 1957. 36p. diagrs. (NACA TN 3967)

An experimental investigation of the characteristics of a 40° cone for measuring Mach number, total pressure, and flow angles has been conducted. Data were taken for angles of pitch up to 26° at Mach numbers of 1.72, 1.95, and 2.46 for Reynolds numbers of 3.12 and 5.41 million per foot. This instrument is capable of measuring Mach number within approximately ±1.0 percent and the flow direction measured within ±0.25°. Charts are presented for the direct determination of these flow quantities.

NACA TN 3968

THE APPLICATION OF MATRIX METHODS TO COORDINATE TRANSFORMATIONS OCCURRING IN SYSTEMS STUDIES INVOLVING LARGE MOTIONS OF AIRCRAFT. Brian F. Doolin. May 1957. 36p. (NACA TN 3968)

The paper shows the method and advantages of matrix algebra in setting up geometric aspects of problems of airplane motion. Such aspects arise particularly in studies of systems which include aircraft. The paper first discusses the matrix properties needed. Then it applies them in several examples.

NACA TN 3969

A THEORETICAL STUDY OF THE EFFECT OF UPSTREAM TRANSPIRATION COOLING ON THE HEAT-TRANSFER AND SKIN-FRICTION CHARACTERISTICS OF A COMPRESSIBLE, LAMINAR BOUNDARY LAYER. Morris W. Rubesin and Mamoru Inouye. May 1957. 41p. diagrs., tab. (NACA TN 3969)

The present analysis considers a compressible, laminar boundary layer on a flat plate. The flat plate is divided into two regions: an upstream region of finite length which is porous and transpiration cooled with air, and a downstream region which is nonporous and is protected by the upstream cooling process.

NACA TN 3973

ORIGIN AND PREVENTION OF CRASH FIRES IN TURBOJET AIRCRAFT. I. Irving Pinkel, Solomon Weiss, G. Merritt Preston, and Gerard J. Pesman. May 1957. 65p. diagrs., photos., tab. (NACA TN 3973)

The manner in which the jet engine may start a crash fire was explored in test-stand and full-scale crash studies. On the basis of these studies, a method was devised for inerting and cooling the engine parts that may serve as ignition sources in crash. This method was tried successfully in full-scale crashes of jet-powered airplanes carrying engines in pod nacelles and engines buried within the airplane structure.

NACA TN 3975

INVESTIGATION OF A FULL-SCALE, CASCADE-TYPE THRUST REVERSER. Robert C. Kohl and Joseph S. Algranti. April 1957. 53p. diagrs., photos. (NACA TN 3975)

A double set of turning vanes was carried inside the jet tailpipe. To produce reverse thrust, the tailpipe opens into two side sections and the turning vanes move outward to form a V-shaped cascade, which deflects the exhaust-gas flow. Forward and reverse net thrust were measured over a range of engine speeds with the airplane stationary. Taxi tests were made to determine the comparative stopping distances using wheel braking and reverse thrust separately, and a combination of both. The effect of turning-vane spacing on thrust-reverser performance was determined by scale-model tests using unheated air.

CURRENT NACA RESEARCH REPORTS

NACA TN 3978

SURVEY OF THE ACOUSTIC NEAR FIELD OF THREE NOZZLES AT A PRESSURE RATIO OF 30. Harold R. Mull and John C. Erickson, Jr. April 1957. 32p. diagrs., photos. (NACA TN 3978)

The sound pressures radiating from the exhaust streams of two convergent-divergent and one convergent nozzle were measured. Exit diameters were 1.206 in. for the expanded nozzle and 0.625 in. for the convergent nozzle. The results are presented in a series of contour maps of overall and fine 1/3-octave-band sound pressures. The location of the source of the noise in each 1/3-octave band in the frequency range of 30 to 16,000 cps and the total power radiated were determined and compared with those of subsonic jets.

NACA TN 3979

EFFECT OF BLUNTNESS ON TRANSITION FOR A CONE AND A HOLLOW CYLINDER AT MACH 3.1. Paul F. Brinich and Norman Sands. May 1957. 42p. diagrs. (NACA TN 3979)

Bluntness was more effective in displacing transition downstream on a cylinder than on a cone. The downstream displacement of transition is related to the formation of a shock layer within which the Reynolds and Mach numbers are reduced and to pressure gradients that exist over the forward part of the model. Round bluntness in general had a favorable effect, whereas sharp-cornered flat bluntness above a certain size had unfavorable effects on the location of the transition point.

NACA TN 3980

INVESTIGATION OF SEMIVANELESS TURBINE STATOR DESIGNED TO PRODUCE AXIALLY SYMMETRICAL FREE-VORTEX FLOW. Harold E. Rohlik and William T. Wintucky. April 1957. 39p. diagrs., photos., tabs. (NACA TN 3980)

A semivaneless turbine stator designed to eliminate blade wakes and secondary-flow accumulations of boundary-layer air was built and tested. Performance of this stator was evaluated with static pressures measured in the vaneless section and surveys of total pressure and flow angle made at the stator exit. Results are presented in terms of theoretical and experimental velocities and flow angles, boundary-layer parameters, and contours of total-pressure loss across the stator.

NACA TN 3981

TABLES OF VARIOUS MACH NUMBER FUNCTIONS FOR SPECIFIC-HEAT RATIOS FROM 1.28 TO 1.38. Lewis Laboratory Computing Staff. April 1957. 76p. tabs. (NACA TN 3981)

Tables of Mach number functions are presented for a range of specific-heat ratios. The tables provide information supplemental to the notes and tables of Report 1135.

NACA TN 3982

EXPLORATORY STUDY OF GROUND PROXIMITY EFFECTS ON THRUST OF ANNULAR AND CIRCULAR NOZZLES. Uwe H. von Glahn. April 1957. 48p. diagrs., photos. (NACA TN 3982)

The proximity of the ground to an annular nozzle can result in thrust augmentation of up to 50 percent. The magnitude of thrust augmentation was a function of ground-to-nozzle distance, nozzle configuration, and nozzle pressure ratio. With a conventional circular nozzle a thrust reduction of 15 to 40 percent due to ground effect was obtained. The degree of thrust reduction was primarily a function of nozzle pressure ratio and ground-to-nozzle distance.

NACA TN 3993

BURSTING STRENGTH OF UNSTIFFENED PRESSURE CYLINDERS WITH SLITS. Roger W. Peters and Paul Kuhn. April 1957. 21p. diagrs., photos., tabs. (NACA TN 3993)

Internal-pressure tests were made on aluminum-alloy unstiffened cylinders with precut slits to study the effect of slit length and curvature on the hoop stress developed at the bursting pressure. The results are predicted with good accuracy by applying a curvature correction to the method presented in NACA TN 3816 for computing the strength of flat plates with cracks. In this investigation cylinders were pressurized with air and oil. The results indicate that the pressurizing medium has a negligible effect on the bursting pressure.

NACA TN 3997

A NOTE ON THE EFFECT OF HEAT TRANSFER ON PEAK PRESSURE RISE ASSOCIATED WITH SEPARATION OF TURBULENT BOUNDARY LAYER ON A BODY OF REVOLUTION (NACA RM-10) AT A MACH NUMBER OF 1.61. K. R. Czarnecki and Archibald R. Sinclair. April 1957. 13p. diagrs., photos. (NACA TN 3997)

The effects of heat transfer on the peak pressure rise associated with the separation of a turbulent boundary layer on a body of revolution (NACA RM-10) at a Mach number of 1.61 have been determined experimentally. Tests were made over a Reynolds number range, based on the distance from model nose to separation point, from 11.6×10^6 to 34.8×10^6 for a ratio of model-wall temperature to stagnation temperature of 0.96 (zero heat transfer) to 0.75. The results indicate little or no effect of heat transfer on the peak pressure rise for separation. The technique of using shock angles to determine the peak pressure rise for separation gave results that were in fairly good agreement with those obtained in previous investigations by means of measured pressures.

CURRENT NACA RESEARCH REPORTS

NACA TN 3998

GROUND SIMULATOR STUDIES OF THE EFFECTS OF VALVE FRICTION, STICK FRICTION, FLEXIBILITY, AND BACKLASH ON POWER CONTROL SYSTEM QUALITY. B. Porter Brown. April 1957. 45p. diagrs., photo. (NACA TN 3998)

Ground simulator tests were made to study the effects of various ratios of valve friction to stick friction on power control system quality. Boundaries are determined for good, tolerable, and unsatisfactory ranges of valve and stick friction for a rigid control system and a system with flexibility between the source of stick friction and the valve. The effect of various friction ratios with flexibility between the pilot and the source of stick friction is presented. The effect of backlash with various friction ratios is also presented.

NACA TN 4000

A PHENOMENOLOGICAL RELATION BETWEEN STRESS, STRAIN RATE, AND TEMPERATURE FOR METALS AT ELEVATED TEMPERATURES. Elbridge Z. Stowell. May 1957. 19p. diagrs., tab. (NACA TN 4000)

A phenomenological relation between stress, strain rate, and temperature is suggested to account for the behavior of polycrystalline metals above the equicohesive temperature. The properties of the metal included in the relation are elasticity, linear thermal expansion, and viscosity. The relation may be integrated under various conditions to provide information on creep rates, creep rupture, stress-strain curves, and rapid-heating curves. It is shown that for one material - 7075-T6 aluminum-alloy sheet - the information yielded by the relation for these four applications agrees reasonably well with test data.

NACA TN 4002

INTERACTION OF MOVING SHOCKS AND HOT LAYERS. Robert V. Hess. May 1957. 65p. diagrs. (NACA TN 4002)

Interactions are treated of normal and oblique shocks with hot layers at various temperatures. A brief discussion of spherical and cylindrical shocks is also given. Emphasis is on the fact that at very high temperatures the hot-layer shape undergoes drastic changes. The hot layer is forced to accumulate in a growing bubble-shaped region bound to the moving shock. If the cold flow over the bubble is subsonic, it may divide as it approaches the wall at the end of the bubble and cause a cold jet to penetrate under the bubble. A supersonic flow over the bubble can meet the wall with a shock. Under the influence of mixing, the hot-layer flow can no longer accumulate and a separation bubble is formed. It differs significantly from that in steady boundary layers since it is bound to the moving shock.

NACA TN 4010

EXPERIMENTALLY DETERMINED NATURAL VIBRATION MODES OF SOME CANTILEVER-WING FLUTTER MODELS BY USING AN ACCELERATION METHOD. Perry W. Hanson and W. J. Tuovila. April 1957. 46p. diagrs., photo., tab. (NACA TN 4010)

Three-dimensional views are presented of the first three natural vibration mode shapes of ten cantilever-wing models. A table of normalized deflections at six spanwise and five chordwise stations is included for each mode. These mode shapes were measured by a rather unique experimental technique using grains of sand as accelerometers. The technique, which is particularly suited for measuring mode shapes of small wing models, is described and some of the difficulties likely to be encountered in applying the technique are discussed.

BRITISH REPORTS

N-48514*

National Gas Turbine Establishment (Gt. Brit.) TEMPERATURE EFFECTS IN A TURBO-JET ENGINE NOZZLE BLADE DURING TRANSIENT OPERATION. H. Taylor, R. E. Wilsdon, and M. R. Abbott. January 1957. 83p. diagrs., photos. NGTE R.191. (Ask for N-48514*)

Transient operation of a turbojet engine may result in the turbine blading being subjected to severe thermal stresses. An engine experiment showed that shutdown from full speed was the most severe case and subsequent work was directed to this problem. Calculations of blade temperature were made based on equilibrium heat-transfer data to assess a quasi-static approach to the transient temperature problem. Reasonable correlation was obtained between calculated results and the engine experiment.

N-48516*

Royal Aircraft Establishment (Gt. Brit.) SOME METALLOGRAPHIC OBSERVATIONS ON THE FATIGUE BEHAVIOUR OF COPPER AND NICKEL AND CERTAIN OF THEIR ALLOYS. C. A. Stubbington and P. J. E. Forsyth. August 1956. 13p. photos. RAE Tech. Note Met. 250. (Ask for N-48516*)

In order to understand further the slipband extrusion phenomenon exhibited in cyclic stress and discover whether overaging necessarily played a part, it was decided to carry out an investigation on an alloy from a system showing complete solubility at the temperature of test. Monel metal was chosen as a suitable material for such an investigation. Work was also carried out on electrolytic copper and nickel, and also on a copper rich nickel-copper alloy. The observations will be reported in the present note.

BRITISH REPORTS

N-48614*

Aeronautical Research Council (Gt. Brit.)
LIST OF CURRENT PAPERS PUBLISHED BY THE AERONAUTICAL RESEARCH COUNCIL (NUMBERS 201-250). 1956. 5p. ARC CP 250.
(Ask for N-48614*)

MISCELLANEOUS

Errata on NACA RM L56F04, by Sternfield, August 1956.

N-41550*

Advisory Group for Aeronautical Research and Development. MACH NUMBER MEASUREMENTS IN HIGH-SPEED WIND TUNNELS. Jacques A. F. Hill, Judson R. Baron, Leon H. Schindel, and John R. Markham, Naval Supersonic Laboratory, Massachusetts Institute of Technology. October 1956. (xii), 113p. diagrs., tabs. AGARDograph 22.
(Ask for N-41550*)

A discussion of Mach number measurement in the empty tunnel, at local flow points around a model, and in the presence of wall interference. Sources of errors are discussed and certain procedures recommended.

N-51482*

A STUDY OF THE CORRELATION BETWEEN FLIGHT AND WIND-TUNNEL BUFFET LOADS. Wilber B. Huston. (Presented to Structures and Materials Panel, Advisory Group for Aeronautical Research and Development, Copenhagen, Denmark, April 29-May 4, 1957). 31p. diagrs.
(Ask for N-51482*)

Methods and concepts developed in the study of random processes are applied to the loads on an airplane wing in buffeting. The power spectrum and probability distribution of the buffet loads as measured by electrical wire resistance strain gages suggest that these loads can be considered as the linear response of a lightly damped single-degree-of-freedom system to a random input. Dimensional analysis and beam theory are employed to develop a relation between the buffet loads on an airplane in flight and the loads on a model in a wind tunnel. Flight and model results are compared for several different configurations.

N-51483*

ATMOSPHERIC TURBULENCE ENVIRONMENT WITH SPECIAL REFERENCE TO CONTINUOUS TURBULENCE. Harry Press. (Presented to Structures and Materials Panel, Advisory Group for Aeronautical Research and Development, Copenhagen, Denmark, April 29-May 4, 1957). 46p. diagrs.
(Ask for N-51483*)

The flight-test techniques for measuring continuous atmospheric turbulence are briefly outlined and available measurements of the power spectrum of atmospheric turbulence reviewed. The measured results are examined in order to determine how well they approximate the idealized models of a stationary Gaussian random process and of isotropic turbulence. Finally, some recent results on the variation with altitude of the probability distribution of the root-mean-square gust velocity are presented and the application of these results to operational response history calculations indicated.

N-51605*

SOME EFFECTS OF SHED VORTICES ON THE FLOW FIELDS AROUND STABILIZING TAIL SURFACES. Ralph W. Stone, Jr., and Edward C. Polhamus. (Presented to Structures and Materials Panel of Advisory Group for Aeronautical Research and Development, Copenhagen, Denmark, April 29 - May 4, 1957). 30p. diagrs., photos.
(Ask for N-51605*)

A brief study is made of the effects of vortices shed primarily from bodies on the flow angularities in the regions of stabilizing tail surfaces. The results generally show a rather large adverse effect of such flow fields on the tail loads and tail-load distributions. The results further indicate that, for some conditions an oscillatory characteristic of vortex flows exists and may be conducive to tail buffeting.

N-51809*

Advisory Group for Aeronautical Research and Development. THE INGESTION OF SEA WATER. P. D. G. V. Whittingham, Royal Air Force Institute of Aviation Medicine. (Presented at 7th meeting of Aeromedical Panel, AGARD, Toronto, Canada, June 13, 1955). June 1955. 7p. tab. AGARD Report 1. (Ask for N-51809*)

In this paper the importance of the difference in composition between urine and sea water is discussed. Methods of reducing the loss of body water are stressed in their importance in survival. It is concluded that sea water should never be drunk.

N-51810*

Advisory Group for Aeronautical Research and Development. FLUTTER RESEARCH AT THE ROYAL AIRCRAFT ESTABLISHMENT, FARNBOROUGH. H. Templeton. (Presented at 2nd meeting of Structures & Materials Panel, AGARD, London, September 5-9, 1955). September 1955. 30p. diagrs., photos. AGARD Report 4.
(Ask for N-51810*)

This report outlines the basic objective and the main activities of flutter research at the R.A.E. Some examples of these activities are described.

MISCELLANEOUS

N-51811*

Advisory Group for Aeronautical Research and Development. A METHOD FOR SOLVING DYNAMIC PROBLEMS OF MODERN TRANSONIC AND SUPERSONIC WINGS. Luigi Broglio, Ministero Difesa, Aeronautica, Roma. (Presented at 3rd meeting of Structures & Materials Panel, AGARD, Washington, D. C., April 10-17, 1956). April 1956. 25p. diagrs. AGARD Report 38.
(Ask for N-51811*)

Presents a method for the general solution of dynamic problems of delta, swept, or crescent wings, or those of a more general type. The first part gives a method for the determination of frequencies and modes of vibration, with the influence coefficients and mass distribution assumed known. In the second part the calculation of the influence functions is discussed and, in the third, the methods of the previous two parts are applied to practical problems. The appendix shows how to determine the influence functions in specific simplified cases.

N-51812*

Advisory Group for Aeronautical Research and Development. NEEDED RESEARCH FOR MACHINE INFORMATION SYSTEMS. John W. Kuipers, Eastman Kodak Co. (Presented at 6th meeting of Documentation Committee, AGARD, Rome, February 20-25, 1956). February 1956. 18p. diagrs. AGARD Report 47.
(Ask for N-51812*)

Explains the difficulties which have arisen in using machines for documentation purposes and analyzes their causes. Emphasizes the need for research on the nature of the units to be handled and indicates lines along which research should be directed to overcome these difficulties.

N-51813*

Advisory Group for Aeronautical Research and Development. OPERATIONAL PROBLEMS REQUIRING DOCUMENTATION RESEARCH. Verner W. Clapp, Library of Congress. (Presented at 6th meeting of Documentation Committee, AGARD, Rome, February 20-25, 1956). February 1956. 7p. AGARD Report 48. (Ask for N-51813*)

The operations involved in documentation are so interrelated as to form a seamless whole: the form of the document affects the manner of its treatment and storage, and these in turn affect the retrieval of the information contained in it and the creation of new documents. No part of the cycle may, in consequence, be taken in isolation or for granted - least of all the "information-gathering habits" of intellectual workers, because these assume existing methods of documentation. Similarly, most documentation enterprises involve special activity in one or more parts of the cycle while assuming stability of the other parts, and since such enterprises are under pressure to serve the immediate needs of particular constituencies, no one has a broad assignment for criticism and experimental improvement with respect to the whole cycle. Some suggestions are made with respect to this situation.

N-51964*

Advisory Group for Aeronautical Research and Development. THE PROBLEMS OF VISION IN FLIGHT AT HIGH ALTITUDE. Thomas C. D. Whiteside, U. of Glasgow and Royal Air Force Institute of Aviation Medicine. 1957. 162p. diagrs., photos., tabs., discussion. AGARDograph 13.

This study refers to flight in the stratosphere or upper limits of the troposphere above the clouds. Observations were made at about 40,000 feet, but the findings can also be applied to flight outside the earth's atmosphere. Generally the problems dealt with were not an effect of speed, so the findings are applicable to balloons, civil transports, or high performance fighters. The subjects studied included the effects of changes in intensity and spectral distribution of sunlight, physiological changes affecting visibility of objects inside the cockpit, and physiological factors affecting air-to-air visibility.

(May be purchased from Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, New York, at $5.00)

N-51987*

FLIGHT LOADS MEASUREMENTS ON NACA RESEARCH AIRPLANES. De E. Beeler. (Presented to Structures and Materials Panel, Advisory Group for Aeronautical Research and Development, Copenhagen, Denmark, April 29 - May 4, 1957). 36p. diagrs., photos. (Ask for N-51987*)

Summarizes results from flight loads investigations conducted primarily for the purpose of confirming wind-tunnel results by comparing the full-scale results with comparable wind-tunnel results. Generally, the data have been selected from three research aircraft having a wide range of configuration (X-1, X-5, and XF-92A). Flight loads for the various components of these aircraft were determined by use of calibrated strain gages. Pressure distribution measurements were also made of the fuselage and the wing of the X-1 airplane.

N-53172*

Advisory Group for Aeronautical Research and Development. FLUCTUATIONS AND HOT-WIRE ANEMOMETRY IN COMPRESSIBLE FLOWS. Mark V. Morkovin, Johns Hopkins University. November 1956. (xiv), 102p. diagrs., tabs. AGARDograph 24.
(Ask for N-53172*)

The problem of extracting information from a heated thin wire cooled by an unsteady compressible flow is treated. Empirical evidence on heat transfer from thin wires at high speeds is analyzed. Procedure for the different speed ranges is outlined and probable accuracy discussed. Parallel procedures for mean-flow measurements are also given.

UNPUBLISHED PAPERS

N-41489*

THREE-DIMENSIONAL LAMINAR SEPARATION. (Le Decollement Laminaire En Trois Dimensions). E. A. Eichelbrenner and A. Oudart. November 1956. 11p. diagr., photos., tab. Translation from Recherche Aeronautique, no. 47, p. 11-14, September - October 1955. (Ask for N-41489*)

A three-dimensional definition leads to a new interpretation of laminar separation which coincides with the customary picture in particular cases (three-dimensional separation, separation generatrix of an infinite cylinder in sideslip). This new definition has been confirmed by tests performed in the hydrodynamic tunnel at Chatillon.

N-43015*

THE FLOW PATTERN AROUND A ROTATING DISK IN AN AIRSTREAM. (Die Strömung an einer angeblasenen rotierenden Scheibe). H. Schlichting and E. Truckenbrodt. April 1957. 33p. diagrs., tabs. Translation from Zeitschrift für angewandte Mathematik und Mechanik, v. 32, no. 4/5, Apr./May 1952, p. 97-111. (Ask for N-43015*)

The laminar flow about a rotating plane disk which is simultaneously approached by an airstream in the direction of the axis of rotation is computed. The thickness of the layer carried along by the rotational motion, and therefore the torque, are strongly dependent on the ratio of the free-stream velocity and the peripheral velocity of the disk.

N-43153*

FABRICATION OF MODELS WITH THE AID OF PLASTIC MATERIALS. (Fabrication de maquettes à l'aide des matières plastiques). G. Dixmier. March 1957. 45p. photos. Translation of Office National d'Etudes et de Recherches Aeronautiques Note Technique 33. (Ask for N-43153*)

Shows examples of the fabrication of models which illustrate the use that can be made of low-pressure polymerizable resins in conjunction with glass cloth in the testing technique of experimental aerodynamics.

N-43469*

FLOW AHEAD OF A SUPERSONIC ROTOR. (Strömung vor einem Überschall-Laufrad). H. Söhngen. January 1957. 19p. diagrs. Translation from Deutsche Versuchsanstalt für Luftfahrt E.V., Mülheim/Ruhr, Report 11, December 1955, p. 1-23. (Ask for N-43469*)

We consider a supersonic axial compressor; the blades of the rotor are in a supersonic flow. In the designs which are of chief interest at present, the axial component of the flow velocity lies below the speed of sound; in contrast, the rotational velocity of the rotor is large. We shall limit ourselves to this case. In order to eliminate the difficult question of interference between stator and rotor, we shall further assume that no stator is present, that therefore the rotor alone operates in the annular channel. In order to avoid the difficulties introduced by the radical extension of the blades, we shall finally assume that the height of the blades is small compared to the diameter of the blade rim. The flow process about the blades can then be developed into a plane.

N-45453*

PROPAGATION OF SOUND IN THE ATMOSPHERE AND AUDIBILITY OF ALARM SIGNALS IN SURROUNDING NOISE. (Propagation du Son dans l'Atmosphere et Audibilite des Signaux Avertisseurs dans le Bruit Ambiant). Paul Baron. October 1956. 46p. diagrs., photos. Translation from Groupement des Acousticieus de Langue Francaise, Cahiers d'Acoustique 66, 1954. (Ask for N-45453*)

In the introduction, the author recalls the origin of this study which is quite old but of renewed interest today. He defines the general conditions of the propagation of sound in the atmosphere. He describes the various series of tests performed in the Yonne valley, specifying the character of the region, the sound sources, the devices for measuring the sound pressure, the meteorological measuring devices, the organization of the tests, and the results obtained (variation of the signal received, influence of the height above the ground of the source, of the topographical situation, etc.) in Paris. He then studies the influence of the wind on the propagation of sound, by its direction, by its velocity, and the influence of factors other than the wind. He gives the conditions of audibility of the signals in the presence of noises; and determines the range of the sound sources.

N-51921*

APPLICATION OF THE DISTRIBUTION THEORY TO THE PROBLEM OF THE SUPERSONIC AIRFOIL. (Anwendung der Distributionstheorie auf das Problem des Überschall-Traglügels). R. Sauer. January 1957. 24p. diagrs. Translation from Ministère de l'Air. Publications Scientifiques et Techniques, 1954, p. 289-308. (Ask for N-51921*)

Schwartz's distribution theory is applied to initial- and boundary-value problems of the wave equation, namely to the calculation of the linearized three-dimensional steady supersonic flow about an airfoil of finite width. The fundamental representation formulas of airfoil theory result in a very simple manner, since the difficulties arising in the ordinary analysis due to divergent integrals are eliminated in the distribution theory, because of the enlarged concept of functions. We begin with a short introduction into the distribution theory and develop the fundamental concepts of distribution theory as graphically as possible.

UNPUBLISHED PAPERS

N-51948*

DIFFERENTIAL EQUATIONS OF MOTION CONTAINING A SLOWNESS PARAMETER. (Differentsialnye uravneniya dvizheniya coderzhashchie parametr medlennosti). V. M. Volosov. (1957). 6p. Translation from Akademiia Nauk SSSR, Doklady, v.106, no.1, p.7-10, 1956. (Ask for N-51948*)

The problem of second-order differential equations is considered wherein the slowness of the change in the analogous factors of mass, damping, and spring is characterized by a small slowness parameter appearing as a multiplier of the independent variable, time. The small parameter is also a multiplier of the damping, or friction, term. Several special cases are considered as examples, and some general mathematical formulations are given for the determination of regions of oscillatory solutions.

N-51950*

SUBSTITUTES FOR WIND-TUNNEL MEASUREMENTS, WITH SPECIAL CONSIDERATION OF FREE-FLIGHT MEASUREMENTS. (Ersatz für Windkanalmessungen, bei besonderer Berücksichtigung von Messungen im freien Fluge). Wilhelm Neuberger. December 1956. 69p. diagrs., tabs. Translation from Zeitschrift für Flugwissenshaften, v.3, no.7, July 1955. (Ask for N-51950*)

In the present paper, possibilities and indications for a future development regarding the problem of replacing large and expensive wind tunnels by other more simple methods are discussed. Intensive research and development work in various fields will be necessary before a complete and practical method will be available. Great interest is focused on a method in which the aerodynamic force is determined indirectly from the motion of a rigid body of arbitrary shape in free air.

N-53001*

THE TEST FACILITIES USED FOR THE FLYING ATAR. (Les Installations d'Essais Mises en Oeuvre pout l'ATAR volant). G. Eggers and J. Jardinier. (Presented at 6th meeting of AGARD, Brussels, August 29, 1956). December 1956. 24p. photos. Translation from Societé Nationale d'Etude et de Construction de Moteurs d'Aviation. (Ask for N-53001*)

The special problems involved in vertical take-off and landing have been studied and experimented on separately. After this preliminary period, the S.N.E.C.M.A. has built a device called the "Flying ATAR" which has proved that the system chosen operates well. This engine assembly, equipped with its controls and its stabilization system, lends itself to the construction of an airplane of any aerodynamic conception which can take off vertically.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification May 8, 1957.

NACA ACR dated November 8, 1945, by Davis and Brown (1104 Ryan FR-1/1a)

NACA RM A9E09

AERODYNAMIC STUDY OF A WING-FUSELAGE COMBINATION EMPLOYING A WING SWEPT BACK 63°.- CHARACTERISTICS FOR SYMMETRICAL WING SECTIONS AT HIGH SUBSONIC AND MODERATE SUPERSONIC MACH NUMBERS. Newton A. Mas. July 7, 1949. 28p. diagrs., photos. (NACA RM A9E09)

Results of wind-tunnel tests are presented for a wing with the leading edge swept back 63° and of symmetrical section in combination with a body at Mach numbers from 0.5 to 0.95 and from 1.09 to 1.51. The measured variations with Mach number of lift, drag, and pitching-moment coefficients are compared with calculated variations and the results of higher-scale investigations.

NACA RM A50A23

WIND-TUNNEL INVESTIGATION AT LOW SPEED OF A WING SWEPT BACK 63° AND TWISTED AND CAMBERED FOR A UNIFORM LOAD AT A LIFT COEFFICIENT OF 0.5. James A. Weiberg and Hubert C. Carel. May 9, 1950. 53p. diagrs., photos., tabs. (NACA RM A50A23)

Results are presented of force and pressure-distribution measurements at low speed on a semi-span model of a wing with the leading edge swept back 63° and with the wing cambered and twisted for uniform load at a lift coefficient of 0.5 and at a Mach number of 1.4. Compared with a thicker flat wing of the same plan form, the twisted and cambered wing showed no improvement in longitudinal-stability characteristics. Spanwise boundary-layer flow and separation resulted in large stability changes with angle of attack. By adding flaps and fences to the wing these separation effects were delayed to higher angles of attack. Good agreement was obtained between the measured span load distribution and that computed by methods of Weissinger.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM A53E21

INVESTIGATION OF THE USE OF A STICK FORCE PROPORTIONAL TO PITCHING ACCELERATION FOR NORMAL-ACCELERATION WARNING. Marvin Abramovitz, Stanley F. Schmidt, and Rudolph D. Van Dyke, Jr. August 1953. 23p. diagrs., tab. (NACA RM A53E21)

The feasibility of providing an additional stick force which leads the normal acceleration, in order to serve as a prior warning of excessive normal acceleration in rapid maneuvers, is investigated both experimentally in flight and analytically. It is determined that large stick forces proportional to rate of change of normal acceleration can be provided without adversely affecting the control-system dynamic stability, and that pilots consider the feel characteristics introduced by such a force to be very desirable.

NACA RM A53E28

EXPERIMENTAL INVESTIGATION OF THE EFFECT OF ENTRANCE WIDTH-TO-HEIGHT RATIO ON THE PERFORMANCE OF AN AUXILIARY SCOOP-TYPE INLET AT MACH NUMBERS FROM 0 TO 1.3. George B. Brajnikoff and John F. Stroud. July 1953. 16p. diagrs., photos. (NACA RM A53E28)

As a part of an investigation of variable-area auxiliary inlets intended to provide for the variation of engine air requirements with speed and altitude, three auxiliary scoop inlets were tested in combination with a nose inlet at Mach numbers from 0 to 1.3 at zero angle of attack. The pressure recovery and mass-flow characteristics are presented for these three models with auxiliary-inlet areas of 12 percent of the main-inlet area. The effects of the ratio of scoop width to height, lip alinement, and lip shape are discussed.

NACA RM A55E04

GROUND EFFECTS ON THE LONGITUDINAL CHARACTERISTICS OF TWO MODELS WITH WINGS HAVING LOW ASPECT RATIO AND POINTED TIPS. Donald A. Buell and Bruce E. Tinling. July 1955. 48p. diagrs., photos., tabs. (NACA RM A55E04)

Wind-tunnel tests were conducted to determine the ground effects on a tailless model with a wing of aspect ratio 2 and infinite taper, and on a tailed model with a triangular wing of aspect ratio 3, with flaps. Control-surface hinge moments were measured on the tailless model. The results are compared with the predictions of the theory of Tani, et al.

NACA RM E51E04

INVESTIGATION OF INTERNAL FILM COOLING OF 1000-POUND-THRUST LIQUID-AMMONIA - LIQUID-OXYGEN ROCKET-ENGINE COMBUSTION CHAMBER. Gerald Morrell. July 1951. 42p. diagrs., photos., tabs. (NACA RM E51E04)

Internal film cooling of the combustion chamber of a 1000-pound-thrust liquid ammonia - liquid oxygen rocket engine was investigated at chamber pressures ranging from 220 to 270 pounds per square inch absolute and coolant flows from 2 to 21 percent of total flow. The three coolants investigated were water, ethyl alcohol, and liquid ammonia. The fuels were found to be satisfactory film coolants in the absence of simultaneous regenerative cooling and data were presented for estimating film-cooling requirements of rocket-engine chambers.

#NACA RM E51E22, by Rebeske, Berkey, and Forrette

NACA RM E51E29

DATA PRESENTATION OF FORCE CHARACTERISTICS OF SEVERAL ENGINE-STRUT-BODY CONFIGURATIONS AT MACH NUMBERS OF 1.8 AND 2.0. Robert T. Madden and Emil J. Kremzier. August 1951. 32p. diagrs. (NACA RM E51E29)

Investigation to determine lift, drag, and pitching-moment characteristics of several engine-strut-body combinations was conducted over range of angles of attack from 0° to 10° at Mach numbers of 1.8 and 2.0. The average Reynolds number based on body length was 28×10^{6}. Data are presented without analysis and indicate decreases in minimum drag and lift curve slope with decreasing strut length. Decreases in minimum drag were also noted with rearward movement of engines.

NACA RM E52E01

AN ANALYSIS OF THE POTENTIALITIES OF A TWO-STAGE COUNTERROTATING SUPERSONIC COMPRESSOR. Ward W. Wilcox. July 1952. 41p. diagrs., tab. (NACA RM E52E01)

Evaluation of the potentialities of a two-stage counterrotating supersonic compressor was made by using one-dimensional analysis to indicate magnitude of major design variables at various pressure ratio levels. Results of simplified three-dimensional design study for pressure ratio of 8 are presented to demonstrate similarities to and differences from one-dimensional analysis. Comparison of component performance of two compressor stages recently investigated with analytical requirements for pressure ratio of 5 indicated that a counterrotating compressor with the following characteristics might be constructed: weight flow, 30 pounds per second per square foot frontal area, pressure ratio 5, tip speed 1100 feet per second, adiabatic efficiency 0.80 or higher. If weight penalty resulting from mechanical details of coaxial shafting were not too severe, a distinct advantage in engine size would be possible.

DECLASSIFIED NACA RESEARCH REPORTS

#NACA RM E52E15, by Rebeske and Forrette

NACA RM E53B10

DETERMINATION OF SURGE AND STALL LIMITS OF AN AXIAL-FLOW TURBOJET ENGINE FOR CONTROL APPLICATIONS. Ross D. Schmidt, George Vasu, and Edward W. McGraw. August 1953. 30p. diagrs., tab. (NACA RM E53B10)

Limitations on the transient operation of an axial-flow turbojet engine were determined in relation to altitude and exhaust-nozzle-area parameters. A high-frequency oscillation (stall) at the compressor inlet limited transient operation of the engine below approximately 70 percent of the generalized engine rotational speed. Over 70 percent of the engine-speed transient operation was limited by a low-frequency oscillation (surge) which occurred throughout the engine. The data presented are the result of an analysis of oscillograph traces obtained when the engine was operated off steady state by introducing either a step increase or a ramp increase in fuel flow. For a given speed, a lower fuel flow was required for the engine to recover from surge or stall than was necessary for surge or stall to occur. Very little difference existed between the surge line (compressor pressure ratio against engine rotational speed) obtained under transient conditions and that obtained under steady-state conditions by decreasing the flow area with an adjustable first-stage turbine stator.

#NACA RM E53H26, by Oppenheimer and Pack
#NACA RM E54E04, by Schulze and Prince
#NACA RM E54K30a, by Morse and Johnston

NACA RM E55E11

REMOVAL OF SECONDARY-FLOW ACCUMULATIONS IN A TWO-DIMENSIONAL TURBINE NOZZLE PASSAGE BY BOUNDARY-LAYER BLEED. Robert Y. Wong. June 1955. 22p. diagrs., photos., tab. (NACA RM E55E11)

The results of this investigation indicate that boundary-layer bleed along the juncture of the passage suction surface and end wall may be effectively used to prevent the local accumulation of boundary-layer fluids due to secondary flows in a single-passage nozzle. Bleed-slot geometry and position and bleed pressure were found to markedly influence bleed weight flow and bleed-slot effectiveness. Boundary-layer bleed applied in this manner to a turbine stator thus offers a means of investigating the effect of these loss regions on turbine rotor performance. Bleed weight flow required for an annular cascade remains to be determined.

NACA RM E56B10

ANALYSIS OF A FORM OF PEAK HOLDING CONTROL. G. J. Delio. March 1956. 57p. diagrs. (NACA RM E56B10)

A typical plant process possessing sudden drops and inert zones in its output was studied. The output was subjected to harmonic analysis to determine signal possibilities and the results were used in the design of a control. The particular form of peak holding control used, being only one of the possible forms, was studied for various performance criteria. It was found that a stable control of the type investigated was realizable and the average output could be maintained near the peak output value.

NACA RM L8E25

FREE-FLIGHT INVESTIGATION AT TRANSONIC AND SUPERSONIC SPEEDS OF THE ROLLING EFFECTIVENESS OF A 42.7° SWEPTBACK WING HAVING PARTIAL-SPAN AILERONS. Carl A. Sandahl. October 25, 1948. 13p. diagrs., photo., tab. (NACA RM L8E25)

An investigation of the rolling effectiveness at transonic and supersonic speeds of partial-span ailerons on a 42.7° sweptback wing having symmetrical circular-arc airfoil sections of 10-percent thickness ratio normal to the wing quarter-chord line has been made by means of rocket-propelled test vehicles. The results are compared with results of a supersonic wind-tunnel test at Mach number 1.9.

NACA RM L8E28

FREE-FLIGHT INVESTIGATION AT TRANSONIC AND SUPERSONIC SPEEDS OF A WING-AILERON CONFIGURATION SIMULATING THE D-558-2 AIRPLANE. Carl A. Sandahl. July 21, 1948. 10p. diagrs., photo., tab. (NACA RM L8E28)

An investigation of the rolling effectiveness at transonic and supersonic speeds of a wing-aileron configuration simulating the D-558-2 airplane has been made by means of a rocket-propelled test vehicle. The variation of rolling effectiveness with Mach number is similar to that obtained previously for tapered sweptback wings having full-span, 0.2-chord ailerons.

NACA RM L8H09

FLIGHT AND WIND-TUNNEL INVESTIGATION TO DETERMINE THE AILERON-VIBRATION CHARACTERISTICS OF 1/4-SCALE WING PANELS OF THE DOUGLAS D-558-2 RESEARCH AIRPLANE. Ellwyn E. Angle and Reginald R. Lundstrom. November 30, 1948. 27p. diagrs., photos., tabs. (NACA RM L8H09)

Report contains results of flight and wind-tunnel tests to determine the vibration characteristics of 1/4-scale dynamically similar ailerons for the D-558-2 research airplane. On one flight no vibrations occurred up to a Mach number of 1.03. On a second flight an oscillation developed believed to be flexure-aileron flutter from a Mach number of 0.58 up to a Mach number of 0.73 and aileron "buzz" above a Mach number of 0.96. Wind-tunnel tests confirmed that the vibration between a Mach number of 0.58 and 0.70 was flexure-aileron flutter.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM L8K19a

AN INVESTIGATION OF THE SPIN AND RECOVERY CHARACTERISTICS OF A 1/25-SCALE MODEL OF THE DOUGLAS D-558-II AIRPLANE. Stanley H. Scher and Lawrence J. Gale. January 18, 1949. 29p. diagrs., photos., tabs. (NACA RM L8K19a)

An investigation has been conducted on a 1/25-scale model of the Douglas D-558-II airplane in the Langley 20-foot free-spinning tunnel. The effects of control disposition and movement upon the erect and inverted spins and recoveries have been determined for the normal design gross weight loading. The spin-recovery parachute requirements and the effect of varying the stabilizer incidence, of extending the slats, and of removing the stall-control vanes were also investigated. The results of the investigation indicated that the recovery characteristics of the airplane may be unsatisfactory and that installation of a large ventral fin would cause recoveries to be satisfactory.

NACA RM L9A06

FLIGHT INVESTIGATION OF FLUTTER MODELS WITH 1/10-SCALE DOUGLAS D-558-2 WING PANELS. Jerome M. Teitelbaum. February 16, 1949. 15p. diagrs., photos., tab. (NACA RM L9A06)

Contains the results of flight tests on three models containing scaled versions of the D-558-2 wing panels as horizontal fins. Results indicate that no flexure-torsion flutter occurred during the flights but a pitching oscillation of the entire model developed as the model passed through the transonic range.

NACA RM L9A24

ANALYSIS OF THE EFFECTS OF VARIOUS MASS, AERODYNAMIC, AND DIMENSIONAL PARAMETERS ON THE DYNAMIC LATERAL STABILITY OF THE DOUGLAS D-558-2 AIRPLANE. M. J. Queijo and W. H. Michael, Jr. April 15, 1949. 33p. diagrs., tabs. (NACA RM L9A24)

The effects of various mass, aerodynamic, and dimensional parameters on the dynamic lateral stability of the Douglas D-558-2 airplane have been investigated by means of calculations of the stability boundaries and the period and damping of the lateral oscillation. The results indicate that accurate determination of the stability derivatives, the radii of gyration, and the inclination of the principal axes are required if calculations of the dynamic lateral stability are to be of quantitative significance. Variations in the magnitudes of these quantities that might correspond to errors resulting from casual estimates may be very important.

NACA RM L9C04

HIGH-SPEED WIND-TUNNEL INVESTIGATION OF THE LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A 1/16-SCALE MODEL OF THE D-558-2 RESEARCH AIRPLANE AT HIGH SUBSONIC MACH NUMBERS AND AT A MACH NUMBER OF 1.2. Robert S. Osborne. April 5, 1949. 87p. diagrs., photos., tabs. (NACA RM L9C04)

A 1/16-scale model of the D-558-2 was tested to determine its force, longitudinal stability, and control characteristics at Mach numbers from 0.6 to 0.95 and at a Mach number of 1.2. The effects of chordwise fences on the force and moment characteristics of the model are also presented.

NACA RM L9E20a

EFFECTS OF CERTAIN FLOW NONUNIFORMITIES ON LIFT, DRAG, AND PITCHING MOMENT FOR A TRANSONIC-AIRPLANE MODEL INVESTIGATED AT A MACH NUMBER OF 1.2 IN A NOZZLE OF CIRCULAR CROSS SECTION. Virgil S. Ritchie. August 31, 1949. 12p. diagrs., photo. (NACA RM L9E20a)

Investigation of a model of a transonic airplane at Mach number 1.2 in the Langley 8-foot high-speed tunnel showed no significant changes in model lift, drag, and pitching-moment coefficients for various axial locations of a given flow nonuniformity along the length of the model. The stream normal shock produced no appreciable force changes for the sting-supported model as long as the shock was located entirely downstream of the model base and tail surfaces.

NACA RM L9E27a

A PRESSURE-DISTRIBUTION INVESTIGATION OF A SUPERSONIC AIRCRAFT FUSELAGE AND CALIBRATION OF THE MACH NUMBER 1.59 NOZZLE OF THE LANGLEY 4- BY 4-FOOT SUPERSONIC TUNNEL. Morton Cooper, Norman F. Smith, and Julian H. Kainer. July 29, 1949. 51p. diagrs., photos., tabs. (NACA RM L9E27a)

Experimental pressure distributions have been obtained on a supersonic-aircraft fuselage with and without canopies (body of revolution) in the Langley 4- by 4-foot supersonic tunnel at a Mach number of 1.59 and a Reynolds number of 2.60×10^6. A comparison of the experimental pressures with theoretical pressures for the body of revolution is presented in addition to the experimental pressures over the fuselage with canopies. Calibration data of the test section are also presented.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM L9G18

PRELIMINARY MEASUREMENTS OF THE DYNAMIC LATERAL STABILITY CHARACTERISTICS OF THE DOUGLAS D-558-II (BUAERO NO. 37974) AIRPLANE. Sigurd A. Sjoberg. August 18, 1949. 8p. diagrs., tab. (NACA RM L9G18)

This paper presents some data on the dynamic lateral stability characteristics of the Douglas D-558-II (BuAero No. 37974) airplane. For the airplane in the clean condition, the lateral oscillations are lightly damped. In the landing condition, the airplane performs a constant-amplitude lateral oscillation.

NACA RM L9H31a

PRELIMINARY FLIGHT MEASUREMENTS OF THE STATIC LONGITUDINAL STABILITY AND STALLING CHARACTERISTICS OF THE DOUGLAS D-558-II RESEARCH AIRPLANE (BUAERO. NO. 37974). S. A. Sjoberg and R. A. Champine. October 18, 1949. 16p. diagrs., photos., tab. (NACA RM L9H31a)

Contains results of brief flight measurements of the static longitudinal stability and stalling characteristics of the Douglas D-558-II (BuAero. No. 37974) research airplane.

NACA RM L9L22

LONGITUDINAL TRIM AND DRAG CHARACTERISTICS OF ROCKET-PROPELLED MODELS REPRESENTING TWO AIRPLANE CONFIGURATIONS. James H. Parks and Jesse L. Mitchell. February 6, 1950. 25p. diagrs., photos., tab. (NACA RM L9L22)

The longitudinal trim and drag characteristics of two airplane configurations of a rocket-propelled model are presented. One configuration employed a thin straight wing and tail and the other had a thicker sweptback wing and tail. The basic data obtained were the variation of normal acceleration and Mach number with time at a series of fixed stabilizer incidences and center-of-gravity locations.

NACA RM L50C14

FLIGHT MEASUREMENTS WITH THE DOUGLAS D-558-II (BUAERO NO. 37974) RESEARCH AIRPLANE. STATIC LATERAL AND DIRECTIONAL STABILITY CHARACTERISTICS AS MEASURED IN SIDESLIPS AT MACH NUMBERS UP TO 0.87. S. A. Sjoberg. May 19, 1950. 29p. diagrs., photos., tab. (NACA RM L50C14)

The paper presents flight measurements during sideslips of the static lateral and directional stability characteristics of the Douglas D-558-II (BuAero No. 37974) research airplane. Data are presented for the Mach number range from 0.27 to 0.87.

NACA RM L50E16

SOME EFFECTS OF CHORDWISE FENCES ON THE AERODYNAMIC CHARACTERISTICS OF FOUR MODERATELY SWEPTBACK WINGS IN THE LOW-LIFT RANGE AT TRANSONIC MACH NUMBERS AND AT MACH NUMBER 1.9. Lawrence D. Guy. July 21, 1950. 22p. diagrs., photo., tab. (NACA RM L50E16)

A study of data from available wind-tunnel investigations has been made to determine the effects of several chordwise fences on some of the aerodynamic characteristics of moderately sweptback wings in the low-lift range at transonic Mach numbers and at Mach number 1.9. The wings were equipped with upper-surface fences of comparable size having a height above the wing-chord plane of less than 14 percent of the local chord. The data from tests of a small leading-edge vane and a triangular fin on one wing are also included.

NACA RM L50E17

FLIGHT MEASUREMENTS WITH THE DOUGLAS D-558-II (BUAERO NO. 37974) RESEARCH AIRPLANE. LATERAL CONTROL CHARACTERISTICS AS MEASURED IN ABRUPT AILERON ROLLS AT MACH NUMBERS UP TO 0.86. J. V. Wilmerding, W. H. Stillwell, and S. A. Sjoberg. July 20, 1950. 27p. diagrs., photos., tab. (NACA RM L50E17)

The paper presents flight measurements of the lateral control characteristics of the Douglas D-558-II (BuAero No. 37974) airplane as measured in abrupt rudder-fixed aileron rolls. Data are presented for a Mach number range from 0.25 to 0.86.

NACA RM L50E31

FLIGHT MEASUREMENTS WITH THE DOUGLAS D-558-II (BUAERO NO. 37974) RESEARCH AIRPLANE. MEASUREMENTS OF THE BUFFET BOUNDARY AND PEAK AIRPLANE NORMAL-FORCE COEFFICIENTS AT MACH NUMBERS UP TO 0.90. John P. Mayer and George M. Valentine. August 28, 1950. 31p. diagrs., photos., tab. (NACA RM L50E31)

The airplane buffet boundary and highest normal-force coefficients obtained in flight are presented for the Mach number range from 0.26 to 0.90.

NACA RM L50G10

FLIGHT MEASUREMENTS WITH THE DOUGLAS D-558-II (BUAERO NO. 37974) RESEARCH AIRPLANE. LOW-SPEED STALLING AND LIFT CHARACTERISTICS. W. H. Stillwell, J. V. Wilmerding, and R. A. Champine. September 5, 1950. 45p. diagrs., photos., tab. (NACA RM L50G10)

The paper presents the results of flight measurements of the low-speed stalling and lift characteristics of the Douglas D-558-II (BuAero No. 37974) research airplane. Data are presented for four different combinations of slat and flap settings.

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NACA RM L50H16a

CALCULATIONS OF THE DYNAMIC LATERAL STABILITY CHARACTERISTICS OF THE DOUGLAS D-558-II AIRPLANE IN HIGH-SPEED FLIGHT FOR VARIOUS WING LOADINGS AND ALTITUDES. M. J. Queijo and Alex Goodman. October 3, 1950. 31p. diagrs., tabs. (NACA RM L50H16a)

The dynamic lateral stability characteristics of the Douglas D-558-II airplane in high-speed flight were investigated by means of calculation of the period and rate of damping of the lateral oscillation. The aerodynamic derivatives used in the investigation were based on values measured at low speeds on a 0.13-scale model of the Douglas D-558-II. The effects of principal-axes inclination, wing loading, altitude, and Mach number were investigated.

NACA RM L50K13

FLIGHT MEASUREMENTS WITH THE DOUGLAS D-558-II (BUAERO NO. 37974) RESEARCH AIRPLANE. STATIC LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS AT MACH NUMBERS UP TO 0.87. S. A. Sjoberg, James R. Peele, and John H. Griffith. January 17, 1951. 48p. diagrs., photos., tab. (NACA RM L50K13)

The paper presents the results of flight measurements of the longitudinal stability and control characteristics of the Douglas D-558-II research airplane. Data are presented in the speed range from the stalling speed of the airplane up to a maximum Mach number of 0.87.

NACA RM L51C23

FLIGHT MEASUREMENTS WITH THE DOUGLAS D-558-II (BUAERO NO. 37974) RESEARCH AIRPLANE. DYNAMIC LATERAL STABILITY. W. H. Stillwell and J. V. Wilmerding. June 18, 1951. 36p. diagrs., photos., tabs. (NACA RM L51C23)

The paper presents flight measurements of the dynamic lateral stability of the D-558-II (BuAero No. 37974) research airplane. Data are presented for a range of calibrated airspeed from 167 miles per hour to 474 miles per hour.

NACA RM L51E08

LIFT AND DRAG COEFFICIENTS FOR THE BELL X-1 AIRPLANE (8-PERCENT-THICK WING) IN POWER-OFF TRANSONIC FLIGHT. L. Robert Carman and John R. Carden. June 1951. 24p. diagrs., photo., tab. (NACA RM L51E08)

Drag coefficients have been determined by the accelerometer method for the Bell X-1 airplane with 8-percent-thick wing and 6-percent-thick tail in power-off flight over a Mach number range of 0.64 to 1.14 and at lift coefficients from 0.1 to 1.2.

NACA RM L51E11

INVESTIGATION OF MINIMUM DRAG AND MAXIMUM LIFT-DRAG RATIOS OF SEVERAL WING-BODY COMBINATIONS INCLUDING A CAMBERED TRIANGULAR WING AT LOW REYNOLDS NUMBERS AND AT SUPERSONIC SPEEDS. Clinton E. Brown and L. K. Hargrave. August 1951. 62p. diagrs., photos., tabs. (NACA RM L51E11)

Theoretical and experimental results of the minimum drag and maximum lift-drag ratio of several wing-body combinations with wings of triangular, arrow, and diamond plan form are presented for $M = 1.62$, 1.93, and 2.41 and Reynolds number range of 1.4×10^6 to 0.7×10^6. Also included are two each of triangular and arrow plan-form wings cambered for approximately uniform load at $M = 1.62$ and lift coefficients of 0.08 and 0.20. Also included are liquid-film studies of the flow over the various configurations.

NACA RM L51E25

FLIGHT INVESTIGATION OF THE DRAG OF ROUND-NOSED BODIES OF REVOLUTION AT MACH NUMBERS FROM 0.6 TO 1.5 USING ROCKET-PROPELLED TEST VEHICLES. Roger G. Hart. July 1951. 9p. diagrs., photos., tab. (NACA RM L51E25)

Values of total drag coefficient were measured for four round-nosed bodies of revolution in free flight at Mach numbers from 0.6 to 1.5 and Reynolds numbers from 10×10^6 to 50×10^6. The bodies were designed by rounding off the sharp, fineness-ratio-3.56 nose of a previously tested configuration. The nose radii tested were 27.4, 38.7, 80.6, and 100 percent of the maximum body radius.

NACA RM L52C25

EFFECTS OF CHORD DISCONTINUITIES AND CHORDWISE FENCES ON LOW-SPEED STATIC LONGITUDINAL STABILITY OF AN AIRPLANE MODEL HAVING A 35° SWEPTBACK WING. Byron M. Jaquet. June 1952. 54p. photos., diagrs., tab. (NACA RM L52C25)

Results are presented for a low-speed investigation to determine effects of chord discontinuities and chordwise fences on static longitudinal stability characteristics of a 35° sweptback-wing model. Included are wake surveys, surface-tuft photographs, and tuft-grid photographs.

NACA RM L52E02

LONGITUDINAL FREQUENCY-RESPONSE AND STABILITY CHARACTERISTICS OF THE DOUGLAS D-558-II AIRPLANE AS DETERMINED FROM TRANSIENT RESPONSE TO A MACH NUMBER OF 0.96. Euclid C. Holleman. September 1952. 35p. diagrs., tabs. (NACA RM L52E02)

By an application of the Fourier transformation to transient-flight data the longitudinal frequency response of the Douglas D-558-II airplane has been determined over a Mach number range of 0.62 to 0.96 at altitudes between 21,000 and 43,000 feet; however,

the results have been reduced to airplane stability derivatives which are presented as functions of Mach number.

NACA RM L52E06a

FLUTTER OF A 60° DELTA WING (NACA 65A003 AIRFOIL) ENCOUNTERED AT SUPERSONIC SPEEDS DURING THE FLIGHT TEST OF A ROCKET-PROPELLED MODEL. Joseph H. Judd and William T. Lauten, Jr. September 1952. 24p. diagrs., photos., tabs. (NACA RM L52E06a)

Results of flight tests of a 60° delta-wing (NACA 65A003 airfoil section) airplane configuration indicated wing flutter during the latter part of accelerating flight to the peak Mach number of 2.29, and during decelerating flight to a Mach number of 1.07. An abrupt change in mode of flutter, from a ratio of flutter to torsional frequency of 0.625 to approximately 1.0 at a Mach number of 1.72, was observed. The flight-time history, natural frequencies of vibrations, and structural influence coefficients of the wing, and the mass, moment of inertia, and center of gravity of streamwise strips of the wing are presented.

NACA RM L52E12a

AN EXPERIMENTAL INVESTIGATION OF THE EFFECT OF HIGH-PRESSURE TAILPIPE LENGTH ON THE PERFORMANCE OF SOLID-PROPELLANT MOTORS FOR ROCKET-POWERED AIRCRAFT. Charles J. Rodriguez. August 1952. 37p. diagrs., tabs. (NACA RM L52E12a)

The effect of high-pressure exhaust duct length on the performance of solid-propellant rocket motors has been evaluated from thrust-stand tests. For increasing pipe lengths, boundary-layer development progressively reduces the effective throat area, with resultant marked increases in operating pressure and thrust. Duct losses result in lower values of impulse as pipe length is increased. The magnitude of these losses is within practical limits. The increases in operating pressure may prove significant when structural considerations are critical.

NACA RM L52E14

AERODYNAMIC CHARACTERISTICS OF A 45° SWEPTBACK WING-FUSELAGE COMBINATION AND THE FUSELAGE ALONE OBTAINED IN THE LANGLEY 8-FOOT TRANSONIC TUNNEL. Robert S. Osborne and John P. Mugler, Jr. September 1952. 71p. diagrs., photos., tabs. (NACA RM L52E14)

A fuselage and a wing-fuselage combination employing a wing with 45° sweepback of the 0.25-chord line, aspect ratio 4, taper ratio 0.6, and NACA 65A006 airfoil sections were tested at Mach numbers from 0.6 to 1.13 at angles of attack up to 36°. Force, moment, and base pressure characteristics were determined and tuft patterns were photographed. Maximum lift was reached at Mach numbers from 0.6 to 0.92.

NACA RM L52E15

WIND-TUNNEL INVESTIGATION OF A RAM-JET CANARD MISSILE MODEL HAVING A WING AND CANARD SURFACES OF DELTA PLAN FORM WITH 70° SWEPT LEADING EDGES. LONGITUDINAL AND LATERAL STABILITY AND CONTROL CHARACTERISTICS AT A MACH NUMBER OF 1.60. M. Leroy Spearman and Ross B. Robinson. August 1952. 63p. diagrs., photo., tabs. (NACA RM L52E15)

An investigation has been conducted in the Langley 4- by 4-foot supersonic pressure tunnel to determine the longitudinal and lateral stability and control characteristics of a ram-jet canard missile at a Mach number of 1.60 and a Reynolds number of 3.83×10^6 based on the wing mean aerodynamic chord. The model had a wing and vertical and horizontal canard surfaces of delta plan form with 70° swept leading edges. Nacelles were mounted in the vertical plane on unswept pylons near the rear of the model. The effects of vertical canard size and nacelle location on the stability characteristics were investigated. The tests covered an angle-of-attack range from -4° to 14° and an angle-of-sideslip range from -4° to 10°. The aileron deflection range was ±10° and the canard controls were deflected up to 12°.

NACA RM L52G07

WIND-TUNNEL INVESTIGATION OF THE LOW-SPEED STATIC AND ROTARY STABILITY DERIVATIVES OF A 0.13-SCALE MODEL OF THE DOUGLAS D-558-II AIRPLANE IN THE LANDING CONFIGURATION. M. J. Queijo and Evalyn G. Wells. August 1952. 17p. diagrs., photo., tab. (NACA RM L52G07)

An investigation was made in the Langley stability tunnel to determine the low-speed static and rotary stability derivatives of a 0.13-scale model of the Douglas D-558-II in the landing configuration. Results are presented for the model with tail surfaces on and off for an angle-of-attack range from 0° to about 24°.

NACA RM L52K14a

AN ANALYSIS OF THE LATERAL STABILITY OF THE DOUGLAS D-558-II AIRPLANE EQUIPPED WITH A YAW DAMPER, WITH SPECIAL REFERENCE TO THE EFFECT OF YAW-DAMPER RATE-GYRO SPIN-AXIS ORIENTATION. Ordway B. Gates, Jr., Albert A. Schy, and C. H. Woodling. March 1953. 36p. diagrs., tabs. (NACA RM L52K14a)

An investigation has been made to determine the effect of a yaw damper on the lateral stability of the Douglas D-558-II airplane. Effects of rate-gyro spin-axis inclination and possible advantages of orientation in the direction of the airplane Y-axis are considered. A combination of control gearing and rate-gyro inclination is recommended which should give satisfactory stability to the airplane for the flight conditions considered. Also, a particular auxiliary control surface is proposed for use with the damper and the characteristics of the surface are discussed. Airplane motions subsequent to an initial disturbance in sideslip are presented for each flight condition, with and without the yaw damper assumed installed.

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NACA RM L52K21a

EFFECTS OF CHORD-EXTENSION AND DROOP OF COMBINED LEADING-EDGE FLAP AND CHORD-EXTENSION ON LOW-SPEED STATIC LONGITUDINAL STABILITY CHARACTERISTICS OF AN AIRPLANE MODEL HAVING A 35° SWEPTBACK WING WITH PLAIN FLAPS NEUTRAL OR DEFLECTED. Byron M. Jaquet. January 1953. 34p. diagrs., photos. (NACA RM L52K21a)

Low-speed results are presented of an investigation made in the Langley stability tunnel to determine mainly the effects of a chord-extension and droop of the combined leading-edge flap and chord-extension on static longitudinal characteristics of an airplane model having a 35° sweptback wing with plain flaps neutral or deflected. Comparisons are made between a drooped leading-edge flap and chord-extension combination and a previously investigated slat arrangement.

NACA RM L53E05

FLIGHT DETERMINATION OF THE PRESSURE RECOVERY AND DRAG CHARACTERISTICS OF A TWIN SIDE-INLET MODEL AT TRANSONIC SPEEDS. Howard S. Carter and Charles F. Merlet. July 1953. 35p. diagrs., photos., tabs. (NACA RM L53E05)

External-drag and total-pressure-recovery data are presented for a twin side-inlet configuration between Mach numbers 0.8 and 1.45, and between mass-flow ratios of 0.3 and 0.9. At mass-flow ratios of 0.8 and 0.9, the supersonic external-drag coefficient was about 0.35, and the subsonic drag coefficient was about 0.12. The maximum total-pressure recovery varied from 0.92 at a Mach number of 0.8 and a mass-flow ratio of 0.8 to 0.77 at a Mach number of 1.45 and a mass-flow ratio of 0.9. Oscillating flow, which occurred at reduced mass-flow ratios throughout the Mach number range, affected the total drag as much as ±0.10. The Reynolds number per foot varied from 4×10^6 to 10×10^6.

NACA RM L53H31

SOME LOW-SPEED WIND-TUNNEL EXPERIMENTS PERTAINING TO THE LONGITUDINAL STABILITY CHARACTERISTICS OF A 35° SWEPT-WING MODEL AND AN UNSWEPT-WING MODEL. Byron M. Jaquet. October 1953. 43p. diagrs., photos., tab. (NACA RM L53H31)

Results are presented of an investigation made in the Langley stability tunnel to determine the effects of various leading-edge flow-control notches, leading- and trailing-edge extensions, horizontal-tail span, wing sweep, aspect ratio of an unswept wing, and horizontal-tail position on the static longitudinal stability characteristics of an airplane model having swept tail surfaces.

NACA RM L53J01

CALCULATED LATERAL FREQUENCY RESPONSE AND LATERAL OSCILLATORY CHARACTERISTICS FOR SEVERAL HIGH-SPEED AIRPLANES IN VARIOUS FLIGHT CONDITIONS. Byron M. Jaquet. December 1953. 72p. diagrs., tabs. (NACA RM L53J01)

Results are presented to show for several high-speed airplanes the effects of Mach number and altitude on the period and damping of the lateral oscillation, the lateral frequency response, and the response to a sinusoidal lateral gust distribution. Aeroelastic and unsteady lift effects have not been included in the calculations. The results are presented without analysis.

NACA RM L54E04

EFFECT OF WING FLEXIBILITY ON THE DAMPING IN ROLL OF A NOTCHED DELTA WING-BODY COMBINATION BETWEEN MACH NUMBERS 0.6 AND APPROXIMATELY 2.2 AS DETERMINED WITH ROCKET-PROPELLED MODELS. William M. Bland, Jr. June 1954. 20p. diagrs., photos. (NACA RM L54E04)

An experimental investigation employing sting-mounted rocket-propelled models in free flight at approximately zero lift has been made to determine the effect of wing flexibility on the damping-in-roll characteristics of a wing-body combination in the range of Mach numbers from 0.6 to approximately 2.2. The wing used in this investigation had a notched delta plan form of aspect ratio 3.2 with leading edges swept back 55°, trailing edges swept back 10°, and NACA 65A003 airfoil sections parallel with the model center line. Wing flexibility was varied by changing from solid-steel construction to solid-magnesium construction.

NACA RM L54E05a

INVESTIGATION OF THE JET EFFECTS ON A FLAT SURFACE DOWNSTREAM OF THE EXIT OF A SIMULATED TURBOJET NACELLE AT A FREE-STREAM MACH NUMBER OF 2.02. Walter E. Bressette. June 1954. 38p. diagrs., photos., tab. (NACA RM L54E05a)

Static-pressure surveys were made on a flat surface that was located in the vicinity of the propulsive jet from a convergent sonic nozzle at a free-stream Mach number of 2.02. It was found that shock waves, formed in the external flow from the presence of the propulsive jet, impinged on the flat surface and greatly altered the pressure distribution. The integration of this pressure distribution resulted in a strong incremental lift on the flat surface.

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NACA RM L54E27

STUDY OF THE ATTACK OF AN AUTOMATICALLY CONTROLLED INTERCEPTOR ON A MANEUVERING BOMBER WITH EMPHASIS ON PROPER COORDINATION OF LIFT-ACCELERATION AND ROLL-ANGLE COMMANDS DURING ROLLING MANEUVERS. Charles W. Mathews. August 1954. 52p. diagrs., photo., tabs. (NACA RM L54E27)

The study is primarily concerned with the coordination or combination of lift-acceleration and roll-attitude commands of an automatic interceptor. The results were obtained from an investigation on an analog computer of encounters of an interceptor with a maneuvering bomber. The effects on tracking errors of several types of coordination are discussed and some information on the effect of interceptor rolling performance on tracking is also presented.

NACA RM L55C17

LOW-SPEED INVESTIGATION OF THE EFFECTS OF WING TANKS AND SPEED BRAKES ON THE STATIC STABILITY OF A MODEL HAVING A 40° SWEPT WING. William C. Sleeman, Jr., and William J. Alford, Jr. May 1955. 62p. diagrs., photo., tabs. (NACA RM L55C17)

A wind-tunnel investigation was conducted to determine the effects of wing tanks and speed brakes on the directional stability characteristics of a complete model having sweptback wing and tail surfaces. The wing had 40° sweepback of the quarter-chord line, aspect ratio 3.45, taper ratio 0.578, and had NACA 64A010 airfoil sections normal to the quarter-chord line. The two wing tanks were of fineness ratio 10.4 and were pylon-mounted at approximately the 22-percent-wing-semispan station. The test results include effects of several modifications investigated to improve the directional stability of the model, such as dorsal fins and an extended vertical tail.

NACA RM L55E03

STATISTICAL MEASUREMENTS OF LANDING-CONTACT CONDITIONS OF A HEAVY BOMBER. Norman S. Silsby and Eziaslav N. Harrin. June 1955. 22p. diagrs., tabs. (NACA RM L55E03)

Statistical measurements of landing-contact conditions have been obtained by a special photographic technique for 144 landings of a heavy bomber airplane during routine daytime operations at Carswell Air Force Base, Fort Worth, Texas. From these measurements, sinking speeds, bank angles, rolling velocities, and horizontal speeds at the instant before contact have been evaluated and a limited statistical analysis of the results has been made.

NACA RM L55E06

AN INVESTIGATION OF JET EFFECTS ON ADJACENT SURFACES. Walter E. Bressette and Maxime A. Faget. June 1955. 13p. diagrs. (NACA RM L55E06)

Static-pressure surveys were made on a flat surface that was located in the vicinity of a propulsive jet issuing into subsonic and supersonic free-stream flow. In conjunction with the static-pressure surveys a temperature analysis was made at subsonic speeds. There was also a preliminary investigation of the acoustic pressure fluctuations from the propulsive jet made at supersonic speeds. The steady pressure loads as well as the temperature change on adjacent surfaces due to the presence of a propulsive jet at free-stream subsonic speeds are shown to be insignificant, whereas at free-stream supersonic speeds the steady pressure loads were found to increase greatly on surfaces downstream of the propulsive jet exit.

NACA RM L55E09b

REDUCTION OF HYDRODYNAMIC IMPACT LOADS FOR WATERBORNE AIRCRAFT. Emanuel Schnitzer. July 1955. 17p. diagrs. (NACA RM L55E09b)

Recent NACA research aimed at the reduction of water loads on both hull and hydro-ski-equipped seaplanes is presented. It is shown that hull loads can be reduced by proper trim programming from elevator action and by use of high dead rise. For the hydro-ski-equipped seaplanes, loads are shown to be reduced by a decrease of ski beam or length and by mounting the ski on either conventional shock struts or on a new type of frequency-discriminating shock strut.

NACA RM L55E10

EXPERIMENTAL DRAG COEFFICIENTS OF ROUND NOSES WITH CONICAL WINDSHIELDS AT MACH NUMBER 2.72. Jim J. Jones. June 1955. 18p. diagrs., photos. (NACA RM L55E10)

An exploratory investigation at Mach number 2.72 has been made to show the decrease in the drag of a round-nose model achieved by mounting a small cone on a rod ahead of the nose. The geometric parameters which were varied were the cone-base diameter, cone angle, and rod length. On one model the rod was replaced by two off-axis legs. All models showed large decreases in drag compared to that of the round nose alone.

NACA RM L55E12

SIMPLIFIED PROCEDURES FOR ESTIMATING FLAP-CONTROL LOADS AT SUPERSONIC SPEEDS. K. R. Czarnecki and Douglas R. Lord. May 1955. 14p. diagrs. (NACA RM L55E12)

An investigation has been made to determine the possibility of using simplified procedures for the estimation of control loads at supersonic speeds. The results of the investigation indicate that relatively simple procedures are possible for the estimation of loadings on flap-type controls at supersonic speeds for the case where no flow separation occurs ahead of the hinge line. For tip-type controls, the simplified procedures have been tested only in a few cases and need further development. For controls with swept hinge lines, experimental data are lacking, but

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it is anticipated that the procedures developed for the unswept hinge-line controls will apply provided that there is no flow separation at the hinge line or that the sweep angle is not too large. In general, the loadings predicted by the simplified procedures are in better agreement with experiment than is unmodified three-dimensional linear theory.

NACA RM L55E13

AN INVESTIGATION OF LOADS ON AILERONS AT TRANSONIC SPEEDS. Jack F. Runckel and W. H. Gray. May 1955. 8p. diagrs. (NACA RM L55E13)

Some load characteristics of unbalanced ailerons for three thin wings varying in sweep are presented for Mach numbers from 0.80 to 1.05.

NACA RM L55E18c

LANDING CONDITIONS FOR LARGE AIRPLANES IN ROUTINE OPERATIONS. Norman S. Silsby and Eziaslav N. Harrin. July 1955. 10p. diagrs. (NACA RM L55E18c)

Measurements have been obtained by means of a specially developed photographic method of landing contact conditions of some commercial transports, the Boeing KC-97 tanker, the Boeing B-47 jet bomber, and the Convair B-36 bomber. From these measurements, vertical velocities and airspeeds at contact have been evaluated and a brief statistical analysis of the results, including the effect of horizontal gusts on the landing conditions for the transports, has been made.

NACA RM L55E20b

SOME FACTORS AFFECTING THE VARIATION OF PITCHING MOMENT WITH SIDESLIP OF AIRCRAFT CONFIGURATIONS. Edward C. Polhamus. July 1955. 29p. diagrs. (NACA RM L55E20b)

A brief study of available wind-tunnel data with regard to the variation of pitching-moment coefficient with sideslip angle is presented. The effects of such factors as wing plan form, wing-body interference, and tail location are illustrated and discussed, and regions where additional data are needed are indicated.

NACA RM L55E25

EFFECTS OF COMBINING AUXILIARY BLEED WITH EJECTOR PUMPING ON THE POWER REQUIREMENTS AND TEST-SECTION FLOW OF AN 8-INCH BY 8-INCH SLOTTED TUNNEL. B. H. Little, Jr., and James M. Cubbage, Jr. July 1955. 44p. diagrs., photo. (NACA RM L55E25)

The effects of using varying amounts of auxiliary bleed for slot-flow removal in an 8-inch by 8-inch slotted tunnel were determined for two ejector configurations. Auxiliary bleed adversely affected the test-section Mach number distributions for the ejector with slot-flow reentry flaps 1 tunnel height in length, but this effect was relieved when the flaps were shortened. Total-horsepower requirements were always reduced by using some auxiliary bleed. The amounts of bleed required for minimum total horsepower were determined by the ejector characteristics and the test-section Mach number.

NACA RM L55E25a

EXPERIMENTAL INVESTIGATION AT HIGH SUBSONIC SPEEDS OF THE EFFECTS OF LEADING-EDGE RADIUS ON THE AERODYNAMIC CHARACTERISTICS OF A SWEPTBACK-WING—FUSELAGE COMBINATION WITH LEADING-EDGE FLAPS AND CHORD-EXTENSIONS. Kenneth P. Spreemann. July 1955. 42p. diagrs., photo., tabs. (NACA RM L55E25a)

A limited investigation was made at high subsonic speeds to determine the effects of wing leading-edge radius on the aerodynamic characteristics of a sweptback-wing—fuselage combination with leading-edge flaps and chord-extensions. The basic wing had 45° sweepback, aspect ratio 4, taper ratio 0.3, and NACA 65A006 airfoil section. The investigation was made in the Langley high-speed 7- by 10-foot tunnel over a Mach number range of 0.80 to 0.92 and an angle-of-attack range of -2° to 24°. The results indicate that the changes in leading-edge radius employed in this investigation generally had only small effects on the aerodynamic characteristics of the model and the altered leading edges usually were less favorable than the normal NACA 65A006 airfoil section.

NACA RM L57A30a

THEORETICAL INVESTIGATION OF THE EFFECT OF RUDDER AND STABILIZER DEFLECTIONS ON THE ANGLES OF ATTACK AND SIDESLIP IN RAPID ROLLS. C. H. Woodling. March 1957. 43p. diagrs., tabs. (NACA RM L57A30a)

A theoretical investigation has been made of the effect of rudder and stabilizer deflections on the angles of attack and sideslip in rapid rolls. Expressions are derived from the five-degree-of-freedom airplane equations of motion which define the rudder and stabilizer motions necessary to maintain constant angle of attack and zero sideslip during an aileron roll. The control motions calculated by using these expressions are useful in determining the magnitude and direction of the rudder and stabilizer deflections that might be applied by a pilot or by automatic controls to maintain small variations in the angles of attack and sideslip during aileron rolls.

NACA RM SA52C10, by Canning and Denardo
NACA RM SL50C14a, by Hewes
NACA RM SL53I24, by Sleeman

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NACA Rept. 1277

INTERACTION OF A FREE FLAME FRONT WITH A TURBULENCE FIELD. Maurice Tucker. 1956. ii, 19p. diagrs., tabs. (NACA Rept. 1277. Supersedes TN 3407)

Theoretical values are obtained for the root-mean-square flame-generated turbulence velocities and the attenuating pressure fluctuations resulting from a linearized interaction of a constant-pressure combustion front with a field of isotropic turbulence. The anisotropic flame-generated turbulence is found to be of about the same intensity as the incident turbulence. A brief discussion of turbulent flame speed is given. Directly at the flame front the noise pressure levels characterizing the pressure fluctuations are fairly intense (59 to 81 decibels) even at moderate approach-flow turbulence intensities.

NACA Rept. 1278

EFFECT OF INTERACTION ON LANDING-GEAR BEHAVIOR AND DYNAMIC LOADS IN A FLEXIBLE AIRPLANE STRUCTURE. Francis E. Cook and Benjamin Milwitzky. 1956. ii, 30p. diagrs., tabs. (NACA Rept. 1278. Supersedes TN 3467)

The effects of interaction between a landing gear and a flexible airplane structure on the behavior of the landing gear and the loads in the structure have been studied by treating the equations of motion of the airplane and the landing gear as a coupled system where the landing gear is considered to have nonlinear characteristics. Numerical examples, based on the characteristics of two large airplanes, show the effects of interaction on the loads in the landing gear and in the structure. The effects of neglecting interaction and using the landing-gear forcing function for a rigid body in a dynamic analysis of a flexible airframe are also discussed.

NACA Rept. 1279

THEORETICAL ANALYSIS OF INCOMPRESSIBLE FLOW THROUGH A RADIAL-INLET CENTRIFUGAL IMPELLER AT VARIOUS WEIGHT FLOWS. James J. Kramer, Vasily D. Prian, and Chung-Hua Wu. 1956. ii, 16p. diagrs., tab. (NACA Rept. 1279. Supersedes TN 3448; TN 3449)

A method for the solution of the incompressible nonviscous flow through a centrifugal impeller, including the inlet region, is presented. Several numerical solutions are obtained for four weight flows through an impeller at one operating speed. These solutions are refined in the leading-edge region. The results are presented in a series of figures showing streamlines and relative velocity contours. A comparison is made with the results obtained by using a rapid approximate method of analysis.

NACA Rept. 1280

THEORETICAL INVESTIGATION OF FLUTTER OF TWO-DIMENSIONAL FLAT PANELS WITH ONE SURFACE EXPOSED TO SUPERSONIC POTENTIAL FLOW. Herbert C. Nelson and Herbert J. Cunningham. 1956. ii, 24p. diagrs., tabs. (NACA Rept. 1280. Supersedes TN 3465)

A Rayleigh type analysis is used to treat the flutter of a two-dimensional flat panel supported at its leading and trailing edges and subjected to a middle-plane tensile force, with a supersonic stream over its upper surface and still air below. Numerical results in the form of stability boundaries are presented for determining some effects of number of modes, Mach number, densities of the supersonic stream and still air, panel mass and stiffness, edge fixity, structural damping, and middle-plane tensile force. Comparison is made with a few experimental results.

NACA Rept. 1286

PROPAGATION OF A FREE FLAME IN A TURBULENT GAS STREAM. William R. Mickelsen and Norman E. Ernstein. 1956. ii, 26p. diagrs., photos., tabs. (NACA Rept. 1286. Supersedes TN 3456)

Effective turbulent free-flame speeds measured in turbulent, flowing propane-air mixtures were found to have statistical distributions about mean values. The statistical spread was greater for rich and lean fuel-air ratios and at high turbulence intensities. The measured flame speeds, together with hot-wire-anemometer measurements, formed a basis for comparison with three theories and other types of flames. Although the free-flame speeds are lower than those for turbulent Bunsen and stabilized flames, values calculated from the Tucker analysis and a modified Scurlock-Grover analysis seem to form an upper limit to the turbulent free-flame-speed data.

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NACA Rept. 1290

DEVELOPMENT OF CRAZE AND IMPACT RESISTANCE IN GLAZING PLASTICS BY MULTIAXIAL STRETCHING. G. M. Kline, I. Wolock, B. M. Axilrod, M. A. Sherman, D. A. George, and V. Cohen, National Bureau of Standards. 1956. ii, 16p. diagrs., photos., tabs. (NACA Rept. 1290)

The loss of strength of cast polymethyl methacrylate plastic as a result of crazing is of considerable importance to the aircraft industry. In the course of this study of crazing the following factors were examined: (1) The effect of stress-solvent crazing on tensile strength of polymethyl methacrylate; (2) the critical stress and strain for onset of crazing at various temperatures; (3) the effect of molecular weight on crazing; and (4) the effect of multiaxial stretching on crazing of polymethyl methacrylate and other acrylic glazing materials.

NACA Rept. 1291

LIFT HYSTERESIS AT STALL AS AN UNSTEADY BOUNDARY-LAYER PHENOMENON. Franklin K. Moore. 1956. ii, 10p. diagrs., tab. (NACA Rept. 1291. Supersedes TN 3571)

With the problem of rotating compressor stall in view, an unsteady boundary-layer calculation is made to find the unsteady increment of lift of a stalled elliptic airfoil in a flow of time-dependent incidence. The analysis indicates a counterclockwise hysteresis loop of the lift curve, the various forms of which are discussed.

NACA Rept. 1293

SIMILAR SOLUTIONS FOR THE COMPRESSIBLE LAMINAR BOUNDARY LAYER WITH HEAT TRANSFER AND PRESSURE GRADIENT. Clarence B. Cohen and Eli Reshotko. 1956. ii, 38p. diagrs., tabs. (NACA Rept. 1293. Supersedes TN 3325)

Stewartson's equations for the compressible laminar boundary layer with pressure gradient and heat transfer are solved for pressure gradients varying from that causing separation to the infinitely favorable gradient and for wall temperatures from absolute zero to twice the free-stream stagnation temperature. For the case of favorable pressure gradients with heated walls, it is shown that the velocity within a portion of the boundary layer must exceed the local external velocity. The variation of a Reynolds analogy parameter, which indicates the ratio of skin friction to heat transfer, is from zero to 7.4 for a surface of temperature twice the free-stream stagnation temperature and from zero to 2.8 for a surface held at absolute zero, where the value 2 applies to a flat plate.

NACA Rept. 1294

THE COMPRESSIBLE LAMINAR BOUNDARY LAYER WITH HEAT TRANSFER AND ARBITRARY PRESSURE GRADIENT. Clarence B. Cohen and Eli Reshotko. 1956. ii, 16p. diagrs., tabs. (NACA Rept. 1294. Supersedes TN 3326)

An approximate method for the calculation of the compressible laminar boundary layer with heat transfer and arbitrary pressure gradient, based on Thwaites' correlation concept, is presented. With the definition of dimensionless shear and heat-transfer parameters and an assumed correlation of these parameters in terms of a momentum parameter, a complete system of relations for calculating skin friction and heat transfer results. Knowledge of velocity or temperature profiles is not necessary in using this calculation method. When the method is applied to a convergent-divergent, axially symmetric rocket nozzle, it shows that high rates of heat transfer are obtained at the initial stagnation point and at the throat of the nozzle. Also indicated are negative displacement thicknesses in the convergent portion of the nozzle; these occur because of the high density within the lower portions of the cooled boundary layer.

NACA Rept. 1295

AN ANALYSIS OF ONCE-PER-REVOLUTION OSCILLATING AERODYNAMIC THRUST LOADS ON SINGLE-ROTATION PROPELLERS ON TRACTOR AIRPLANES AT ZERO YAW. Vernon L. Rogallo, Paul F. Yaggy, and John L. McCloud, III. 1956. ii, 30p. diagrs., photos. (NACA Rept. 1295. Supersedes TN 3395)

A simplified procedure is shown for calculating the once-per-revolution oscillating aerodynamic thrust loads on propellers of tractor airplanes at zero yaw. The only flow field information required is a knowledge of the upflow angles at the horizontal center line of the propeller disk. Methods are presented whereby these angles may be determined by theoretical procedures.

NACA RM L57D19b

RECENT DATA ON TIRE FRICTION DURING LANDING. Sidney A. Batterson. June 1957. 7p. diagrs. (NACA RM L57D19b)

An investigation was made at the Langley landing loads track to obtain data on the coefficient of friction during wheel spin-up. A landing gear was tested at horizontal velocities ranging from 0 to 180 feet per second together with vertical velocities of 7.0 and 9.3 feet per second. The results indicate the effect of forward speed and tire inflation pressure on the coefficient of friction.

CURRENT NACA RESEARCH REPORTS

NACA TM 1428

EFFECT OF FATIGUE CRACK ON STATIC STRENGTH: 2014-T6, 2024-T4, 6061-T6, 7075-T6 OPEN-HOLE MONOBLOC SPECIMENS. Glenn E. Nordmark and Ian D. Eaton, Aluminum Company of America. May 1957. 22p. diagrs., tabs. (NACA TM 1428)

Static tensile test results are presented for specimens of 2014-T6, 2024-T4, 6061-T6, and 7075-T6 aluminum alloy containing fatigue cracks. The results are found to be in good agreement with the results reported for similar tests from other sources. The results indicate that the presence of a fatigue crack reduced the static strength, in all cases, by an amount larger than the corresponding reduction in net area; the 6061-T6 alloy specimens were least susceptible to the crack and the 7075-T6 alloy specimens most susceptible. It is indicated that a 7075-T6 specimen may develop as little as one-third of the expected static tensile strength when the fatigue crack has consumed only one-fourth of the original area.

NACA TN 3858

A LOW-SPEED EXPERIMENTAL INVESTIGATION OF THE EFFECT OF A SANDPAPER TYPE OF ROUGHNESS ON BOUNDARY-LAYER TRANSITION. Albert E. von Doenhoff and Elmer A. Horton. October 1956. 45p. diagrs., photos. (NACA TN 3858) CORRECTED COPY

An investigation conducted in the Langley low-turbulence pressure tunnel at low speeds showed that for sandpaper-type roughness the occurrence of transition could be correlated on the basis of a local roughness Reynolds number based on the size of the roughness and the velocity at the top of the roughness. The extent of the roughened area does not appear to have an important effect on the critical value of the roughness Reynolds number.

NACA TN 3943

A POWER-SERIES SOLUTION FOR THE UNSTEADY LAMINAR BOUNDARY-LAYER FLOW IN AN EXPANSION WAVE OF FINITE WIDTH MOVING THROUGH A GAS INITIALLY AT REST. Nathaniel B. Cohen. June 1957. 56p. diagrs., tabs. (NACA TN 3943)

The equations of motion and energy for the laminar boundary-layer flow in an expansion fan moving into undisturbed fluid were considered. Infinite power-series solutions were indicated and the first three terms of each series were numerically evaluated. Validity of the numerical results was restricted to the region near the leading edge of the fan. Results were compared with those given by a solution which considered the expansion fan as an isentropic wave of zero thickness. The solutions were shown to be very different, qualitatively as well as quantitatively. Singularities in the flow field were discussed in regard to both finite- and zero-width expansion-wave solutions.

NACA TN 3944

AN INTEGRAL SOLUTION TO THE FLAT-PLATE LAMINAR BOUNDARY-LAYER FLOW EXISTING INSIDE AND AFTER EXPANSION WAVES AND AFTER SHOCK WAVES MOVING INTO QUIESCENT FLUID WITH PARTICULAR APPLICATION TO THE COMPLETE SHOCK-TUBE FLOW. Robert L. Trimpi and Nathaniel B. Cohen. June 1957. ii, 180 p. diagrs., tab. (NACA TN 3944)

A solution to the unsteady two-dimensional laminar boundary-layer flow inside centered expansion waves and behind both centered expansion waves and shock waves is obtained by utilizing an extension of the Kármán-Pohlhausen method. The reduced hyperbolic differential equations are integrated in closed form for flow behind shock waves and by numerical methods for the flow inside or following expansion waves. An integral technique is applied at the discontinuities existing at the trailing edge of the expansion fan and at contact discontinuities (entropy discontinuities) so that the characteristic solution may proceed across these discontinuities. The solution to the two-dimensional unsteady laminar boundary layer existing at all points in an air-air shock tube is obtained by this method. A much shorter approximate method of solution is devised and is found to agree favorably with this method. This approximate method is used to predict the flow in hydrogen-air and helium-air shock tubes. Plots of wall heat-transfer rate and skin friction in air-air, helium-air, and hydrogen-air shock tubes are presented.

NACA TN 3952

EFFECTS OF HORIZONTAL-TAIL POSITION AND A WING LEADING-EDGE MODIFICATION CONSISTING OF A FULL-SPAN FLAP AND A PARTIAL-SPAN CHORD-EXTENSION ON THE AERODYNAMIC CHARACTERISTICS IN PITCH AT HIGH SUBSONIC SPEEDS OF A MODEL WITH A 45° SWEPTBACK WING. William D. Morrison, Jr., and William J. Alford, Jr. June 1957. 37p. diagrs., photo., tab. (NACA TN 3952. Supersedes RM L53E06)

The effects of horizontal-tail position (13.9 percent wing semispan below and 13.9 and 25.6 percent semispan above chord plane extended) on the pitch characteristics of a general research model having full-span wing leading-edge deflection and a partial-span chord-extension have been determined at Mach numbers of 0.40 to 0.93 at Reynolds numbers ranging from about 2,000,000 to 3,000,000. Lift, drag, and pitching moments were determined for three horizontal-tail angles at all Mach numbers investigated for angles of attack ranging from -2° to 24° except at the higher Mach numbers where tunnel choking restricted this angle range.

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NACA TN 3954

A THEORY FOR THE LATERAL RESPONSE OF AIRPLANES TO RANDOM ATMOSPHERIC TURBULENCE. John M. Eggleston. May 1957. i, 75p. diagrs., tabs. (NACA TN 3954)

The power spectra of the lateral motions of an airplane flying through continuous random isotropic turbulence are derived in terms of airplane transfer functions, the power spectra of coefficients relating the lateral moments and forces to gust velocities, and the power spectra of the three orthogonal components of gust velocities along the flight path. Random variations of gust velocities across the span and along the fuselage are considered. Three example airplanes are used to demonstrate the method, trends, and simplifications. Comparisons with less comprehensive methods are drawn.

NACA TN 3957

SOME EFFECTS OF TAIL HEIGHT AND WING PLAN FORM ON THE STATIC LONGITUDINAL STABILITY CHARACTERISTICS OF A SMALL-SCALE MODEL AT HIGH SUBSONIC SPEEDS. Albert G. Few, Jr., and Thomas J. King, Jr. May 1957. 62p. diagrs., photo. (NACA TN 3957. Supersedes RM L54G12)

The present paper presents some effects of horizontal-tail height and wing plan form on the static longitudinal characteristics of a complete model at high subsonic speeds. All wings had an aspect ratio of 3, quarter-chord sweep angles of 25°, 30°, and 35°, and NACA 65A004 airfoil sections parallel to the free stream. The Mach number range extended from about 0.80 to 0.94 with corresponding Reynolds numbers ranging from about 1.17×10^6 to 1.29×10^6. The drag due to lift increases with increasing sweep through the Mach number range. In relation to the pitch-up problem, the low-tail arrangement provides, in general, stable breaks and fairly linear pitching-moment curves above an angle of attack of approximately 4° for all wing plan forms at the low Mach numbers but not at the highest test Mach number.

NACA TN 3970

THIN AIRFOIL THEORY BASED ON APPROXIMATE SOLUTION OF THE TRANSONIC FLOW EQUATION. John R. Spreiter and Alberta Y. Alksne. May 1957. 82p. (NACA TN 3970)

A method is presented for the approximate solution of the nonlinear equations of transonic flow theory. Solutions are found for two-dimensional flows at a Mach number of 1 and for purely subsonic and purely supersonic flows. Results are obtained in closed analytic form for a large and significant class of nonlifting airfoils. At a Mach number of 1 general expressions are given for the pressure distribution on an airfoil of specified geometry and for the shape of an airfoil having a prescribed pressure distribution. Extensive comparisons are made with available data, particularly for a Mach number of 1, and with existing solutions.

NACA TN 3971

ON FLOW OF ELECTRICALLY CONDUCTING FLUIDS OVER A FLAT PLATE IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD. Vernon J. Rossow. May 1957. 54p. tabs. (NACA TN 3971)

Several basic boundary-layer solutions for the velocity and temperature profiles are found for flow of electrically conducting fluid over a flat plate in the presence of a transverse magnetic field. It is concluded that the skin friction and the heat-transfer rate are reduced when the transverse magnetic field is fixed relative to the plate and increased when fixed relative to the fluid. The total drag is increased in all the cases studied.

NACA TN 3983

EFFECT OF STANDING TRANSVERSE ACOUSTIC OSCILLATIONS ON FUEL-OXIDANT MIXING IN CYLINDRICAL COMBUSTION CHAMBERS. William R. Mickelsen. May 1957. (i), 49p. diagrs. (NACA TN 3983)

Vapor fuel-oxidant mixing is analyzed for standing transverse acoustic fields simulating those existing in screeching or screaming combustors. The additional mixing due to the acoustic field is shown to be a function of sound pressure and frequency, stream velocity, and turbulence. The effects of these parameters are shown graphically for a realistic range of combustor conditions. The fuel-oxidant ratio at various combustor stations is shown to have a cyclic fluctuation which is in phase with the pressure fluctuations. Possible mechanisms contributing to screech and scream are discussed.

NACA TN 3984

STATISTICAL STUDY OF AIRCRAFT ICING PROBABILITIES AT THE 700- AND 500-MILLIBAR LEVELS OVER OCEAN AREAS IN THE NORTHERN HEMISPHERE. Porter J. Perkins, William Lewis, and Donald R. Mulholland. May 1957. 31p. diagrs., tabs. (NACA TN 3984)

A statistical study is made of icing observations reported from weather reconnaissance aircraft flown by Air Weather Service (USAF). Wide areas of the Pacific, Atlantic, and Arctic Oceans were surveyed at fixed flight levels of 500 mb (18,000 ft) and 700 mb (10,000 ft). Icing statistics presented include the relative frequencies of the occurrence of icing, the estimated probability of flight in icing, and the relation of these probabilities to the frequencies of flight in clouds and cloud temperatures. Icing probabilities varied widely throughout the year from near zero in cold Arctic areas in winter up to 7 percent in areas where greater cloudiness and warmer temperatures prevail.

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NACA TN 3986

COMPRESSIBLE LAMINAR BOUNDARY LAYER OVER A YAWED INFINITE CYLINDER WITH HEAT TRANSFER AND ARBITRARY PRANDTL NUMBER. Eli Reshotko and Ivan E. Beckwith. June 1957. (i), 86p. diagrs., tabs. (NACA TN 3986)

Numerical solutions to the equations for the compressible laminar boundary layer have been obtained for the flow in the stagnation region of an infinite cylinder in yaw for large free-stream Mach numbers and large yaw angles. The wall temperature was varied from zero to twice the stream stagnation temperature. Solutions are given for Prandtl numbers of 1 and 0.7. The results indicate that the heat-transfer coefficient decreases with yaw angle about as the square root of the cosine of the yaw angle for subsonic Mach numbers and somewhat less than the cosine of the yaw angle for Mach numbers greater than 2.

NACA TN 3992

CHARTS FOR ESTIMATING THE EFFECTS OF SHORT-PERIOD STABILITY CHARACTERISTICS ON AIRPLANE VERTICAL-ACCELERATION AND PITCH-ANGLE RESPONSE IN CONTINUOUS ATMOSPHERIC TURBULENCE. Kermit G. Pratt and Floyd V. Bennett. June 1957. 61p. diagrs., tabs. (NACA TN 3992)

Charts are presented from which the root-mean-square vertical acceleration and pitch angle in dimensionless form can be estimated for values of four other dimensionless parameters that describe the airplane short-period stability characteristics and the scale of atmospheric turbulence. The trends of the root-mean-square responses with each of the four parameters are discussed in terms of two significant combinations of the parameters involved. The vertical-acceleration response is compared with that of an airplane free to be disturbed in the vertical direction only. Some examples of chart application are given.

NACA TN 3996

INVESTIGATION OF A SHORT-ANNULAR-DIFFUSER CONFIGURATION UTILIZING SUCTION AS A MEANS OF BOUNDARY-LAYER CONTROL. Stafford W. Wilbur and James T. Higginbotham. June 1957. 33p. diagrs., photo. (NACA TN 3996)

A straight outer-wall annular diffuser having a center-body length of one-half the outer-body diameter and an area ratio of 1.9:1 has been investigated for mean inlet flow angles of 0° and 19.5° with an inlet Mach number of 0.26 in order to determine the effect of area suction applied on the inner wall. The entrance shape, number, and location of the openings through which the air was removed were varied. The auxiliary air flow was varied from 0 to approximately 4 percent of the main-stream air flow. For most of the configurations, significant improvement in performance was obtained over no control when a suction flow rate of as little as 1 percent was utilized. The diffuser-exit velocity distributions were also improved by the increase in suction area and by an increase in the amount of suction.

NACA TN 3999

EXPERIMENTAL INFLUENCE COEFFICIENTS AND VIBRATION MODES OF A BUILT-UP 45° DELTA-WING SPECIMEN. Eldon E. Kordes, Edwin T. Kruszewski, and Deene J. Weidman. May 1957. 41p. diagrs., photos., tabs. (NACA TN 3999)

Experimental influence coefficients and vibration modes and frequencies of a built-up 45° delta-wing specimen are presented. The symmetrical and antisymmetrical static influence coefficients were obtained on a three-point support. The first 10 vibration modes and frequencies were obtained for an essentially free-free condition. A detailed description of the structural properties of the specimen is also given.

NACA TN 4001

SOME CONSIDERATIONS OF HYSTERESIS EFFECTS ON TIRE MOTION AND WHEEL SHIMMY. Robert F. Smiley. June 1957. 45p. diagrs. (NACA TN 4001)

A theoretical study is made of the influence of tire hysteresis effects on the rolling motion and wheel shimmy of landing gears. The results of this study indicate that hysteresis forces and moments have a noticeable secondary influence on the landing-gear rolling behavior. Comparisons of the available experimental data with the corresponding theoretical predictions provide a fair confirmation of the theory.

NACA TN 4003

A VARIATIONAL THEOREM FOR CREEP WITH APPLICATIONS TO PLATES AND COLUMNS. J. Lyell Sanders, Jr., Harvey G. McComb, Jr., and Floyd R. Schlechte. May 1957. 23p. diagrs. (NACA TN 4003)

A variational theorem is presented for a body undergoing creep. Solutions to problems of creep bending and creep collapse of plates, columns, beams, and shells can be obtained by means of the direct methods of the calculus of variations in conjunction with the stated theorem. The application of the theorem is illustrated for plates and columns by the solution of two sample problems.

NACA TN 4004

SOME EFFECTS OF VALVE FRICTION AND STICK FRICTION ON CONTROL QUALITY IN A HELICOPTER WITH HYDRAULIC-POWER CONTROL SYSTEMS. B. Porter Brown and John P. Reeder. May 1957. 8p. diagr. (NACA TN 4004)

Flight tests have been made in a helicopter with hydraulic-power control systems to investigate the effect of various ratios of servovalve friction and stick friction, both with and without feel devices.

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The tests showed that, when an objectionable amount of valve friction is present, some benefits can be gained by introducing stick friction. The addition of feel devices resulted in an overall improvement in the control systems and was therefore considered to be very desirable.

NACA TN 4006

INVESTIGATION AT TRANSONIC SPEEDS OF DEFLECTORS AND SPOILERS AS GUST ALLEVIATORS ON A 35° SWEPT WING. TRANSONIC-BUMP METHOD. Delwin R. Croom and Jarrett K. Huffman. June 1957. 19p. diagrs. (NACA TN 4006)

An investigation was made in the Langley high-speed 7- by 10-foot tunnel by means of the transonic-bump method to determine the gust-alleviation capabilities of a deflector control and a spoiler-deflector control when mounted on a 35° swept semispan wing having NACA 65A006 airfoil sections. The lift-curve slope was reduced by about 20 percent, the drag was increased, and a destabilizing effect was noted because of the addition of the controls.

NACA TN 4008

A SUMMARY OF GROUND-LOADS STATISTICS. John R. Westfall, Benjamin Milwitzky, Norman S. Silsby, and Robert C. Dreher. May 1957. 15p. diagrs. (NACA TN 4008)

This paper briefly summarizes the more important statistical data obtained by the NACA on the subject of ground loads. The information presented relates primarily to landing-impact and taxiing loads; however, some limited data are also presented on one phase of ground-handling loads, namely, braking friction. A number of experimental and theoretical papers dealing with various aspects of the subject are listed in the bibliography.

NACA TN 4009

SOME RESEARCH RESULTS ON SANDWICH STRUCTURES. Melvin S. Anderson and Richard G. Updegraff. June 1957. 12p. diagrs., photos. (NACA TN 4009)

The results of compressive-buckling tests of steel sandwich plates are given, and the significant parameters which affect the strength of the plates are discussed. The various types of sandwich construction are shown to be comparable on a weight-strength basis with conventional high-strength aluminum-alloy construction.

NACA TN 4011

SOME ASPECTS OF FAIL-SAFE DESIGN OF PRESSURIZED FUSELAGES. Paul Kuhn and Roger W. Peters. June 1957. 13p. diagrs. (NACA TN 4011)

Separate investigations have dealt with the critical crack length of flat sheets or of unstiffened cylinders and with the type of rupture experienced by stiffened cylinders. These investigations are correlated, supplemented by new tests, and combined into a uniform scheme for predicting critical crack length and type of rupture in stiffened pressurized cylinders.

NACA TN 4012

FATIGUE-CRACK PROPAGATION AND RESIDUAL STATIC STRENGTH OF BUILT-UP STRUCTURES. Herbert F. Hardrath and Richard E. Whaley. May 1957. 11p. diagrs. (NACA TN 4012)

Crack-propagation and static-strength tests in several types of built-up specimens and full-scale wings are reviewed. The results, to date, indicate that the rate of crack propagation is influenced strongly by the mode of connecting the skin to stringers and by the proportions of areas of the skin and stringers. The analysis of residual static strength of complex structures indicates the feasibility of applying simple methods, but the results are subject to questions regarding the redistribution of loads, interactions between various members, and such seemingly trivial considerations as whether or not a crack terminates at a rivet.

NACA TN 4015

THEORETICAL AND EXPERIMENTAL INVESTIGATIONS OF DELTA-WING VIBRATIONS. Edwin T. Kruszewski, Eldon E. Kordes, and Deene J. Weidman. June 1957. 11p. diagrs., photo., tab. (NACA TN 4015)

The results of some theoretical and experimental investigations of delta-wing vibrations are discussed. Nodal-line patterns and frequencies of a 45° built-up thin-skin delta-wing specimen obtained experimentally are compared with those calculated by the Levy method (with and without transverse shear) and by the Stein-Sanders method. Experimental nodal-line patterns and frequencies for a 60° thick-skin delta wing are also shown.

NACA TN 4021

NONUNIFORMITIES IN SHOCK-TUBE FLOW DUE TO UNSTEADY-BOUNDARY-LAYER ACTION. Harold Mirels and W. H. Braun. May 1957. 45p. diagrs. (NACA TN 4021)

The boundary layer along the walls of a shock tube induces pressure and velocity gradients within the core of potential flow. These nonuniformities are

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evaluated herein for shock tubes in which the boundary layer is thin relative to the tube diameter and is either wholly laminar or wholly turbulent. The hot gas region between the shock wave and the contact surface is considered. Both the axial distributions at any instant and the temporal distributions at any axial position within this region are found. Numerical computations are presented for an air-air shock tube.

NACA TN 4022

ESTIMATION OF COMPRESSIBLE BOUNDARY-LAYER GROWTH OVER INSULATED SURFACES WITH PRESSURE GRADIENT. Gerald W. Englert. June 1957. 35p. diagrs. (NACA TN 4022)

The incompressible boundary-layer theory of Truckenbrodt was extended using a modified Stewartson-type transformation to include compressible boundary-layer development over insulated surfaces. The variation of turbulent shear stress with Mach number of the bounding potential stream was considered using the reference-temperature method of Eckert. The explicit technique of Truckenbrodt for determining profile parameter in the incompressible theory was unchanged so that profile parameter as well as momentum thickness can still be evaluated by simple quadratures in the present method. Good agreement of theory with experimental boundary-layer measurements on several small axisymmetric bodies and on the wall of a large supersonic tunnel was obtained.

NACA TN 4023

DESIGN AND EXPERIMENTAL EVALUATION OF A LIGHT-WEIGHT TURBINE-WHEEL ASSEMBLY. W. C. Morgan and R. H. Kemp. June 1957. 25p. diagrs., photos. (NACA TN 4023)

Light-weight design concepts were developed and tested in a full-scale turbine wheel with a tip diameter of 34.3 inches and a tip speed of 1190 feet per second. The rotor consisted of two thin disks attached to each other by spacers and bolts. Each disk was contoured for optimum stress distribution. The turbine blades were hollow castings with an integral serrated root. The total weight of the wheel, exclusive of the shafts and bolts, was 121 pounds. A disk serration segment failed after 6 hours and 46 minutes of engine operation. Failure was attributed to excessive blade vibration.

NACA TN 4024

APPRAISAL OF THE HAZARDS OF FRICTION-SPARK IGNITION OF AIRCRAFT CRASH FIRES. John A. Campbell. May 1957. 23p. photos., tabs. (NACA TN 4024)

A study was made to determine if common aircraft metals produce friction sparks capable of igniting combustibles that might be spilled in an airplane crash. Samples of aluminum, titanium, magnesium, chrome-molybdenum steel, and stainless steel were dragged over both concrete and asphalt runways while a combustible mixture of gasoline, JP-4 fuel, kerosene, or preheated oil was sprayed around the sample. No ignitions occurred from the sliding aluminum; but the titanium, magnesium, chrome-molybdenum steel, and stainless steel produced friction sparks that ignited the combustibles.

NACA TN 4025

THERMODYNAMIC STUDY OF A ROOTS COMPRESSOR AS A SOURCE OF HIGH-TEMPERATURE AIR. Clarence B. Cohen, Richard R. Woollett, and Kenneth C. Weston. June 1957. 34p. diagrs., tab. (NACA TN 4025)

Thermodynamic analysis of a Roots blower indicates that leakage of hot air from the high- to the low-pressure side produces a large preheating effect on the supply air. The resulting outlet temperatures are extremely sensitive to heat losses in the cycle. Calculations indicate that outlet temperatures of 7000° and 5000° R will result if the Stanton numbers, based on rotor tip speed, are 0.002 and 0.003, respectively.

NACA TN 4038

PERFORATED SHEETS AS THE POROUS MATERIAL FOR A SUCTION-FLAP APPLICATION. Robert E. Dannenberg, James A. Weiberg, and Bruno J. Gambucci. May 1957. 36p. diagrs., photos. (NACA TN 4038)

Two-dimensional tests were made of an NACA 0006 airfoil with area suction applied to a porous region on a 0.3-chord trailing-edge flap deflected 50°. The lift with suction approached the value computed from thin-airfoil theory. The lift gains and suction quantity requirements were unaffected by the perforation patterns of the surface over a wide range of hole sizes and spacings.

NACA TN 4049

INFLUENCE OF CRUCIBLE MATERIALS ON HIGH-TEMPERATURE PROPERTIES OF VACUUM-MELTED NICKEL-CHROMIUM-COBALT ALLOY. R. F. Decker, John P. Rowe, and J. W. Freeman, University of Michigan. June 1957. 34p. diagrs., photos., tabs. (NACA TN 4049)

A study of the effect of induction-vacuum-melting procedure on the high-temperature properties of a titanium-and-aluminum-hardened nickel-base alloy revealed that a major variable was the type of ceramic used as a crucible. Reactions between the melt and magnesia or zirconia crucibles apparently increased high-temperature properties by introducing small amounts of boron or zirconium into the melts. Heats melted in alumina crucibles had relatively low rupture life and ductility at 1,600° F and cracked during hot-working as a result of deriving no boron or zirconium from the crucible.

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NACA TN 4051

EFFECTS OF RAPID HEATING ON STRENGTH OF AIRFRAME COMPONENTS. Richard A. Pride, John B. Hall, Jr., and Melvin S. Anderson. June 1957. 14p. diagrs., photos., tab. (NACA TN 4051)

Results of several experimental investigations are presented which indicate that thermal stresses reduce the bending load carried by beams and ring-stiffened cylinders at buckling. For beams that buckle locally, no apparent effect of thermal stress on the maximum load has been found. For beams that buckle in the wrinkling mode and for cylinders, a reduction in maximum load has been observed.

NACA TN 4052

TWO FACTORS INFLUENCING TEMPERATURE DISTRIBUTIONS AND THERMAL STRESSES IN STRUCTURES. William A. Brooks, Jr., George E. Griffith, and H. Kurt Strass. June 1957. 13p. diagrs. (NACA TN 4052)

The influence of joint conductivity and internal radiation on temperature distribution and thermal stresses has been discussed. Joints of poor conductivity can occur in normal fabrication procedure and greatly alter temperature distributions and increase thermal stresses. On the other hand, internal radiation tends to make the temperature distributions more uniform and thereby relieves thermal stress.

NACA TN 4053

THE COMBINATIONS OF THERMAL AND LOAD STRESSES FOR THE ONSET OF PERMANENT BUCKLING IN PLATES. George W. Zender and Richard A. Pride. June 1957. 10p. diagrs., photo. (NACA TN 4053)

A simple and practical method for evaluating the onset of permanent buckling in plates in the presence of combined thermal and compressive load stresses is outlined. A particular application of the method shows reasonable agreement with tests of 17-7 PH stainless-steel square tubes. The results indicate that the compressive load stress which the plate can support at the onset of permanent buckling is substantially reduced as the temperature difference of the plate and adjoining members increases.

NACA TN 4054

EFFECT OF TRANSIENT HEATING ON VIBRATION FREQUENCIES OF SOME SIMPLE WING STRUCTURES. Louis F. Vosteen, Robert R. McWithey, and Robert G. Thomson. June 1957. 10p. diagrs. (NACA TN 4054)

Thermal stresses, which may result from transient heating, can cause changes in the effective stiffness of wing structures. Some effects of this change in stiffness were investigated experimentally by radiantly heating three types of simple wing structures: a uniform plate, a solid double-wedge section, and a circular-arc multiweb-wing section. Changes in stiffness were determined by measuring the changes in natural frequency of vibration during transient heating. Some comparisons are made between theoretical calculations and the measured data.

NACA TN 4056

LOADS IMPLICATIONS OF GUST-ALLEVIATION SYSTEMS. William H. Phillips. June 1957. 11p. diagrs., tab. (NACA TN 4056)

A brief review is presented of the basic methods of gust alleviation. Some results obtained in flight tests of a gust-alleviation system are included.

NACA TN 4057

INVESTIGATION AT LOW SPEEDS OF DEFLECTORS AND SPOILERS AS GUST ALLEVIATORS ON A MODEL OF THE BELL X-5 AIRPLANE WITH 35° SWEPT WINGS AND ON A HIGH-ASPECT-RATIO 35° SWEPT-WING—FUSELAGE MODEL. Delwin R. Croom and Jarrett K. Huffman. June 1957. 37p. diagrs., tab. (NACA TN 4057)

Results of an investigation at low speeds to determine the gust-alleviation capabilities (reduction in lift-curve slope) of spoilers and deflectors on a 35° swept-wing model of high aspect ratio and on a 1/4-scale model of the X-5 airplane with 35° swept wings indicate that deflector and spoiler-deflector types of controls can be designed to provide considerable gust alleviation for a swept-wing airplane while still maintaining stability and control.

NACA TN 4060

A WIDE-FREQUENCY-RANGE AIR-JET SHAKER. Robert W. Herr. June 1957. 15p. diagrs. (NACA TN 4060)

This paper presents a description of a simple air-jet shaker. Its force can be calibrated statically and appears to be constant with frequency. It is relatively easy to use, and it has essentially massless characteristics. This shaker is applied to define the unstable branch of a frequency-response curve obtained for a nonlinear spring with a single degree of freedom.

BRITISH REPORTS

N-48704*

Aeronautical Research Council (Gt. Brit.)
THE HOT-WIRE ANEMOMETER FOR TURBULENCE MEASUREMENTS. PART I. B. Wise. 1956. 13p. diagrs. ARC CP 273. (Ask for N-48704*)

An equivalent circuit is developed for the hot-wire anemometer, as used for turbulence measurements. Improvements in the frequency response, which can be produced by feedback systems, and by the use of radio-frequency heating, are also described.

BRITISH REPORTS

N-48705*

Aeronautical Research Council (Gt. Brit.)
THE HOT-WIRE ANEMOMETER FOR TURBULENCE MEASUREMENTS. PART II. B. Wise and D. R. Stewart. 1956. 15p. diagrs., photos. ARC CP 274. (Ask for N-48705*)

An account is given of some experimental work undertaken to test the theory of operation of a hot-wire anemometer with radio-frequency heating, which has been given in a previous paper.

N-48706*

Aeronautical Research Council (Gt. Brit.)
THE HOT-WIRE ANEMOMETER FOR TURBULENCE MEASUREMENTS. PART III. B. Wise and D. L. Schultz. 1956. 71p. diagrs. ARC CP 275. (Ask for N-48706*)

Further investigation of the operation of the hot-wire anemometer has shown that there are only two systems which are both statically stable and capable of improving the frequency response. A description is given of further experiments which have been made to verify the theory of operation of the wire, using both radio-frequency and direct current heating. An analysis of some feedback systems is given, and it is shown how these techniques may be used in the measurement of turbulence at high air speeds.

N-48707*

Aeronautical Research Council (Gt. Brit.)
THE HOT-WIRE ANEMOMETER FOR TURBULENCE MEASUREMENTS. PART IV. B. Wise and D. L. Schultz. 1956. 39p. diagrs. ARC CP 276. (Ask for N-48707*)

An account is given of some measurements of both turbulence level and spectra at subsonic and supersonic speeds. An investigation of the steady-state heat-loss law over the transonic range is also described.

N-48713*

Aeronautical Research Council (Gt. Brit.)
THE SECONDARY FLOW IN COMPRESSOR BLADES AT HIGH NEGATIVE INCIDENCES. W. D. Armstrong. 1956. 8p. diagrs. ARC CP 297. (Ask for N-48713*)

Measurements have shown that when blades operate at high negative incidences in nonuniform streams a variation of outlet angle is obtained which may be qualitatively explained by considering the detailed curvature of the streamlines. The α_2 variation is considerably different from that anticipated using the conventional theory.

N-48714*

Aeronautical Research Council (Gt. Brit.)
TURBULENT DIFFUSER FLOW. B. S. Stratford. 1956. 64p. diagrs. ARC CP 307. (Ask for N-48714*)

Exact solutions are obtained for the equations of motion for flow which everywhere is just at the condition of separation. Application is limited to that part of a diffuser in which the velocity profile has reached a constant shape. Standard mixing length theory as developed by Prandtl is the basis of the solutions. The solutions yield the value of the critical angle of a diffuser for just avoiding flow separation; this value is proportional to the square of the turbulence level.

N-48718*

Aeronautical Research Council (Gt. Brit.)
AERODYNAMIC DERIVATIVES FOR TWO CROPPED DELTA WINGS AND ONE ARROWHEAD WING OSCILLATING IN DISTORTION MODES. D. L. Woodcock. 1956. 69p. tabs. ARC CP 268. (Ask for N-48718*)

Aerodynamic derivatives are given for three particular plan forms oscillating with symmetric distortion modes in incompressible flow. The plan forms are: (1) a cropped delta wing of aspect ratio 3 and taper ratio 1/7, (2) a cropped delta wing of aspect ratio 1.2 and taper ratio 1/7, (3) an arrowhead wing of aspect ratio 1.32, taper ratio 7/18 and angle of sweep of 63.4^{o} at the quarter chord. The results are for modes of the form $/\eta/^{n}$ for $n = 0(1)4$ where η is a nondimensional spanwise coordinate. They have been determined from intermediate results which D. E. Lehrian had earlier obtained by the vortex lattice method. The results are compared, for some cases, with the corresponding values given by very low aspect-ratio theory.

N-48719*

Aeronautical Research Council (Gt. Brit.)
SOME ADVANTAGES AND DISADVANTAGES OF VARIABLE AND NON-LINEAR GEARING BETWEEN THE PILOT'S CONTROL AND THE CONTROL SURFACE. D. A. Lang. 1956. 27p. diagrs., tab. ARC CP 263. (Ask for N-48719*)

The advantages and disadvantages arising from the use of variable and nonlinear gearing are considered, mainly in relation to a reduction of the pilot's control movements required during an approach under bumpy conditions, to reducing oversensitivity of control at high speed and mitigating the effects of friction and backlash.

BRITISH REPORTS

N-48720*

Aeronautical Research Council (Gt. Brit.)
TURBULENCE ENCOUNTERED BY VIKING AIRCRAFT OVER EUROPE. J. R. Heath-Smith. 1957. 15p. diagrs., tabs. ARC CP 311.
(Ask for N-48720*)

Accelerations in turbulence were recorded on B.E.A. Viking aircraft for 117,000 miles of flying over European routes during three years. The records show that the number of gusts decreases from sea level to 8000 feet. There is some evidence below 5000 feet that turbulence is greatest in spring and least in autumn. Average gust frequencies during climb and descent were twice those during cruise below 8000 feet and this is attributed to the pilot's discretion in the choice of cruising altitude.

N-48721*

Aeronautical Research Council (Gt. Brit.)
A THEORETICAL INVESTIGATION OF THE FACTORS AFFECTING STALLING FLUTTER OF COMPRESSOR BLADES. A. D. S. Carter. 1956. 22p. diagrs. ARC CP 265. (Ask for N-48721*)

Recent work has drawn attention to the importance of the critical flutter velocity in applying cascade data to axial compressors. The hope has been expressed that it was primarily an aerodynamic phenomenon, though the possibility of mechanical damping being an important factor was not excluded. The mechanism of stalling flutter has been reexamined to establish, as far as is at present possible, the major parameters involved. On the basis of the hypothesis advanced, the factors governing the critical flutter velocity have been isolated. The variation of this velocity with respect to blade thickness has been deduced, and compared with test results. Agreement is good, but further work is necessary before the hypothesis can be accepted "in toto." Mechanical damping appears to be a major parameter, and may severely limit the practical application of the theoretical solution.

N-48722*

Aeronautical Research Council (Gt. Brit.)
AN EXPERIMENTAL INVESTIGATION OF THE BLADE VIBRATORY STRESSES IN A SINGLE-STAGE COMPRESSOR. A. D. S. Carter, D. A. Kilpatrick, C. E. Moss, and J. Ritchie. 1956. 30p. diagrs., photos. ARC CP 266.
(Ask for N-48722*)

The compressor blade flutter investigation has so far been concentrated primarily on static cascades. As a link with full-scale compressor results a series of tests has been undertaken on the untwisted stator of a single-stage compressor. The tests were carried out in a variable density return circuit rig.

N-48723*

Aeronautical Research Council (Gt. Brit.)
THE NUMERICAL INTEGRATION OF THE LAMINAR COMPRESSIBLE BOUNDARY LAYER EQUATIONS, WITH SPECIAL REFERENCE TO THE POSITION OF SEPARATION WHEN THE WALL IS COOLED. G. E. Gadd. 1957. 17p. tabs. ARC CP 312.
(Ask for N-48723*)

A method of integrating the laminar compressible boundary-layer equations is described. It is assumed that the external velocity at the leading edge of the boundary layer is not zero, but cases with leading-edge stagnation points could be dealt with on broadly similar lines. The method enables results of fair accuracy to be obtained even when large intervals of integration are used, and it is thus suitable where the computations are performed by means of a slide rule or mechanical computing machine. Certain solutions obtained by the method and concerned with the position of separation under adverse pressure gradients are presented.

N-48724*

Aeronautical Research Council (Gt. Brit.)
FLUTTER CALCULATIONS ON A RESONANCE MODEL DELTA WING. H. Hall. 1956. 18p. diagrs. ARC CP 260. (Ask for N-48724*)

Resonance tests on a dural model delta wing are used as a basis for flutter calculations to determine the effect on the flutter characteristics of changes in structural inertias and stiffnesses. Forward movement of the inertia axis and increased stiffness of the wing spars are shown to be separately beneficial. The calculated flutter speeds are compared with flutter speeds given by formulas derived from earlier flutter tests on model delta wings in the wind tunnel and on ground-launched rockets. There is qualitative agreement on the effects of the structural changes, but the absolute values of flutter speed differ appreciably. Possible explanations for the differences are discussed.

N-48725*

Aeronautical Research Council (Gt. Brit.)
THE DEVELOPMENT OF AN IMPROVED DIFFUSER FOR A 3 FT. X 3 FT. WIND TUNNEL. J. B. Scott-Wilson and D. I. T. P. Llewelyn-Davies. 1956. 12p. diagrs. ARC CP 308.
(Ask for N-48725*)

A summary is given of the significant results of diffuser development tests made in a 4-inch by 4-inch supersonic tunnel at Mach numbers from 1.4 to 2.0. The application of these results to the design of an improved first diffuser stage for the 3-foot by 3-foot supersonic tunnel, is described. The design incorporates a long single wedge center body, which divides the diffuser into two approximately constant area passages. Using this improved diffuser, the pressure ratio needed to run the tunnel at its maximum Mach number of 2.0, is reduced from 2.04 to 1.76.

BRITISH REPORTS

N-48726*

Aeronautical Research Council (Gt. Brit.)
VIBRATION AND FLUTTER FLIGHT TESTING. M. O. W. Wolfe. 1956. 19p. diagrs., photos. ARC CP 310. (Ask for N-48726*)

A review is made of the techniques that have been developed or are being developed in the United Kingdom for flight vibration-testing and flight flutter-testing aircraft. This includes a description of the instrumentation used for recording the vibrational response, and a comparative assessment of the various methods used for exiting the aircraft in flight flutter tests.

N-48727*

Aeronautical Research Council (Gt. Brit.)
CALIBRATION OF THE FLOW IN THE WORKING SECTION OF THE 3FT X 3FT TUNNEL, NATIONAL AERONAUTICAL ESTABLISHMENT. D. E. Morris. 1956. 43p. diagrs., tab. ARC CP 261. (Ask for N-48727*)

A number of calibrations, consisting of both pitot and static pressure measurements and also flow direction measurements, have been made of the flow in the working section of the 3-foot by 3-foot supersonic tunnel. In this report some selected examples are given to show the general nature of the flow distribution with the M = 1.4, 1.6, 1.8, and 2.0 nozzles and to demonstrate a number of interesting points in the measurements and in the characteristics of the flow.

N-48728*

Aeronautical Research Council (Gt. Brit.)
BOUNDARY LAYER MEASUREMENTS ON 10° AND 20° CONES AT M = 2.45 AND ZERO HEAT TRANSFER. F. V. Davies and J. R. Cooke. 1956. 62p. diagrs., photos., tabs. ARC CP 264. (Ask for N-48728*)

Transition from laminar to turbulent flow occurred between 4 and 6 inches from the tip of the 10° cone at RN between 10^{6} and 1.4×10^{6}; the layer on the 20° cone was laminar over its entire length of 6 inches, that is, up to a RN of 1.4×10^{6}. Most of the laminar boundary-layer measurements were made on the 20° cone and results agree reasonably well with the flat-plate solution of Monaghan transformed by the theoretical cone flat-plate relations of Hantzsche and Wendt, and Mangler. All the data for the turbulent boundary layer were obtained from measurements made on the 10° cone and comparison with flat-plate data indicates that the cone flat-plate relation is within $\frac{6}{\sqrt{3}}$ percent of an empirical relation analogous to the $\sqrt{3}$ laminar boundary-layer factor.

N-48729*

Aeronautical Research Council (Gt. Brit.)
CHARTS OF THE THEORETICAL WAVE DRAG OF WINGS AT ZERO-LIFT. R. A. Bishop and E. G. Cane. 1957. 35p. diagrs. ARC CP 313. (Ask for N-48729*)

Charts are presented for the theoretical wave drag at zero-lift of straight-tapered wings with streamwise tips, and with double-wedge or parabolic-arc sections. A bibliography of theoretical reports is included and their contents are reviewed.

N-48730*

Aeronautical Research Council (Gt. Brit.)
THREE-DIMENSIONAL WIND-TUNNEL TESTS OF A 30° JET FLAP MODEL. J. Williams and A. J. Alexander. 1957. 49p. diagrs., photo. ARC CP 304. (Ask for N-48730*)

As a first investigation of finite aspect-ratio effects in relation to the jet flap scheme, pressure plotting experiments were made on a small-scale model, with a 12-1/2 percent thick wing section already tested under two-dimensional conditions at the N.G.T.E. The spanwise distribution of "pressure lift" loading induced by T.E. blowing was evaluated by chordwise integration of the surface static pressures, and followed closely that which would be expected for a conventional wing at incidence (without T.E. blowing). The total lift, drag, and pitching moments were derived for values of jet momentum coefficient C_J up to 2 at wing incidences between -5° and 20°, and up to 5 at zero incidence, by summing the corresponding integrated pressure forces and jet reaction components.

N-48741*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT ON TRANSITION OF ISOLATED SURFACE EXCRESCENCES IN THE BOUNDARY LAYER. PART I. N. Gregory and W. S. Walker, National Physical Laboratory. BRIEF FLIGHT TESTS ON A VAMPIRE I AIRCRAFT TO DETERMINE THE EFFECT OF ISOLATED SURFACE PIMPLES ON TRANSITION. D. Johnson, Royal Aircraft Establishment. 1956. 23p. diagrs., photos., tabs. ARC R & M 2779. Supersedes ARC 13,436, FM 1482, Perf. 698 & RAE Tech. Memo. Aero 210. (Ask for N-48741*)

The effect of isolated surface excrescences in a laminar boundary layer in producing disturbances which may lead to turbulent flow has been examined experimentally by several methods. Photographs of some of the flow patterns visualized by smoke and china clay techniques are given. The critical heights of roughness which just give rise to spreading wedges of turbulent flow have been measured on a flat plate and on two airfoils at several angles of incidence. Results are analyzed and presented in a form which enables estimates to be made of protuberances permissible on laminar-flow surfaces at full-scale flight RN.

MISCELLANEOUS

Errata on NACA Rept. 1286, by Mickelsen and Ernstein. 1956.

N-53410*

Advisory Group for Aeronautical Research and Development. OPTICAL METHODS FOR EXAMINING THE FLOW IN HIGH-SPEED WIND TUNNELS. PART ONE - SCHLIEREN METHODS. D. W. Holder and R. J. North, National Physical Laboratory. PART TWO - INTERFEROMETER METHODS. George P. Wood, National Advisory Committee for Aeronautics. November 1956. (vii), 148p. diagrs., photos., tabs. AGARDograph 23. (Ask for N-53410*)

A review of the present state of knowledge concerning the use of schlieren, direct-shadow, and interferometer techniques for visualizing and photographing the flow in high-speed wind tunnels, including methods in an early stage of development, or useful only in a limited range. Information on light sources and photographic materials is included.

UNPUBLISHED PAPERS

N-43143*

TEMPERATURE MEASUREMENTS ON WATER-STABILIZED HIGH-POWER ARCS. (Temperaturmessungen am wasser-stabilisierten Hochleistungsbogen). F. Burhorn, H. Maecker, and T. Peters. January 1957. 19p. diagrs., photo. Translation from Zeitschrift für Physik, v. 131, 1951, p. 28-40. (Ask for N-43143*)

Spectroscopic temperature measurements on water-stabilized high-power arcs of 2.3 mm diameter, for currents of 100 to 1,500 amp, according to the method of R. W. Larenz, give temperatures up to 50,000° K. These and other measurements, together with theoretical considerations, permit us to plot the field of isotherms in the characteristic diagram for all water-stabilized high-power arcs.

N-43144*

ON THE GENERATION OF VERY HIGH TEMPERATURES IN HIGH-POWER SPARKS. (Über die Erzeugung sehr hoher Temperaturen im Hochleistungsfunken). G. Glaser. January 1957. 18p. diagrs., tab. Translation from Zeitschrift für Naturforschung, v. 6a, 1951, p. 706-713. (Ask for N-43144*)

The high-power spark is produced by a condenser discharge in a high-pressure atmosphere at high voltage and short discharge duration. Instantaneous powers of 10^8 w/cm^3 result by which the spark channel is very highly heated. The estimates of temperature according to various methods show temperatures of about 40,000° K. Describes the occurring phenomena and points out the conditions for obtaining maximum temperatures.

N-53190*

ON THE INTERFERENCE OF WING, FUSELAGE, AND TAIL SURFACES IN OBLIQUE FLOW. (Über die gegenseitige Beeinflussung von Flügel, Rumpf und Leitwerken bei Schräganblasung). H. J. Puffert. January 1957. 25p. diagrs. Translation from Zeitschrift für Flugwissenschaften, v. 3, no. 9, 1955, p. 323-331. (Ask for N-53190*)

The present report deals with the additional lift and lateral forces and the pitching and yawing moments which occur in oblique flow, caused by the interference between wing, fuselage, and tail surfaces. Simple formulas for their calculation are given. The results are compared with experimental data. The agreement between measurement and calculation is generally satisfactory.

N-53384*

PLASTIC STRAIN AND FRACTURE OF SINGLE-CRYSTALS AND POLYCRYSTALS OF METAL UNDER STATIC AND CYCLIC TORSION. (Plasticheskaia deformatsiia i razrushenie metallicheskikh poli- i monokristallov pri staticheskom i tsiklicheskom kruchenii). F. P. Rybalko. April 1957. 18p. diagr., photos. Translation from Fizika Metallov i Metallovedenie, v. 1, issue 2, 1955, p. 231-238. (Ask for N-53384*)

An investigation was made of plastic strain and fracture of cylindrical specimens, prepared of polycrystal copper, α-brass and zinc, and also single-crystals, bicrystals, and tricrystals of zinc, cadmium, and aluminum. It was established that the viscous fracture by torsion is preceded by a localization of the strain, in the shape of a zone which coincides, as to direction, with one of the principal shearing stresses; or in the shape of a system of zones parallel to it; or, finally, in the shape of two mutually perpendicular systems of zones of localized strain. The localization of the strain decreases with increase in the rate of strain and appears most perfectly under cyclic torsion. Fracture of metals, analogous to that of plexiglass occurs under the action of normal stresses.

N-53514*

LESSONS OF FIFTY YEARS OF FLOW RESEARCH. (Lehren einer fünfzigjährigen Strömungsforschung.) Albert Betz. (1957.) 18p. Translation from Zeitschrift für Flugwissenschaften, v. 5, no. 4, April 1957. (Ask for N-53514*)

Several of the most important advances of the past fifty years are discussed. These include boundary-layer theory, airfoil theory, high-speed studies, and wind-tunnel development. The author also discusses the trend in modern development and the best methods of continuing high standards of technological advancement.

UNPUBLISHED PAPERS

N-53764*

ANALYSIS OF TRANSONIC FLOW ABOUT LENTICULAR AIRFOILS AT ZERO ANGLE OF ATTACK. (Etude des Ecoulements Transsoniques autour des Pr ils Lenticulaires, a Incidence Nulle.) R. Michel, F. Marchaud, and J. Le Gallo. April 1957. 42p. diagrs. Translation of Office National d'Etudes et de Recherches Aeronautiques, Publication No. 65, 1953, 27p. (Ask for N-53764*)

A detailed experimental analysis of a steady-state transonic flow which is concerned with that essential property of a wing profile which constitutes its drag at zero angle of attack. The profile was either immersed in the throat or embedded in the wall of the tunnel. On the half model placed at the wall completely immersed in a boundary layer of a thickness much larger than its own, the pressure distribution coincided almost exactly with that found on a complete model which was exposed, at zero angle of attack, in the middle of the stream of the unseparated flow.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification June 20, 1957.

NACA RM A50F13

AN EXPERIMENTAL INVESTIGATION AT LARGE SCALE OF AN NACA SUBMERGED INTAKE AND DEFLECTOR INSTALLATION ON THE REARWARD PORTION OF A FUSELAGE. Curt A. Holzhauser. August 30, 1950. 22p. diagrs., photos. (NACA RM A50F13)

Presented are the results of an experimental investigation in the Ames 40- by 80-foot wind tunnel of an NACA submerged intake and deflector installation on the rearward portion of the fuselage of a model. The entrance ram-recovery ratio of the intake was between 0 and 0.05 lower than that obtained with a similar, but smaller, intake located farther forward on a fuselage. The external drag of the intake approached zero at the higher mass-flow ratios.

NACA RM A53F16

INVESTIGATION OF THE NACA 1.167-(0)(03)-058 AND NACA 1.167-(0)(05)-058 THREE-BLADE PROPELLERS AT FORWARD MACH NUMBERS TO 0.92 INCLUDING EFFECTS OF THRUST-AXIS INCLINATION. Fred A. Demele and William R. Otey. August 1953. 61p. diagrs., photos., tabs. (NACA RM A53F16)

This report presents the aerodynamic characteristics of NACA 1.167-(0)(03)-058 and NACA 1.167-(0)(05)-058 three-blade propellers at Mach numbers to 0.92. The data include the effects of thrust-axis inclination on the performance of both propellers, the negative-thrust characteristics of the thick-blade propeller at low forward speeds, and the static-thrust characteristics of both propellers.

NACA RM A54F18

A COMPARISON OF THE LONGITUDINAL AERODYNAMIC CHARACTERISTICS AT MACH NUMBERS UP TO 0.94 OF SWEPTBACK WINGS HAVING NACA 4-DIGIT OR NACA 64A THICKNESS DISTRIBUTIONS. Fred B. Sutton and Jerald K. Dickson. August 1954. 67p. diagrs., tab. (NACA RM A54F18)

The investigation was conducted in the Ames 12-foot pressure wind tunnel with two twisted and cambered wings, identical in all respects except section. Sweepback was varied from 40° to 50°. The corresponding aspect ratios varied from 7 to 5. Tests were made at Reynolds numbers up to 10 million at low speed and at Mach numbers from 0.25 to 0.94 at a Reynolds number of 2 million.

NACA RM A54F21

FLIGHT INVESTIGATION OF THE EFFECTS OF HORIZONTAL-TAIL HEIGHT, MOMENT OF INERTIA, AND CONTROL EFFECTIVENESS ON THE PITCH-UP CHARACTERISTICS OF A 35° SWEPT-WING FIGHTER AIRPLANE AT HIGH SUBSONIC SPEEDS. Norman M. McFadden and Donovan R. Heinle. January 1955. 24p. diagrs., photos., tab. (NACA RM A54F21)

The pitch-up and buffet characteristics of a YF-86D airplane with two horizontal-tail configurations are compared over a Mach number range of 0.70 to 0.91. Results of calculations are presented which correlate the differences in pilots' opinions of the pitch-up for the YF-86D and F-86A with the differences in control effectiveness and moment of inertia of the two airplanes.

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NACA RM A55I15

A METHOD FOR SIMULATING THE ATMOSPHERIC ENTRY OF LONG-RANGE BALLISTIC MISSILES. A. J. Eggers, Jr. December 1955. 19p. diagr. (NACA RM A55I15)

It is demonstrated with the aid of similitude arguments that a model fired from a hypervelocity gun upstream through a special supersonic nozzle should undergo motion and experience aerodynamic heating and resulting thermal stresses like those encountered by a long-range ballistic missile entering the earth's atmosphere. This combination of hypervelocity gun and supersonic nozzle is therefore termed an "Atmospheric Entry Simulator."

NACA RM E9F01

EXPERIMENTAL PERFORMANCE OF CHLORINE TRIFLUORIDE - HYDRAZINE PROPELLANT COMBINATION IN 100-POUND-THRUST ROCKET ENGINE. Paul M. Ordin and Riley O. Miller. August 15, 1949. 22p. diagrs., photos. (NACA RM E9F01)

Values of specific impulse, volume specific impulse, heat rejection, nozzle thrust coefficient, and characteristic velocity were determined over range of mixture ratios using chlorine trifluoride - hydrazine propellant combination in 100-pound-thrust rocket engine. Maximum measured values were specific impulse, 234 pound-seconds per pound and characteristic velocity 5590 feet per second. Maximum performance values corrected for heat rejection were 247 pound-seconds per pound for specific impulse, 349 x 62.4 pound-seconds per cubic foot for volume specific impulse. Maximum values occurred at approximately 33 percent fuel by weight. Average nozzle thrust coefficient was 1.34.

NACA RM E51C26

COMBUSTION PERFORMANCE EVALUATION OF MAGNESIUM-HYDROCARBON SLURRY BLENDS IN A SIMULATED TAIL-PIPE BURNER. Leonard K. Tower and J. Robert Branstetter. May 15, 1951. 53p. diagrs., photos., tabs. (NACA RM E51C26)

An experimental investigation was conducted on a 6-inch simulated tailpipe burner to determine the performance characteristics of magnesium-hydrocarbon slurries at sea-level conditions. The combustion stability of slurries with high magnesium concentration showed large improvements over the reference hydrocarbon fuel (MIL-F-5624). Compared to the reference hydrocarbon, slurries containing 30 and 60 percent magnesium produced a 15- and 51-percent increase in net tailpipe thrust, respectively, corresponding to 5 and 14 percent increase in air specific impulse.

NACA RM E51D23

STATUS OF COMBUSTION RESEARCH ON HIGH-ENERGY FUELS FOR RAM JETS. Walter T. Olson and Louis C. Gibbons. October 1951. 75p. diagrs., photos., tabs. (NACA RM E51D23)

A review has been made of the present status of research and development on high-energy fuels for ram jets. Fuels considered include aluminum, boron, boron hydrides, carbon, coal, coal and metal compositions, liquid hydrogen, and magnesium. Theoretical potentialities of the fuels are presented along with a summary of experimental combustion data from 12 investigators.

NACA RM E52A23

PREPARATION AND PHYSICAL PROPERTIES OF METAL SLURRY FUELS. James B. Gibbs and Preston N. Cook, Jr. March 1952. 36p. diagrs., photos., tabs. (NACA RM E52A23)

A preliminary investigation was conducted to determine the physical properties of slurries and the use of a metal-soap additive to prepare stable slurries of commercial magnesium, aluminum, and boron powders in a MIL-F-5624 grade JP-3 base fuel. Several of the prepared slurries have physical properties acceptable for combustion-research evaluation and limited flight use.

NACA RM E52B01

AN EXPERIMENTAL INVESTIGATION OF THE COMBUSTION PROPERTIES OF A HYDROCARBON FUEL AND SEVERAL MAGNESIUM AND BORON SLURRIES. Albert M. Lord. April 1952. 30p. diagrs. (NACA RM E52B01)

The combustion products of several magnesium and boron slurries were analyzed to explore the characteristics of metal-hydrocarbon combustion over a range of fuel-air ratios and to determine how the metal and hydrocarbon separately contribute to the overall combustion.

NACA RM E52F04

EXPERIMENTAL INVESTIGATION OF A TWO-DIMENSIONAL SPLIT-WING RAM-JET INLET AT MACH NUMBER OF 3.85. James F. Connors and Richard R. Woollett. August 1952. 28p. diagrs., photos. (NACA RM E52F04)

Performance characteristics of a two-dimensional isentropic diffuser have been experimentally determined at a Mach number of 3.85. At zero angle of

attack, a maximum total-pressure recovery of 0.41 was obtained with a supercritical mass-flow ratio of 0.95. As a consequence of the twin-duct arrangement of the diffuser, a large discontinuity in pressure recovery and mass flow with a characteristic hysteresis was encountered between critical and subcritical operation. An asymmetric shock pattern with large-scale separation and flow reversal in one of the passages occurred at reduced mass flows. Pressure and force data are presented for an angle-of-attack range from zero to 4°.

NACA RM E52F16

INFLUENCE OF A CANARD-TYPE CONTROL SURFACE ON THE INTERNAL AND EXTERNAL PERFORMANCE CHARACTERISTICS OF NACELLE-MOUNTED SUPERSONIC DIFFUSERS (CONICAL CENTERBODY) AT A REARWARD BODY STATION FOR A MACH NUMBER OF 2.0. L. J. Obery and H. S. Krasnow. August 1952. 24p. diagrs. (NACA RM E52F16)

An investigation was conducted in the Lewis 8- by 6-foot supersonic wind tunnel at a Mach number of 2.0 to determine the effects of the wake resulting from a canard control surface on diffuser performance and on the engine-body favorable interference drag. Nacelle-type engines were mounted on a body of revolution approximately 10 mean chords downstream of and in the plane of the canard surface. Severe performance reductions resulted when the inlet was alined with the canard surface tips; however, these reductions could be considerably mitigated by a rather small outboard shift of the diffusers. At the higher angles of attack, the body upwash field adversely affected the diffuser performance. The engine-body interference drag was not changed measurably by the canard-surface wake.

NACA RM E52K12

EFFECT OF PARTICLE SIZE AND STABILIZING ADDITIVES ON THE COMBUSTION PROPERTIES OF MAGNESIUM SLURRY. Albert M. Lord and Vernida E. Evans. January 1953. 28p. diagrs., photos. (NACA RM E52K12)

An experimental investigation was conducted with a 1-7/8 inch diameter burner to determine the effects of particle size and of stabilizing additives on the combustion performance of magnesium-hydrocarbon slurry fuels. The fuels tested were MIL-F-5624-A grades JP-3 and JP-4 and slurries of magnesium in JP-3 fuel. A slurry composed of 4-1/2 micron magnesium particles had a leaner mixture limit at which a flame could be maintained and a maximum blowout velocity much higher than a slurry composed of 20-micron particles. The combustion efficiency of the metal in the 4-1/2 micron slurry was consistently higher than in the 20-micron slurry in spite of its being burned at a much higher burner-inlet velocity. The slurries stabilized with petrolatum had combustion efficiencies and blowout velocities comparable with those of the gel-stabilized slurries.

NACA RM E53D30

EXPERIMENTAL INVESTIGATION OF PHYSICAL AND COMBUSTION PROPERTIES OF SEVERAL RESIDUAL FUEL OILS AND MAGNESIUM - FUEL-OIL SLURRIES IN A RAM-JET-TYPE COMBUSTOR. Preston N. Cook, Jr., Vernida E. Evans, and Erwin A. Lezberg. June 1953. 23p. diagrs., photos., tab. (NACA RM E53D30)

An experimental investigation was conducted with a 1-7/8 inch diameter burner to determine the suitability of residual fuel oils as carriers in magnesium slurries. The residual-fuel-oil slurries were compared to slurries containing MIL-F-5624A grade JP-4 fuel stabilized with petrolatum or gel with respect to combustion efficiency, blowout velocity, and stability of the magnesium-hydrocarbon suspension. Four residual fuel oils having viscosities of 5 to 415 centipoises were investigated by themselves and in slurries of 50 percent magnesium having viscosities from 22 to 8050 centipoises. The blowout velocities of the fuel-oil slurries were lower than those of the petrolatum- or gel-stabilized JP-4 slurries. Fuel-oil slurries containing 2-micron powder had much higher blowout velocities than fuel-oil slurries made with 13-micron powder. All the 13-micron-magnesium-powder slurries with fuel oil or JP-4 carriers had substantially the same metal and hydrocarbon combustion efficiencies over a range of equivalence ratios. The 2-micron-powder slurry, although burned at four times the inlet air velocity of the 13-micron-powder slurries, showed a slightly higher metal combustion efficiency. Neither the fuel oils by themselves nor the slurries made with the two lower viscosity oils required preheating for combustion using the air atomizing nozzle, while the slurries made with the two more viscous fuel oils could be burned only when preheated to a temperature approaching 212° F. Slurries made with 2-micron powder in each of the fuel oils and with 13-micron powder in the two more viscous fuel oils were sufficiently stable to be usable for at least 48 hours. Slurries made with the 13-micron powder in the two lower viscosity oils were unstable; that is, they settled out within 48 hours and needed agitation before they could be used.

NACA RM E53E27

MAGNESIUM-SLURRY COMBUSTION PERFORMANCE IN 6.5-INCH-DIAMETER RAM-JET ENGINE MOUNTED IN CONNECTED-PIPE FACILITY. J. Robert Branstetter, James B. Gibbs, and Warner B. Kaufman. August 1953. 63p. diagrs., photos., tabs. (NACA RM E53E27)

The combustion performance of slurry type fuels, consisting of 50 percent magnesium powder in a hydrocarbon carrier, has been investigated in a flight-type, 6.5-inch-diameter ram-jet engine in a connected-pipe facility. A combustor configuration, deemed suitable for short-range flight applications, has been developed that provides acceptable and reproducible combustion performance over the full range of equivalence ratio investigated, from 0.40 to 0.95.

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NACA RM E53F11

PERFORMANCE COMPARISON OF THREE CANARD-TYPE RAM-JET MISSILE CONFIGURATIONS AT MACH NUMBERS FROM 1.5 TO 2.0. Evan A. Fradenburgh and Emil J. Kremzier. August 1953. 31p. diagrs., tabs. (NACA RM E53F11)

Performance characteristics of three canard-type ram-jet missiles were investigated at Mach numbers from 1.5 to 2.0 to obtain a performance comparison. The investigation covered a range of angle of attack, control surface deflection angle, and engine mass-flow ratio. The missiles were similar except for their engine installations, two of which were twin-engine nacelle-type and the third, a fuselage scoop type. Range comparisons indicated approximately comparable ranges for the scoop type and the wing-mounted nacelle-type installations, that of the scoop type being slightly greater. The nacelle type with engines strut-mounted in a vertical plane through the fuselage center line had the shortest range.

NACA RM E53F17

METHOD FOR ESTIMATING COMBUSTION EFFICIENCY AT ALTITUDE FLIGHT CONDITIONS FROM COMBUSTOR TESTS AT LOW PRESSURES. Walter T. Olson, J. Howard Childs, and Wilfred E. Scull. August 1953. 15p. diagrs. (NACA RM E53F17)

The development and the use of a chart for use in estimating the combustion efficiency of a turbojet at altitude flight conditions are described. Use of the chart requires that the following data be available for the particular combustor and turbojet engine under consideration: (1) The combustion efficiency must be known from tests of the combustor over a range of conditions to determine the correlation curve of efficiency against the parameter $V_r/p_i t_i$ (where V_r is a combustor reference velocity and p_i and t_i are the pressure and temperature at the combustor inlet). These combustor tests need not be conducted at conditions simulating the flight conditions of interest. (2) The sea-level, static performance of the turbojet engine must be known to determine the air-flow rate, compressor pressure ratio, and turbine-inlet temperature at various engine speeds. The combustion efficiency chart is based on the assumption that the corrected gas flows, pressures, and temperatures of engine components other than the combustor are unique functions of corrected engine speed. The validity of the chart is dependent, of course, on the validity of the correlation of combustion efficiency with the parameter $V_r/p_i t_i$, and this correlation is subject to the limitations discussed in this report.

NACA RM E53J16

STUDY OF THE PHYSICAL PROPERTIES OF PETROLATUM-STABILIZED MAGNESIUM-HYDROCARBON SLURRY FUELS. Murray L. Pinns and Irving A. Goodman. January 1954. 58p. diagrs., tabs. (NACA RM E53J16)

Magnesium-hydrocarbon slurries containing a moderate proportion of petrolatum have physical properties such that they offer promise as experimental aircraft fuels. The settling of the magnesium is greatly retarded by the petrolatum, and the slurries can easily be remixed to their original condition after storage. Successive batches which have closely similar properties can be prepared readily. The apparent viscosity of these slurries increased rapidly with increasing magnesium concentration, with increasing petrolatum concentration, and with decreasing temperature. As the apparent viscosity increased, the extent of settling and the ease of remixing both decreased. Although no quantitative correlation was found between the properties of the slurry and those of the petrolatum, and no one petrolatum gave slurries which were best in all respects, one of the five petrolatums used was judged to be superior to the others.

NACA RM E53K05

STARTING CHARACTERISTICS AND COMBUSTION PERFORMANCE OF MAGNESIUM SLURRY IN 6.5-INCH-DIAMETER RAM-JET ENGINE MOUNTED IN CONNECTED-PIPE FACILITY. James B. Gibbs. January 1954. 25p. diagrs., tabs. (NACA RM E53K05)

The starting characteristics and combustion performance of slurry type fuels, consisting of 50 percent magnesium powder in a hydrocarbon carrier, have been investigated in a flight-type, 6.5-inch-diameter ram-jet engine in a connected-pipe facility. Quick, dependable starting of the engine was obtained by the use of a disk which blocked part of the combustor area downstream of the flame holder. Acceptable performance was achieved with a short fuel-air mixing length by the development of a fuel-distribution control sleeve.

NACA RM E53K23

A PRELIMINARY STUDY OF THE PREPARATION OF SLURRY FUELS FROM VAPORIZED MAGNESIUM. Walter R. Witzke, George M. Prok, and Thomas J. Walsh. February 1954. 21p. diagrs., photos., tabs. (NACA RM E53K23)

Slurry fuels containing extremely small particles of magnesium were prepared by concentrating the dilute slurry product resulting from the shock-cooling of magnesium metal vapors with a liquid hydrocarbon spray. A complete description of the equipment and procedure used in preparing the fuel is given.

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Ninety-five percent by weight of the solid particles formed by this process passed through a 100-mesh screen. The particle-size distribution of the screened fraction of one run, as determined by sedimentation analysis, indicated that 73 percent by weight of the metal particles were finer than 2 microns in equivalent spherical diameter. The purity of the solid particles ranged as high as 98.9 percent by weight of free magnesium. The screened product was concentrated by means of a bowl-type centrifuge from 0.5 to more than 50 percent by weight solids content to form an extremely viscous, clay-like mass. By the addition of a surface active agent, this viscous material was converted into a pumpable slurry fuel.

NACA RM E53L09

STUDY OF SOME DIELECTRIC PROPERTIES OF SUSPENSIONS OF MAGNESIUM PARTICLES IN MINERAL OIL. Aubrey P. Altshuller. February 1954. 42p. diagrs., photo., tabs. (NACA RM E53L09)

The variation of dielectric constant has been measured as a function of the concentration of magnesium particles; the shape, size, and degree of oxidation of the particles; the temperature; and the frequency of oscillation. The variation of dielectric constant and settling rate was investigated as a function of time. Also investigated were the effects of particle concentration, shape, and time on dielectric losses.

NACA RM E54A22

THE EFFECT OF MAGNESIUM PARTICLES OF VARIOUS EQUIVALENT DIAMETERS ON SOME PHYSICAL PROPERTIES OF PETROLATUM-STABILIZED MAGNESIUM-HYDROCARBON SLURRIES. Joseph M. Lamberti. April 1954. 48p. diagrs., photos., tabs. (NACA RM E54A22)

The effect of magnesium particles of various equivalent diameters on the apparent viscosity, sedimentation ratio, and redispersibility of petrolatum-stabilized magnesium - JP-4 slurries is described. The investigation was conducted by use of laboratory-scale apparatus. Powders of the following equivalent diameters were investigated: 2.8, 3.7, 7.2, 9.3, 12.0, and 14.8 microns. Data are also presented showing the effect of various magnesium concentrations on these physical properties.

NACA RM E54A28

BLOW-OUT VELOCITIES OF VARIOUS PETROLEUM, SLURRY, AND HYDRIDE FUELS IN A 1-7/8 INCH DIAMETER COMBUSTOR. Preston N. Cook, Jr., Albert M. Lord, and Samuel Kaye. April 1954. 20p. diagrs., tab. (NACA RM E54A28)

A 1-7/8 inch inside-diameter combustor has been developed which can be used to measure and compare the blowout velocities of single-component fuels, slurries, and fuel mixtures having a wide range of reactivity and physical properties. The blowout velocities of isooctane, n-heptane, isopentane, allyl chloride, and propylene oxide varied in the same way as the flame speeds of these fuels determined by the Bunsen flame method. The blowout velocity of 50 percent 1.5-micron magnesium slurry was much higher than that of the 50-percent 15-micron magnesium slurry. The blowout velocity of JP-4 was not increased by the addition of 50 percent boron. However, the addition of 3 percent pentaborane in JP-4 substantially increased its blowout velocity, and 40 percent pentaborane in JP-4 had a blowout velocity that approached that of 50 percent 1.5-micron magnesium slurry.

NACA RM E54C10

STABILIZATION OF 50-PERCENT MAGNESIUM - JP-4 SLURRIES WITH SOME ALUMINUM SOAPS OF C_8 ACIDS. Robert M. Caves. May 1954. 48p. diagrs., tabs. (NACA RM E54C10)

The effect of soap concentration on the gelling properties and stabilizing ability of three aluminum di-soaps of C_8 acids was investigated in small batches of slurry which consisted of 50 percent magnesium of 15-micron average particle size and MIL-5624A, grade JP-4 fuel. Each of the soaps at low concentrations (< 1 percent) was found to gel the slurry satisfactorily and reproducibly, and the best soap gave increased useful life to a slurry with increasing soap concentration. The overall useful life was greatly extended by regelling the slurry with an additional small quantity of soap. The best soap was also used satisfactorily in gelling larger (100 lb) batches of slurry. The physical properties measured were apparent viscosity at low rate of shear and, in a few cases, apparent viscosity at high rates of shear.

NACA RM E54D07

PERFORMANCE OF SLURRIES OF 50 PERCENT BORON IN JP-4 FUEL IN 5-INCH RAM-JET BURNER. Thaine W. Reynolds and Donald P. Haas. June 1954. 31p. diagrs., photos., tabs. (NACA RM E54D07)

The combustion performance of slurries of 50 percent boron in MIL-F-5624A grade JP-4 fuel was evaluated in a 5-inch connected-pipe ram-jet burner. It was necessary to use can-type flame holders to obtain an adequate piloting region for the slurry fuel. Higher heat outputs were obtained with slurry fuel than with JP-4 fuel alone but at higher fuel-air ratios. The combustion efficiency with slurry fuel dropped rapidly at leaner-than-stoichiometric fuel-air ratios, indicating low reactivity. High wall temperatures and increased burner length had little effect on heat output with boron slurry fuel; combustion smoothness was aided by high wall temperatures, however. Performance data are presented for several can-type flame holders. A maximum combustion efficiency of 89 percent for the slurry fuel was obtained at an equivalence ratio of 1.

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NACA RM E54D27

HIGH-TEMPERATURE LUBRICANTS AND BEARINGS FOR AIRCRAFT TURBINE ENGINES. NACA Subcommittee on Lubrication and Wear. APPENDIX A: HIGH-SPEED AIRCRAFT MISSIONS. C. M. Michaels, Wright Air Development Center. APPENDIX B: ENGINE DESIGN TRENDS AFFECTING LUBRICANTS AND BEARINGS. C. C. Singleterry, Bureau of Aeronautics, Department of the Navy. APPENDIX C: PROBLEMS ENCOUNTERED AT HIGH TEMPERATURES IN LUBRICATION SYSTEMS OF TURBINE ENGINES. G. P. Townsend, Westinghouse Electric Corp. APPENDIX D: TURBOPROP GEAR LUBRICATION PROBLEMS. C. J. McDowall, General Motors Corp. APPENDIX E: NOTES ON HIGH-TEMPERATURE FLUIDS AND LUBRICANTS. E. E. Klaus and M. R. Fenske, Pennsylvania State College. APPENDIX F: NACA RESEARCH ON LUBRICANTS, BEARINGS, AND LUBRICATION FOR HIGH-TEMPERATURE TURBINE ENGINES. R. L. Johnson and E. E. Bisson. APPENDIX G: HIGH-TEMPERATURE BEARING PROBLEMS. F. W. Wellons. July 1954. (i), 101p. diagrs., photos., tabs. (NACA RM E54D27)

The problems, research status, and future possibilities for high-temperature lubricants and bearings for aircraft turbine engines are discussed. Higher operating temperatures are inevitable for bearings and lubricants. Liquid lubricants may be usable at high temperatures in closed lubrication systems. At 1000° F, where liquid lubricants may not be useful, solids and gases show promise. Tool steels show promise for high-temperature bearings.

NACA RM E54F14

EXPERIMENTAL DETERMINATION OF AERODYNAMIC FORCES NORMAL TO THE CHORD DUE TO ROTATING STALL ACTING ON COMPRESSOR BLADING. Donald F. Johnson and Eleanor L. Costilow. August 1954. 27p. diagrs., photos. (NACA RM E54F14)

The blade force variation due to flow fluctuations caused by rotating stall was investigated in a single-stage axial-flow compressor of 0.9 hub-tip ratio. Blade forces were determined from calibrated wire-resistance strain gages and flow fluctuations by hot-wire anemometers. The amplitude of the stator force variation equalled the maximum stator steady-state force. The amplitude of the oscillatory force on the guide vanes was two to three times the steady-state force at the maximum flow between stall zones.

NACA RM E54F17a

NOTE ON PERFORMANCE OF AIRCRAFT EJECTOR NOZZLES AT HIGH SECONDARY FLOWS. Fred D. Kochendorfer. August 1954. 20p. diagrs. (NACA RM E54F17a)

Theoretical considerations have shown that for an ejector having a convergent shroud the maximum weight-flow ratio and ejector pressure ratio which permit operation with a choked primary nozzle can be much less than the corresponding values for a cylindrical ejector, the discrepancy increasing for larger amounts of convergence. Comparison of experimental results with those of a simple one-dimensional analysis indicated good agreement for the value of the maximum weight-flow ratio and for the slope of the discharge coefficient curve, but only fair agreement for values of ejector pressure ratio.

NACA RM E54F18a

PREPARATION AND PROPERTIES OF CONCENTRATED BORON-HYDROCARBON SLURRY FUELS. Irving A. Goodman and Virginia O. Fenn. August 1954. 35p. diagrs., photos., tabs. (NACA RM E54F18a)

Fluid slurry fuels were prepared containing 50 to 60 percent boron powder of 1-micron average particle size in JP-4 and JP-5 fuels. The boron-hydrocarbon mixtures were fluidized with glycerol sorbitan laurate and stabilized with aluminum octoate. Satisfactory stability up to 6 months was observed for some slurries. Apparent viscosities changed with time, were higher for JP-5 slurries, decreased with increasing glycerol sorbitan laurate concentrations, increased with increasing boron and aluminum octoate concentrations, and were considerably lowered in the presence of acid traces.

NACA RM E54K22a

EFFECT OF SURFACE-ACTIVE ADDITIVES ON PHYSICAL BEHAVIOR OF 50-PERCENT SLURRIES OF 1.5-MICRON MAGNESIUM IN n-DECANE. Murray L. Pinns. February 1955. 54p. diagrs., photo., tabs. (NACA RM E54K22a)

The concentration and molecular structure of the additive, the presence of moisture, and the characteristics of the magnesium powder controlled the viscosity of the slurry. Other factors were the temperature and age of the slurry. The more fluid the slurry was made by the additive, the more the magnesium tended to settle and to form a hard cake. The additives that yielded the most fluid slurries had a hydroxly group together with one or more ester, metal salt, or polyoxyethylene groups in the molecule. Additives having only one of these types of polar group per molecule gave slurries that were less fluid. Suggestions are made regarding application of the results obtained, and a mechanism is proposed to explain some of the observed phenomena.

NACA RM E54L27a

BLOW-OUT VELOCITIES OF SEVERAL SLURRY AND LIQUID FUELS IN A 1-7/8 INCH DIAMETER COMBUSTOR. James F. Morris, Robert M. Caves, and Albert M. Lord. February 1955. 12p. diagrs., tab. (NACA RM E54L27a)

Blowout velocities of four slurries and three liquid fuels were determined in a 1-7/8 inch diameter combustor. Neohexane and a slurry containing 60 percent, 18-micron magnesium in neohexane had the same blowout limits. A slurry containing 60-percent,

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18-micron magnesium in propylene oxide yielded blowout velocities substantially greater than those for propylene oxide fuel. A slurry produced by quenching vaporized magnesium with JP-4 fuel demonstrated a reactivity greater than that of any slurry previously evaluated in this combustor.

NACA RM E55B02

PERFORMANCE OF PURE FUELS IN SINGLE J33 COMBUSTORS. II - HYDROCARBON AND NON-HYDROCARBON FUELS. Arthur L. Smith and Jerrold D. Wear. April 1955. 63p. diagrs., photos., tabs. (NACA RM E55B02)

Investigations of the pure fuels - isooctane, n-pentane, isopentane, 2,2-dimethylbutane, pentene-2, methanol, propylene oxide, diethyl ether, acetone, carbon disulfide, acrolein, acrylonitrile, and butylsilane - were conducted in a J33 single combustor at several inlet-air conditions to determine a possible relation between combustor performance and fuel properties. Combustion efficiency at a constant heat-input value was correlated approximately by the parameter $u_x/L_v^{1/3}$, where u_x is the maximum burning velocity and L_v is the latent heat of vaporization. The data exhibited a slight trend toward an increase in maximum temperature rise with maximum burning velocity.

NACA RM E55B14

NACA RESEARCH ON SLURRY FUELS THROUGH 1954. Walter T. Olson and Roland Breitwieser. (Presented orally to Office of Naval Research (Pasadena) and NACA Subcommittee on Combustion in December 1954) April 1955. 30p. diagrs., photos. (NACA RM E55B14)

NACA research on slurry fuels (high-concentration suspensions of powdered metals in hydrocarbons) has included slurries of boron for greater flight range and of magnesium for greater thrust than is possible with hydrocarbons alone. Although slurries that are stable and fluid enough for research have been made, their physical properties are not yet good enough for use in aircraft. Combustion tests, mostly small-scale, show poor performance for boron, and excellent performance for magnesium.

NACA RM E55D01

PREPARATION AND HANDLING OF MAGNESIUM-HYDROCARBON SLURRIES FOR JET-ENGINE APPLICATIONS. Henry C. Barnett, A. M. Lord, and P. H. Wise. June 1955. 60p. diagrs., photos., tabs. (NACA RM E55D01)

In order to provide a summary of NACA slurry research, details of magnesium - jet-fuel slurry preparation, physical properties, storage, experimental fuel systems, disposal of solid combustion products, flammability hazards, and physiological hazards are discussed. The influence of additives and metal properties on slurry preparation and physical properties such as stability, viscosity, and density is discussed. Types of valves, pumping devices, and instrumentation are included in the discussion of experimental fuel systems for slurries.

NACA RM E55E17

PREPARATION OF 50 PERCENT BORON-HYDROCARBON SLURRIES USING COMBINATIONS OF GLYCEROL SORBITAN LAURATE WITH VARIOUS THICKENERS. Irving A. Goodman and Virginia O. Fenn. July 1955. 30p. diagrs., tab. (NACA RM E55E17)

Fluid slurries were prepared containing 50 percent boron powder of 1-micron average particle size in JP-5 fuel. Combinations of glycerol sorbitan laurate (as a fluidizing agent) with each of seven different commercial products (as thickening agents) were studied over a range of concentrations. Brookfield apparent viscosities were measured. The various additive formulations were evaluated on the basis of these viscosities as well as the settling characteristics and general physical appearance of the slurries containing these additives.

NACA RM E55E19

EFFECT OF TEMPERATURE ON VISCOSITY OF SLURRIES OF BORON AND MAGNESIUM IN JP-5 FUEL. Harold F. Hipsher. July 1955. 20p. diagrs., tabs. (NACA RM E55E19)

The viscosities for slurries containing 50 to 65 percent by weight of boron in JP-5 fuel were determined at temperatures from 30° to 80° C (86° to 176° F), and for slurries containing 50 percent magnesium in JP-5 from -40° to 80° C (-40° to 176° F). Plastic viscosities of the boron slurries as calculated from Severs Rheometer and Stormer viscometer data decreased consistently with an increase in temperature. An exponential curve of the form $\log y = aT + b$ fits the viscosity-temperature relation for the magnesium slurries from about 0° to 80° C, but does not fit the data below 0° C. The plastic viscosity and yield value of the magnesium slurries decreased with increasing temperature.

NACA RM E55F02

SOME DIELECTRIC PROPERTIES OF SUSPENSIONS OF BORON POWDERS IN MINERAL OIL. Aubrey P. Altshuller. August 1955. 21p. diagrs., tabs. (NACA RM E55F02)

The dielectric constant for suspensions of two types of boron powder in mineral oil was measured as a function of concentration of boron particles, moisture content, temperature, and frequency of oscillation. The effects of boron-powder concentration and moisture content on the dielectric loss (dissipation factor) also were investigated.

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NACA RM E55F06

APPLICATION OF STREAM-FILAMENT TECHNIQUES TO DESIGN OF DIFFUSER BETWEEN COMPRESSOR AND COMBUSTOR IN A GAS-TURBINE ENGINE. Norbert O. Stockman. August 1955. 15p. diagrs. (NACA RM E55F06)

A rapid design method based on stream-filament techniques was developed and used to obtain the boundaries of an annular combustor-inlet diffuser from a given stagnation streamline, given boundaries of the combustor liner, and given inlet and terminal velocities.

NACA RM E55F08

PERFORMANCE OF INCONEL 550 TURBINE BLADES IN A TURBOJET ENGINE AND EFFECTS OF DIFFERENT FORGING TEMPERATURES AND HEAT TREATMENTS. C. A. Gyorgak, J. R. Johnston, and J. W. Weeton. August 1955. 55p. diagrs., photos., tabs. (NACA RM E55F08)

An investigation was made to determine effects of two forging temperatures and several heat treatments on engine performance of Inconel 550 turbine blades. Best performance was associated with a forging and solution temperature of 2150° F. Reducing either the forging or solution temperature to 1950° F reduced blade life. Reducing the forging temperature to 1950° F if the solution temperature is above 2100° F appears less damaging than reducing the solution temperature to 1950° F after forging at 2150° F.

NACA RM E55H26

EFFECT OF SURFACE-ACTIVE ADDITIVES ON PHYSICAL PROPERTIES OF SLURRIES OF VAPOR-PROCESS MAGNESIUM. Murray L. Pinns. November 1955. 22p. diagrs., photos., tabs. (NACA RM E55H26)

The presence of 3 to 5 percent surface-active additive gave the lowest Brookfield apparent viscosity, plastic viscosity, and yield value that were obtained for slurry fuels containing approximately 50 percent vapor-process magnesium in JP-1 fuel. The slurries settled little and were easily remixed. A polyoxyethylene dodecyl alcohol was the most effective of 13 additives tested in reducing the Brookfield apparent viscosity and the yield value of the slurry. The seven most effective additives all had a hydroxyl group plus an ester or polyoxethylene group in the molecule. The densities of some of the slurries were measured.

NACA RM E55K04a

PERFORMANCE OF PURE FUELS IN A SINGLE J33 COMBUSTOR. III - FIVE HYDROCARBON GASEOUS FUELS AND ONE OXYGENATED-HYDROCARBON GASEOUS FUEL. Arthur L. Smith and Jerrold D. Wear. February 1956. 36p. diagrs., tabs. (NACA RM E55K04a)

The gaseous fuels propane, ethane, ethylene, acetylene, 1,3-butadiene, and ethylene oxide were investigated using a J33 single combustor at several inlet-air conditions to determine relations between combustor performance and fuel properties. Combustion efficiency at a constant heat-input value increased at the more severe operating conditions with an increase in maximum burning velocity, an increase in flammability range, and a decrease in minimum spark-ignition energy. Combustion efficiency was altered when the injection of the gaseous fuel in the primary combustion zone was varied by changing fuel-injector design.

NACA RM E55K24

EXPERIMENTAL INVESTIGATION OF TURBINE STATOR-BLADE-OUTLET BOUNDARY-LAYER CHARACTERISTICS AND A COMPARISON WITH THEORETICAL RESULTS. Warren J. Whitney, Warner L. Stewart, and James W. Miser. March 1956. 24p. diagrs. (NACA RM E55K24)

The boundary-layer momentum thickness for the blade, as well as for the two surfaces individually, was in reasonably close agreement with the theoretical values. The boundary-layer form, pressure, and energy factors could be satisfactorily approximated by a simple power-law velocity profile having an exponent of 1/7. The trend of the experimental values of boundary-layer momentum thickness as a function of blade-outlet critical-velocity ratio was similar to the theoretical curve, verifying to some extent the effect of Reynolds and Mach numbers that was assumed in theory.

NACA RM E56J19a

EFFECT OF PLASTIC VISCOSITY AND YIELD VALUE ON SPRAY CHARACTERISTICS OF MAGNESIUM-SLURRY FUEL. George M. Prok. January 1957. 23p. diagrs., photo., tabs. (NACA RM E56J19a)

Magnesium slurries were sprayed onto a sheet of paper from an air-atomizing injector. Drop sizes and distributions were then determined from photomicrographs. Four different surface-active additives were used in preparing the slurries to give plastic viscosities between 0.22 and 0.51 poise and yield values between 150 and 810 dynes-cm^2. It was found that there was no significant variation in the spray characteristics of these slurries when tested under the same conditions.

DECLASSIFIED NACA RESEARCH REPORTS

#NACA RM L7E28, by Olson, Haar, and Woodward

#NACA RM L9F22, by Goodwin

NACA RM L9K29

TANK INVESTIGATION OF THE GRUMMAN JRF-5 AIRPLANE FITTED WITH HYDRO-SKIS SUITABLE FOR OPERATION ON WATER, SNOW, AND ICE. Kenneth L. Wadlin and John A. Ramsen. June 12, 1950. 30p. diagrs., photos. (NACA RM L9K29)

Results are presented from tank tests of a 1/8-size powered dynamic model of the Grumman JRF-5 airplane fitted with tandem hydro-skis and auxiliary wing-tip skids suitable for operation on water, snow, and ice. Take-off stability and control of the airplane would be adequate for water operation with this arrangement. Water take-offs would be possible with the available thrust. Landing behavior in smooth water would be satisfactory with yaw up to 15°. Motions and accelerations during landings in rough seas would be much less than those for the airplane without skis. Accelerations in 7-foot waves would be less than those for the airplane without skis in 4-foot waves.

NACA RM L51E02

FLIGHT DETERMINATION OF DRAG AND PRESSURE RECOVERY OF A NOSE INLET OF PARABOLIC PROFILE AT MACH NUMBERS FROM 0.8 TO 1.7. Richard I. Sears and C. F. Merlet. October 1951. 22p. diagrs., photo. (NACA RM L51E02)

External-drag and total-pressure-recovery data are presented for a nose inlet of parabolic arc profile. The tests were made of rocket-propelled models in free flight at Mach numbers from 0.8 to 1.7. The Reynolds number based on the 10-inch body diameter varied from about 4×10^6 to 9×10^6.

NACA RM L51E21

TANK INVESTIGATION OF THE GRUMMAN JRF-5 AIRPLANE WITH A SINGLE HYDRO-SKI AND AN EXTENDED AFTERBODY. John A. Ramsen and George R. Gray. August 1951. 12p. diagrs., photos. (NACA RM L51E21)

Results from a tank investigation of a 1/8-size powered dynamic model of the Grumman JRF-5 airplane fitted with a single hydro-ski and an extended afterbody are presented. A comparison with results of a previous investigation with tandem hydro-skis indicates that the afterbody extension in place of the tail ski reduced the maximum resistance 10 percent. A further reduction of 3 percent was obtained by removal of the wing-tip skids. The effects on longitudinal stability were negligible.

NACA RM L52B28

FORCE CHARACTERISTICS IN THE SUBMERGED AND PLANING CONDITION OF A 1/5.78-SCALE MODEL OF A HYDRO-SKI-WHEEL COMBINATION FOR THE GRUMMAN JRF-5 AIRPLANE. Norman S. Land and Charles A. Pelz. July 1952. 28p. diagrs., tab. (NACA RM L52B28)

Force characteristics determined from tank tests of a 1/5.78-scale model of a hydro-ski-wheel combination for the Grumman JRF-5 airplane are presented. The model was tested in both the submerged and planing conditions over a range of trim, speed, and load sufficiently large to represent the most probable full-size conditions.

NACA RM L52F12

INVESTIGATION OF VANES IMMERSED IN THE JET OF A SOLID-FUEL ROCKET MOTOR. Leo V. Giladett and Andrew R. Wineman. September 1952. 30p. diagrs., photos., tab. (NACA RM L52F12)

The results of a series of static tests of a jet-vane configuration oscillated in the jet of the 6.25-inch Deacon solid-fuel rocket motor are presented. The lift, drag, hinge moment, and center of pressure were determined for deflection angles of ±12.5°. The effect of the jet vanes on the rocket-motor performance was determined, as well as the effect of the jet on both SAE 1020 steel and grade 15 carbon-graphite vane materials. The SAE 1020 steel vanes have been found satisfactory for inclusion into a jet-vane stabilization system.

NACA RM L52J23

AN INVESTIGATION OF THREE NACA 1-SERIES NOSE INLETS AT SUBSONIC AND TRANSONIC SPEEDS. Robert E. Pendley, Joseph R. Milillo, and Frank F. Fleming. January 1953. 71p. diagrs., photos., tab. (NACA RM L52J23)

Schlieren photographs and drag, surface-pressure, and pressure-recovery measurements are presented for three NACA 1-series nose inlets at zero angle of attack for a Mach number range extending from about 0.6 to 1.11. Pressure-recovery data for two of these inlets are presented at additional angles of attack of 4°, 7°, and 10°. The mass-flow-ratio range extended from about 0.2 up to the choking value. Small differences were found in the drag characteristics at subsonic speeds, but an appreciable effect of inlet proportion was indicated at supersonic speeds.

NACA RM L53F08a

A FLIGHT INVESTIGATION OF THE EFFECTS OF VARIED LATERAL DAMPING ON THE EFFECTIVENESS OF A FIGHTER AIRPLANE AS A GUN PLATFORM. Helmut A. Kuehnel, Arnold R. Beckhardt, and Robert A. Champine. August 1953. 30p. diagrs., photo., tabs. (NACA RM L53F08a)

An investigation has been made of the effects of varied lateral damping on the effectiveness of a jet-powered fighter aircraft as a gun platform. Flight

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tests were conducted at three conditions of damping and two atmospheric turbulence levels with both a fixed-reticle and a gyro-computing gunsight. A brief investigation was also made with a fixed-reticle telescopic gunsight. Results of simulated strafing runs made in this investigation indicate that the gun-line dispersion could be expected to decrease about 7 percent by increased lateral damping and to increase about 85 percent by decreased damping and about 40 percent by rough air of the type encountered. Use of the telescopic sight indicated a 20-percent decrease in gun-line dispersion.

NACA RM L53F18

FREE-FLIGHT LONGITUDINAL-STABILITY INVESTIGATION INCLUDING SOME EFFECTS OF WING ELASTICITY FROM MACH NUMBERS OF 0.85 TO 1.34 OF A TAILLESS MISSILE CONFIGURATION HAVING A 45° SWEPTBACK WING OF ASPECT RATIO 5.5. Richard G. Arbic and Warren Gillespie, Jr. August 1953. 30p. diagrs., photos., tabs. (NACA RM L53F18)

A free-flight longitudinal-stability investigation was conducted between Mach numbers 0.85 and 1.34 to obtain the aerodynamic characteristics of a long-range ground-to-ground missile having a wing of aspect ratio 5.5, 45° sweepback, and taper ratio 0.4 mounted on a body with a vertical tail but with no horizontal tail. Two models were flown, one with a wing of steel and the other with a wing of 75S-T6 aluminum alloy permitting determination of aeroelastic effects on the lift-curve slope and aerodynamic center. Flight data were analyzed to obtain longitudinal stability, zero-lift drag, and longitudinal trim data.

NACA RM L53F18a

AN EXPERIMENTAL STUDY OF FIVE ANNULAR AIR INLET CONFIGURATIONS AT SUBSONIC AND TRANSONIC SPEEDS. Robert E. Pendley, Joseph R. Milillo, Frank F. Fleming, and Carroll R. Bryan. August 1953. 86p. diagrs., tabs. (NACA RM L53F18a)

Four annular inlets consisting of an NACA 1-80-100 nose inlet containing a short, rapidly diverging diffuser and fitted alternately with an elliptical, a parabolic, a 14°-conical, and a 22°-conical central body were tested through a Mach number range of 0.6 to 1.1 and a mass-flow range of about 0.12 to the choking value. Presented are drag, surface-pressure, and pressure-recovery measurements at an angle of attack of 0° and surface-pressure and pressure-recovery measurements at angles of attack of 4°, 7°, and 10°. In addition, the drag of an NACA 1-80-300 nose inlet fitted with the elliptical central body was tested and presented at a Mach number of 1.1. Reductions in external drag, obtained by utilizing the configurations with lower pressures over the central-body surface, were accompanied by resultant losses in pressure recovery.

NACA RM L53F19

SOME MEASUREMENTS OF AERODYNAMIC FORCES AND MOMENTS AT SUBSONIC SPEEDS ON A RECTANGULAR WING OF ASPECT RATIO 2 OSCILLATING ABOUT THE MIDCHORD. Edward Widmayer, Jr., Sherman A. Clevenson, and Sumner A. Leadbetter. August 1953. 45p. diagrs., tabs. (NACA RM L53F19)

Some measurements were made of the aerodynamic forces and moments acting on a rectangular wing of aspect ratio 2 which was oscillated about the midchord. Results are presented for a range of Mach number from 0.15 to 0.81, a range of reduced frequency from 0.15 to 1.32, and a range of Reynolds number from 0.60×10^6 to 9.21×10^6. A comparison of the measured aerodynamic forces and moments is made with some available published data. Comparisons are also made between the measured data and theoretical incompressible-flow coefficients obtained from the aspect-ratio theory of Reissner, the aspect-ratio theory of Lawrence and Gerber, and the two-dimensional-flow theory. Some experimental results pertaining to the influence of wind-tunnel-wall effects on nonsteady aerodynamic measurement are included.

NACA RM L54F04

THEORETICAL INVESTIGATION BASED ON EXPERIMENTAL FREQUENCY-RESPONSE MEASUREMENTS OF AN AUTOMATIC ALTITUDE CONTROL IN COMBINATION WITH A SUPERSONIC MISSILE CONFIGURATION. Ernest C. Seaberg, Edward S. Geller, and William W. Willoughby. August 1954. 28p. diagrs., photos. (NACA RM L54F04)

An investigation has been made to determine the possibility of maintaining flight of a ground-launched missile of the boost-glide type at a constant predetermined altitude with the view toward using the results obtained as a guide to future problems encountered in altitude stabilization of long-range, high-altitude vehicles. The results show that the control system can be made to function successfully for the low-altitude application and it is indicated that it will perform satisfactorily at high altitude.

NACA RM L54F08

PRESSURE DISTRIBUTIONS ON PLUG- AND SEMAPHORE-TYPE SPOILER AILERONS ON A 35° SWEPTBACK WING OF ASPECT RATIO 4, TAPER RATIO 0.6, AND NACA 65A006 AIRFOIL SECTION AT HIGH SUBSONIC SPEEDS. Alexander D. Hammond and William C. Hayes, Jr. August 1954. 55p. diagrs., tabs. (NACA RM L54F08)

This paper presents the pressure distributions at several spanwise stations on a plug-type spoiler and at several stations on one segment of a semaphore-spoiler configuration. The spoilers were located along the 70-percent chord line of a semispan 35° sweptback wing which had an aspect ratio of 4, a taper ratio of 0.6, and NACA 65A006 airfoil sections parallel to free stream. The tests were made at angles of attack up to 20° at Mach numbers from 0.60 to 0.93 for several spoiler projections.

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NACA RM L54F22

INVESTIGATION OF THE EFFECT OF BALANCING TABS ON THE HINGE-MOMENT CHARACTERISTICS OF A TRAILING-EDGE FLAP-TYPE CONTROL ON A TRAPEZOIDAL WING AT A MACH NUMBER OF 1.61. Douglas R. Lord and Cornelius Driver. August 1954. 23p. diagrs., photo. (NACA RM L54F22)

An investigation has been made at a Mach number of 1.61 for a Reynolds number of 3.6×10^6 to determine the effect of 10-percent control-area attached tabs on the hinge-moment characteristics of a trailing-edge control on a trapezoidal wing having a 23° sweptback leading edge, aspect ratio of 3.1, and taper ratio of 0.4. Tests were made for tab deflections of approximately 0°, -10°, and -20° at angles of attack from -12° to 12° over the control-deflection range from -30° to 30°. The basic hinge-moment coefficients are presented as functions of control deflection and tab deflection. Experimental and theoretical analyses are made of the tab incremental hinge-moment coefficients due to tab deflection, control deflection, and angle of attack; analyses are also made of the ratio of tab to control deflection required for balanced control hinge moments with tabs located either inboard or outboard along the control trailing edge.

NACA RM L55F01a

ANALOG STUDY OF THE EFFECTS OF VARIOUS TYPES OF CONTROL FEEL ON THE DYNAMIC CHARACTERISTICS OF A PILOT-AIRPLANE COMBINATION. Charles W. Mathews. August 1955. 13p. diagrs. (NACA RM L55F01a)

Some sources of control feel for the longitudinal control system of an airplane are discussed as to their usefulness and limitations. In particular, feel forces obtained from pilot's control inputs (such as stick force obtained from stick centering springs) are compared with feel forces obtained from the airplane's response (such as stick forces obtained from bob weights).

NACA RM L55F06

EFFECTS OF LEADING-EDGE RADIUS ON THE LONGITUDINAL STABILITY OF TWO 45° SWEPTBACK WINGS AS INFLUENCED BY REYNOLDS NUMBERS UP TO 8.20×10^6 AND MACH NUMBERS UP TO 0.303. Gerald V. Foster and William C. Schneider. July 1955. 65p. diagrs. (NACA RM L55F06)

Force-test data showing the effects of changes in leading-edge radius, aspect ratio, Reynolds number, and Mach number are presented for an uncambered 45° sweptback wing. Data are presented for leading-edge radii of 0.89, 0.50, and 0.25 percent chord; aspect ratios of 3 and 5; Reynolds numbers up to 8.2×10^6; and Mach numbers up to 0.30.

NACA RM L55F20

HYDRODYNAMIC PRESSURE DISTRIBUTION OBTAINED WITH A STREAMLINE BODY EQUIPPED WITH CHINE STRIPS. Bernard Weinflash. September 1955. 29p. diagrs., photos., tabs. (NACA RM L55F20)

Hydrodynamic pressure distributions are given for a streamline body equipped with chine strips and moving on a water surface. Test conditions were selected to indicate maximum negative pressures as well as effects of speed, trim, wetted length, and removal of the chine strips on the general form of the hydrodynamic pressure distribution.

NACA RM L55F22

SOME DESIGN IMPLICATIONS OF THE EFFECTS OF AERODYNAMIC HEATING. Richard R. Heldenfels. July 1955. 26p. diagrs. (NACA RM L55F22)

The structural design problems created by aerodynamic heating appear to be numerous, complex, and very severe. Two of these problems, creep and thermal buckling, are examined to indicate their effect on the design of structures for high-speed aircraft; then consideration is given to the use of insulation as a means of alleviating the effects of aerodynamic heating. The results show that creep may not be a significant factor, but thermal buckling may have a substantial effect on the structural design. The use of insulation has merit under certain conditions but poses many new design problems. These results are based on limited data and may change as more information becomes available.

NACA RM L55F28

AN EXPERIMENTAL INVESTIGATION OF A FLAT RAM-JET ENGINE ON A HELICOPTER ROTOR. Robert D. Powell, Jr., and James P. Shivers. January 1956. 27p. diagrs., photo. (NACA RM L55F28)

The propulsive and aerodynamic characteristics of a flat ram-jet engine suitable for powering a helicopter rotor have been determined on the Langley helicopter test tower. The specific fuel consumption of the flat ram-jet engine with nonuniform fuel injection and radially elongated combustion chamber is not adversely affected by high centrifugal accelerations up to 500g. The flat engine has lift-drag ratios up to three times as great as those of the equivalent circular engine over the range of angle of attack covered.

NACA RM L55F29

DISTRIBUTION OF LOSSES BEHIND A COMPRESSOR ROTOR AS MEASURED BY A ROTATING RAKE. William R. Godwin. January 1956. 66p. diagrs., photo. (NACA RM L55F29)

A rotating total-pressure survey rake was employed to obtain wake measurements of a compressor rotor. The results are compared with two-dimensional cascade data of similar geometry in the

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form of wake distributions, total-pressure-loss coefficients, momentum-loss coefficients, and turning angles covering the Mach number range from 0.2 to 0.8. Also presented are total-pressure-loss contour plots covering the span of one blade for the angle-of-attack and Mach number range. The results show there was considerable radial flow of the inboard-blade boundary layer and little radial flow of the inner casing boundary layer. Under conditions of low angle of attack, the mean-section losses were less than those of the cascade; these differences could not be attributed to "three-dimensional relieving." In general, the total-pressure-loss coefficients, momentum-loss coefficients, and turning angles for the rotor were in close agreement with those of the two-dimensional cascades.

NACA RM L55H05

LOW-SPEED STUDY OF THE EFFECT OF FREQUENCY ON THE STABILITY DERIVATIVES OF WINGS OSCILLATING IN YAW WITH PARTICULAR REFERENCE TO HIGH ANGLE-OF-ATTACK CONDITIONS. John P. Campbell, Joseph L. Johnson, Jr., and Donald E. Hewes. November 1955. 93p. diagrs., photos., tab. (NACA RM L55H05)

Free-to-damp and forced-oscillation tests were made with a 60° delta wing, a 45° swept wing, and an aspect-ratio-3 unswept wing to determine the effects of frequency on the stability derivatives of wings oscillating in yaw over an angle-of-attack range from 0° to 30°. The tests were made at low Reynolds numbers and covered a range of the reduced frequency parameter $\omega b/2V$ of 0.08 to 0.30 for the free-oscillation tests and 0.01 to 0.12 for the forced-oscillation tests.

NACA RM L55L14

PRELIMINARY MEASUREMENTS OF THE AERODYNAMIC YAWING DERIVATIVES OF A TRIANGULAR, A SWEPT, AND AN UNSWEPT WING PERFORMING PURE YAWING OSCILLATIONS, WITH A DESCRIPTION OF THE INSTRUMENTATION EMPLOYED. M. J. Queijo, Herman S. Fletcher, C. G. Marple, and F. M. Hughes. April 1956. 35p. diagrs., photos. (NACA RM L55L14)

A preliminary investigation has been made to determine the effect of motion periodicity on the aerodynamic derivatives due to yawing velocity and yawing acceleration for a 60° delta wing, a 45° sweptback wing, and an unswept wing. Results were obtained from steady-state yawing tests and from tests of the models performing pure yawing oscillations at a reduced frequency of 0.23. A description of the design and function of the instrumentation used in the investigation is included in the appendix.

NACA RM L56A19

EXPERIMENTAL DETERMINATION OF THE EFFECTS OF FREQUENCY AND AMPLITUDE ON THE LATERAL STABILITY DERIVATIVES FOR A DELTA, A SWEPT, AND AN UNSWEPT WING OSCILLATING IN YAW. Lewis R. Fisher. April 1956. 67p. diagrs., photos. (NACA RM L56A19)

Three wing models were oscillated in yaw about their vertical axes to determine the effects of systematic variations of frequency and amplitude of oscillation on the in-phase and out-of-phase combination lateral stability derivatives resulting from this motion. The tests were made at a Mach number of 0.13 and Reynolds numbers of 1.6×10^6, for the 60° delta wing, and 0.71×10^6 for the 45° swept wing and the unswept wing.

NACA RM L56E31

THEORETICAL DETERMINATION OF WATER LOADS ON PITCHING HULLS AND SHOCK-MOUNTED HYDRO-SKIS. Emanuel Schnitzer. October 1956. 65p. diagrs., tab. (NACA RM L56E31)

A dynamic-camber theory was developed for determining the loads and motions of seaplanes with high length-beam ratios, shock-mounted hydro-skis and other bodies impacting or planing on a water surface while undergoing pitching rotation. Partial verification of this theory is obtained through comparisons with classical two- and three-dimensional linearized airfoil theory for steady and unsteady submerged motion and with some low-aspect-ratio oscillating airfoil data. The effects of pitching rotation on longitudinal pressure distribution are shown. Several example solutions were made which indicated that rotational effects were more important for the narrow hull than for the pivoted shock-mounted hydro-ski. Load reductions were predicted for this hydro-ski mounting over the fixed-trim rigidly mounted hydro-ski.

#NACA RM SL9D21, by Michal and Mitcham
#NACA RM SL51D27, by Stevens
#NACA RM SL52B28, by Land and Pelz
#NACA RM SL52D17, by Ramsen and Gray
#NACA RM SL53D01a, by Welsh
#NACA RM SL54D30, by King

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1267

PLASTIC DEFORMATION OF ALUMINUM SINGLE CRYSTALS AT ELEVATED TEMPERATURES. R. D. Johnson, A. P. Young, and A. D. Schwope. Battelle Memorial Institute. 1956. ii, 31p. diagrs., photos., tabs. (NACA Rept. 1267. Supersedes TN 3351)

A study was made of plastic deformation of aluminum single crystals over a wide range of temperatures. Results are presented of constant-stress creep tests, constant-load-rate tests, and constant-load creep tests. The effect of crystal orientation on the operative slip system was determined. The effect of small amounts of prestraining was studied and two high-resolution X-ray techniques were used to detect and follow the strain. Light and electron microscopy were used to study the complex nature of slip bands and kink bands on specimens deformed at elevated temperatures.

NACA Rept. 1274

SECOND-ORDER SUBSONIC AIRFOIL THEORY INCLUDING EDGE EFFECTS. Milton D. Van Dyke. 1956. ii, 23p. diagrs., tabs. (NACA Rept. 1274. Supersedes TN 3390 and portions of TN 3343)

Several recent advances are combined into a unified second-order theory for airfoil sections in subsonic flow. The method includes correction of the thin-wing approximation near stagnation points. Solutions for various profiles are compared with results of experiment and other theories. A computing scheme is given for treating any profile numerically.

NACA RM E57E02

REACTION OF FLUORINE WITH CARBON AS A MEANS OF FLUORINE DISPOSAL. Harold W. Schmidt. July 1957. 17p. diagrs., tab. (NACA RM E57E02)

Experiments have illustrated the feasibility of disposing of gaseous fluorine by reaction with charcoal. Fluorine and fluorine-oxygen and fluorine-nitrogen mixtures containing as little as 6.5 percent fluorine ignited spontaneously when impinged onto a bed of charcoal and reacted to produce chemically inert gaseous fluorocarbons. Fluorine and fluorine-oxygen mixtures were consumed at rates near 25 pounds per hour in an experimental portable reactor containing 6 cubic feet of charcoal; quantitative measurements of residual fluorine in the exhaust products ranged from 20.1 to 77.5 parts per million.

NACA TM 1409

REFLECTION AND REFRACTION OF ACOUSTIC WAVES BY A SHOCK WAVE. (Réflexion et refraction d'ondes acoustiques par une onde de choc.) J. Brillouin. July 1957. 42p. diagrs. (NACA TM 1409. Translation from Acustica, v.5, no.3, 1955, p.149-163)

This paper treats the problem of reflection and refraction of sound waves by a plane, uniform shock wave separating two regions, in both of which the fluid pressure and temperature are originally in equilibrium. Calculations are made of conditions that prevail in the two regions after the equilibrium in either one or the other region has been upset by incidence of a plane, uniform acoustic wave. Dynamic relationships show that the amplitude of reflected waves is always less than that of the incident wave, but the amplitude of refracted waves may, in certain cases, be greater than that of the incident wave.

NACA TN 3991

INTERFACE THERMAL CONDUCTANCE OF TWENTY-SEVEN RIVETED AIRCRAFT JOINTS. Martin E. Barzelay and George F. Holloway, Syracuse University. July 1957. 23p. diagrs., tabs. (NACA TN 3991)

Twenty-seven structural joint specimens of 2024-T3 and 2024-T4 aluminum alloy consisting of a T-stringer rivited to a 10- by 10-inch skin surface were tested under simulated aerodynamic heating with no external loading applied. Interface thermal conductance was determined from local transient-temperature records. The heat input (approximately 10,000 to 75,000 Btu/(sq ft)(hr)) was held constant during any given test and the duration of heating was from 15 to 50 seconds.

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CURRENT NACA RESEARCH REPORTS

NACA TN 4007

AN INVESTIGATION OF DISCHARGE AND THRUST CHARACTERISTICS OF FLAPPED OUTLETS FOR STREAM MACH NUMBERS FROM 0.40 TO 1.30. Allen R. Vick. July 1957. 47p. diagrs. (NACA TN 4007)

Discharge and force characteristics of flapped outlets, rectangular in cross section, have been determined for stream Mach numbers from 0.40 to 1.30. The basic outlet configuration was unchanged, and different flaps were attached to the outlet. Results are presented in the form of design charts for such variables as outlet discharge-flow ratio, flap angle, flap hinge-point location, and flap aspect ratio. Also presented are the variations of outlet duct pressure at a zero discharge rate for different flap angles and aspect ratios.

NACA TN 4014

RECENT RESEARCH ON THE CREEP OF AIRFRAME COMPONENTS. Eldon E. Mathauser, Avraham Berkovits, and Bland A. Stein. July 1957. 12p. diagrs. (NACA TN 4014)

The results of recent research of the National Advisory Committee for Aeronautics on the creep of airframe components at elevated temperatures are summarized. Experimental lifetime data from plates and unstiffened circular cylinders are compared with predictions obtained from isochronous stress-strain curves. An analysis defining the magnitude of creep strains that produce significant structural deformations is presented. A comparison of structural weight determined from assumed strength and creep criteria is made to establish temperature ranges in which creep is expected to influence structural design for various materials.

NACA TN 4019

SOME OBSERVATIONS ON STRESS-CORROSION CRACKING OF SINGLE CRYSTALS OF AZ61X MAGNESIUM ALLOY. F. Meller and M. Metzger, Columbia University. July 1957. 23p. diagr., photos., tabs. (NACA TN 4019)

Exploratory tests were made of the stress-corrosion cracking of single crystals of solution-treated AZ61X magnesium alloy in distilled water, in 0.5 and 1 percent hydrofluoric acid, and in a salt-chromate solution consisting of 35 grams of sodium chloride to 20 grams of potassium chromate per liter. The path chosen by the crack is attributed to mechanical rather than electrochemical factors and the possible importance of prior deformation is pointed out.

NACA TN 4026

EFFECTS OF THERMAL RELAXATION AND SPECIFIC-HEAT CHANGES ON MEASUREMENTS WITH A PNEUMATIC-PROBE PYROMETER. P. W. Kuhns. July 1957. (ii), 67p. diagrs., tabs. (NACA TN 4026)

Equations are derived which evaluate the effects of thermal vibrational relaxation and specific-heat changes on pneumatic-probe pyrometer measurements in the region 1000° to 3000° K and $0.3 < \text{Mach number} < 2.0$. Examples are given for typical probes in two combustion mixtures.

NACA TN 4028

PRELIMINARY INVESTIGATION OF PROPANE COMBUSTION IN A 3-INCH-DIAMETER DUCT AT INLET-AIR TEMPERATURES OF 1400° TO 1600° F. Erwin A. Lezberg. July 1957. 19p. diagrs., photos., tab. (NACA TN 4028)

Ignition delays and combustion efficiencies were determined for propane injected into a heated airstream. Delays of 7 to 49 milliseconds occurred over the range of temperatures investigated; these results followed the Arrhenius relation with an apparent activation energy of 43 kilocalories per mole. Flames stabilized at the fuel injector burned to high efficiencies in lengths of 6 inches or more and were insensitive to changes in air temperature, pressure, or fuel-air ratio. Flames stabilized downstream of the injector by spontaneous ignition burned only to 70- to 80-percent completion at a length of 18 inches. These efficiencies were strongly dependent on temperature and burner length.

NACA TN 4033

SCREEN-TYPE NOISE REDUCTION DEVICES FOR GROUND RUNNING OF TURBOJET ENGINES. Willard D. Coles and Warren J. North. July 1957. 23p. diagrs., photos. (NACA TN 4033)

The noise suppression characteristics of several screen-type noise suppressors for ground running of jet engines have been studied. The addition of a cylindrical muffler to the jet screen eliminated the previously obtained (NACA TN 3452) increases in the sound radiated forward of the engine. The maximum sound pressure levels at 200 ft from the engine were reduced to 104 db (a 16-db reduction), and the overall sound power level was reduced 12 db. Air-jet tests showed that negligible additional improvement could be obtained by using multiple screens. Air-jet and engine tests showed airfoil-vane jet diffusers to be less effective than screens.

CURRENT NACA RESEARCH REPORTS

NACA TN 4050

STUDIES OF STRUCTURAL FAILURE DUE TO ACOUSTIC LOADING. Robert W. Hess, Robert W. Fralich, and Harvey H. Hubbard. July 1957. 11p. diagrs., tab. (NACA TN 4050)

Some discussion of the acoustic fatigue problem of aircraft structures is given along with data pertaining to the acoustic inputs from some powerplants in common use. Comparisons are given for results of some fatigue tests of flat panels and cantilever beams exposed to both random and discrete-type inputs. In this regard it appears that both the stress level of the test and the type of model are significant; hence, no generalization can be made at this time. With regard to increasing the fatigue life, it was noted that increased stiffening of a panel due to curvature and pressure differential is particularly beneficial.

NACA TN 4055

EFFECTS OF AIRPLANE FLEXIBILITY ON WING BENDING STRAINS IN ROUGH AIR. Thomas L. Coleman, Harry Press, and C. C. Shufflebarger. July 1957. 22p. diagrs. (NACA TN 4055)

Some results on the effects of wing flexibility on wing bending strains as determined from flight tests of a Boeing B-29 and a Boeing B-47A airplane in rough air are presented. Results from an analytical study of the flexibility effects on the B-29 wing strains are compared with the experimental results. Both the experimental and calculated results are presented as frequency-response functions of the bending strains at various spanwise wing stations to gust disturbances. In addition, some indirect evidence of the effect of spanwise variations in turbulence on the responses of the B-47A airplane is presented.

NACA TN 4058

CALCULATED EFFECT OF SOME AIRPLANE HANDLING TECHNIQUES ON THE GROUND-RUN DISTANCE IN LANDING ON SLIPPERY RUNWAYS. John A. Zalovcik. July 1957. 30p. diagrs., tabs. (NACA TN 4058)

Some calculations were made on the basis of simplifying assumptions to determine the effect of maintaining a nose-high attitude angle on the ground-run distance for several types of jet airplanes landing on slippery runways. The airplanes considered were a swept-wing transport and unswept-, swept-, and delta-wing fighters. Some computations were also made to indicate the effect of instantaneous flap retraction on the ground-run distance.

NACA TN 4059

NOISE SURVEY OF A FULL-SCALE SUPERSONIC TURBINE-DRIVEN PROPELLER UNDER STATIC CONDITIONS. Max C. Kurbjun. July 1957. 20p. diagrs., photo., tab. (NACA TN 4059)

Overall sound-pressure levels and frequency spectra of the noise emitted from a 7.2-foot-diameter, 3,500-rpm, three-blade supersonic propeller mounted on a turbine-powered vehicle have been obtained under static conditions about the propeller at a 100-foot radius. The results are compared with the results of a turbine-driven airplane of conventional design. The effects of power and rotational-speed changes on the noise levels and spectra are also determined.

NACA TN 4061

FLIGHT MEASUREMENTS OF BOUNDARY-LAYER TEMPERATURE PROFILES ON A BODY OF REVOLUTION (NACA RM-10) AT MACH NUMBERS FROM 1.2 TO 3.5. Andrew G. Swanson, James J. Buglia, and Leo T. Chauvin. July 1957. 40p. diagrs., photos. (NACA TN 4061)

A parabolic body of revolution, the NACA RM-10, was flight tested at Mach numbers up to 3.5 and Reynolds numbers up to 140×10^6 (based on length to the rake and probe measuring station). Boundary-layer temperature profiles determined from total-temperature probes showed excellent agreement with profiles predicted from the theory of Crocco. Skin-friction coefficients determined by the momentum method from total-pressure-rake data were in fair agreement with the Van Driest theory for flat plates with compressible turbulent boundary layers. Heat-transfer measurements indicated a transition Reynolds number (laminar to turbulent flow) of about 15×10^6.

NACA TN 4062

EFFECT OF SWEEP ON PERFORMANCE OF COMPRESSOR BLADE SECTIONS AS INDICATED BY SWEPT-BLADE ROTOR, UNSWEPT-BLADE ROTOR, AND CASCADE TESTS. William R. Godwin. July 1957. 43p. diagrs. (NACA TN 4062)

In order to determine the induced effect of sweep on an axial-flow compressor blade, a 30° swept version of an unswept-blade rotor (described in NACA TN 3806) having NACA 65-series blade sections and a 0.69 hub-tip ratio was tested up to a Mach number of 0.45. The comparisons, at three sections, of pressure distributions for the swept and unswept blades indicated that, in order to obtain the same effective angles of attack, the swept blade required an additional twist of 3.8° for the entire radial span. Two-dimensional cascade data adequately predicted the turning angle through the swept-blade rotor if the change in axial velocity provided by the blockage of the trailing portion of the blade was taken into account.

BRITISH REPORTS

N-36628*

Aeronautical Research Council (Gt. Brit.)
MEASUREMENTS OF THE TURBULENT SURFACE-FRICTION DRAG OF A FLAT PLATE IN TWO-DIMENSIONAL FLOW. R. C. Pankhurst, E. F. Relf, and W. S. Walker. August 31, 1954. 6p. diagrs., tab. ARC 17,024; FM 2120.
(Ask for N-36628*)

The surface-friction drag of a two-dimensional flat plate with turbulent boundary layers has been measured by the wake-traverse method in the 13-foot by 9-foot wind tunnel at the N.P.L. over the range of Reynolds number from 4×10^6 to 13×10^6. The results are all close to, and are mostly intermediate between, the Schoenherr and the Prandtl-Schlichting values.

N-48652*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT ON WEATHER MINIMA OF APPROACH SPEED, COCKPIT CUT-OFF ANGLE AND TYPE OF APPROACH COUPLER FOR A GIVEN LANDING SUCCESS RATE AND LEVEL OF SAFETY. E. S. Calvert and J. W. Sparke. January 1957. 22p. diagrs. RAE Tech. Note EL. 130.
(Ask for N-48652*)

This note attempts to make a realistic assessment of the performance of various approach couplers using the results of some tests made during the past two years, both full-scale and on a landing simulator. The influence of cockpit cutoff angle, approach speed, ground lighting pattern, and runway width on the weather which can be defeated by a coupler of given accuracy is discussed. One important result of the simulator tests is that in marginal weather visual guidance in the vertical plane may be defective at heights above 100 feet. The implications of this on the cockpit and G.C.A. procedures are pointed out, and some suggestions are made for improving safety.

N-48747*

Aeronautical Research Council (Gt. Brit.)
ON A TYPE OF AIR LUBRICATED JOURNAL BEARING. G. L. Shires. 1957. 44p. diagrs. ARC CP 318. (Ask for N-48747*)

Experimental journal bearings have been constructed which will support a radial load when supplied with air at high pressure. The principles of this type of bearing are discussed, and some of the available experimental data analyzed. The results are collated in terms of a nondimensional parameter based on the theory of viscid flow between two adjacent surfaces and these means are extrapolated to give performance figures for bearings outside the range of the experiments. The estimated performance is then compared with that of conventional bearings, and conclusions are drawn regarding possible applications of this type of air lubrication.

N-48748*

Aeronautical Research Council (Gt. Brit.)
IMPACT MEASUREMENTS ON A LARGE MODEL OF A REPRESENTATIVE LANDPLANE FUSELAGE ON WATER. J. E. Allen. 1956. 69p. diagrs., photos., tabs. ARC CP 283. (Ask for N-48748*)

An experimental investigation has been made into splash-up, impact pressures, and impact forces occurring during controlled alightings on smooth water of a representative landplane fuselage of elliptical cross section. The width of the actual wetted surface of the cylinder was found to be $\sqrt{2}$ times the width which would be wetted for immersion to the same draft without splash-up. Pressure distributions are presented in the form of data for several landings over a range of initial attitudes and at flight-path angles down to 1.5°. The acceleration results are of limited usefulness due to imperfections in the apparatus. Photographs are included of the external spray formation. Results are not generally applicable to design cases for ditching until a rational theory of impact of fuselage shapes be made available.

N-48749*

Aeronautical Research Council (Gt. Brit.)
ILL-CONDITIONED FLUTTER EQUATIONS AND THEIR IMPROVEMENT FOR SIMULATOR USE. E. G. Broadbent. 1956. 22p. diagrs., tab. ARC CP 298. (Ask for N-48749*)

If simple arbitrary modes of the form η^a are used as coordinates in a wing-flutter calculation, the equations are ill conditioned and cannot be solved satisfactorily on a simulator. This ill conditioning can be avoided by transforming the flutter matrix so as to reduce the inertia couplings between like modes to zero. This transformation is described with numerical examples, and some observations are made on the general problems of choice of coordinates in a flutter calculation.

N-48750*

Aeronautical Research Council (Gt. Brit.)
SUPPORTS FOR VIBRATION ISOLATION. W. G. Molyneux. 1957. 19p. diagrs. ARC CP 322.
(Ask for N-48750*)

Spring arrangements are described that provide flexible supports of very low stiffness for a limited range of movement. They are suitable as supports for vibration isolation provided the levels of vibration are not too large. Some particular applications of the arrangements for vibration isolation and in other fields are discussed.

BRITISH REPORTS

N-48751*

Aeronautical Research Council (Gt. Brit.)
LOW SPEED WIND TUNNEL TESTS ON PERFORATED SQUARE FLAT PLATES NORMAL TO THE AIRSTREAM: DRAG AND VELOCITY FLUCTUATION MEASUREMENTS. B. G. de Bray. 1957. 13p. diagrs., tab. ARC CP 323. (Ask for N-48751*)

The effects of perforations upon the drag, and velocity fluctuations downstream, of square plates normal to the airstream are described. It is shown that perforations can have a powerful effect upon the level of velocity fluctuations, particularly the low-frequency components, with only a comparatively small reduction in drag coefficient. It is also shown that perforating the central region only of a square plate is as effective in reducing velocity fluctuations as perforating the whole plate while giving a slightly higher drag coefficient than the latter. On the other hand, perforations near the periphery only are less effective.

N-48752*

Aeronautical Research Council (Gt. Brit.)
SUBSTANTIATION OF SAFE FATIGUE LIFE FOR ROTORCRAFT. W. A. P. Fisher. 1957. 18p. ARC CP 317. (Ask for N-48752*)

This paper gives a comprehensive system of development and testing to substantiate rotorcraft for fatigue.

N-48753*

Aeronautical Research Council (Gt. Brit.)
A FLIGHT INVESTIGATION OF THE WAKE BEHIND A METEOR AIRCRAFT, WITH SOME THEORETICAL ANALYSIS. D. R. Andrews. 1956. 34p. diagrs., photos., tab. ARC CP 282. (Ask for N-48753*)

An experimental investigation of the wake behind a Meteor 4 aircraft has been carried out, and theory used wherever possible to confirm and extend the results obtained. Measurements show that for the condition covered in these tests, the jet velocity has fallen to a negligible value by about 200 to 300 ft behind the jet exit. The jet would be expected to persist longest under take-off conditions although no measurements were made of this specific case. The major disturbances behind an aircraft are due to the trailing vortices and these decay only slowly. Tests with a Vampire flying in the wake of the Meteor show that the strength of these vortices has only fallen to about half its initial value by 8000 ft behind the aircraft.

N-48754*

Aeronautical Research Council (Gt. Brit.)
TRANSIENT THERMAL STRESS IN A FLAT PLATE DUE TO NON-UNIFORM HEAT TRANSFER ACROSS ONE SURFACE. N. S. Heaps. 1956. 27p. diagrs., tab. ARC CP 299. (Ask for N-48754*)

Transient thermal stresses are determined theoretically for a long rectangular plate when subjected to a sudden change in temperature on its top surface. On this surface a heat-transfer coefficient is postulated which varies inversely as the square of the distance from one of the longitudinal edges. The solution in terms of Bessel Functions has application to the aerodynamic heating of the wings of an aircraft when suddenly accelerated to a high supersonic speed.

N-48755*

Aeronautical Research Council (Gt. Brit.)
FATIGUE LOADINGS IN FLIGHT LOADS IN THE FUSELAGE AND NOSE UNDERCARRIAGE OF A VARSITY. E. W. Wells. 1956. 19p. diagrs., tabs. ARC CP 287 (Ask for N-48755*)

Flight tests have been made on a Varsity to obtain data on the fatigue loads in the fuselage and the nose undercarriage. The data are tabulated in terms of the number of load ranges of a given magnitude occurring during various ground and flight conditions. An estimate is made of the loads in a typical operational training flight to show the relative importance of the various conditions. A relationship is established between the fuselage loads and the accelerations at the aircraft c.g. when flying in turbulence; this enables the results from the flight tests to be linked to operational data obtained on gusts.

N-48756*

Aeronautical Research Council (Gt. Brit.)
FLUTTER CALCULATIONS ON A RUDDER WITH TRAILING-EDGE SPOILER. Ll. T. Niblett. 1956. 13p. diagrs. ARC CP 277. (Ask for N-48756*)

Flutter calculations made on a rudder with trailing-edge spoilers are described. The results obtained agree with the flight experience which has been acquired so far (except for the frequency of the flutter) in spite of the simplicity of the aerodynamic assumptions. It has been found that, as with tab flutter, a form of flutter involving the main surface (fin) occurs with an overmassbalanced spoiler.

BRITISH REPORTS

N-48757*

Aeronautical Research Council (Gt. Brit.)
FIN-AND-RUDDER LOADS IN A YAWING MANOEUVRE: EFFECT OF DIRECT AND POWER ASSISTED RUDDER MOVEMENT. D. R. Puttock. 1956. 51p. diagrs., tab., charts. ARC CP 301. (Ask for N-48757*)

The severity of a yawing maneuver specified for design purposes is investigated. The maneuver does not always represent the most critical case, higher fin-and-rudder loadings being obtainable when the specified frequency of rudder movement is changed. The inclusion of a power unit in the circuit may impose restrictions on the rudder movement, leading to a reduction in the severity of the loading. Analytical treatment includes the derivation of exact expressions for the angle of sideslip, fin-and-rudder load, and rudder hinge moment induced by a sinusoidal rudder movement of arbitrary frequency. These expressions are analyzed to determine how the maxima of each of the quantities are affected by variations in the frequency of the rudder movement. Computational charts are included. The problems are illustrated with a numerical example.

N-48758*

Aeronautical Research Council (Gt. Brit.)
COMPRESSOR CASCADE FLUTTER TESTS. PART II. 40° CAMBER BLADES, LOW AND MEDIUM STAGGER CASCADES. D. A. Kilpatrick and J. Ritchie. 1956. 19p. diagrs., photos. ARC CP 296. (Ask for N-48758*)

The tests reported here continue the cascade flutter investigation at N.G.T.E., the first part of which, already reported, deals with 20° camber blades, medium, and high stagger cascades. In agreement with those test results, three main flutter zones of high stress are detected, namely, stalling flutter, shock-stalling flutter, and choking flutter. Their disposition, with reference to the aerodynamic cascade characteristics, is also in general agreement. Good correlation of stalling flutter with the experimentally determined blade-force derivative with respect to incidence, is obtained, but only incomplete correlation of shock-stalling and choking flutter with the blade-force derivative with respect to Mach number.

N-48759*

Aeronautical Research Council (Gt. Brit.)
TESTS ON ROUGH SURFACED COMPRESSOR BLADING. R. C. Turner and Hazel P. Hughes. 1956. 37p. diagrs., photos. ARC CP 306. (Ask for N-48759*)

Six stages of medium stagger-free vortex blading, with rough surface finish, were tested in the N.G.T.E. 106 compressor. Overall characteristics were determined at various speeds and compared with those of similar blading with the conventional smooth finish. It was established that appreciable losses in temperature-rise coefficient and efficiency were exhibited, and hoped-for gains in performance at low Reynolds numbers were not realized. There was no change in the general shape of the characteristics at any speed. The condition of the boundary layer on a blade of the fifth-stage stator row was investigated by means of pitot traverse and sensitive film techniques. No appreciable difference was found in this respect between the two sets of blades.

N-48760*

Aeronautical Research Council (Gt. Brit.)
NOTATION FOR ROTORCRAFT WORK.
A. Armitage, compiler. 1957. 30p. diagrs., tabs. ARC CP 314. (Ask for N-48760*)

A suggested standard notation for rotorcraft work is presented. The notation is the outcome of study of numerous papers of many sources of origin.

N-48761*

Aeronautical Research Council (Gt. Brit.)
LOW SPEED STATIC AND FLUCTUATING PRESSURE DISTRIBUTIONS ON A CYLINDRICAL BODY WITH A SQUARE FLAT PLATE AIRBRAKE. T. B. Owen. 1956. 18p. diagrs., tab. ARC CP 288. (Ask for N-48761*)

There is a very rapid increase both in the root-mean-square amplitude of the pressure fluctuations and in the area of the body affected, if the brake angle is increased beyond 50°. At the lower frequencies there is a large increase in amplitude between 40° and 50° which is associated with the appearance of a regular shedding of turbulent eddies. On the model used, with an average gap of about 27 percent of the length of the side of the brake, the shedding frequencies are in close agreement with those measured on an isolated plate at the smaller brake angles and slightly higher than on an isolated plate at the higher brake angles. The fluctuating pressures due to the brake are little affected by the distance of the brake from the tail of the body.

N-48762*

Aeronautical Research Council (Gt. Brit.)
FATIGUE LOADINGS IN FLIGHT: LOADS IN THE WING OF A VARSITY. Anne Burns. 1956. 23p. diagrs., tabs. ARC CP 285. (Ask for N-48762*)

Data are presented on the number of load cycles of various magnitudes occurring in the wing of a Varsity in normal ground and flight conditions. The conditions include taxiing, take-off, landing, and flight in turbulence. The relative importance of the loads in the different conditions is illustrated by reference to the loads in a typical flight. A relationship is determined between wing loads and accelerations in turbulence so that the test results can, if required, be related to gust data obtained operationally by means of the counting accelerometer.

BRITISH REPORTS

N-48763*

Aeronautical Research Council (Gt. Brit.)
TOWING TANK TESTS TO DETERMINE THE WATER DRAG OF THE HULL OF A JET PROPELLED FLYING BOAT FIGHTER (SPEC. E.6/44) AND COMPARISON WITH FULL SCALE MEASUREMENTS. R. V. Gigg, A. G. Kurn, and J. K. Friswell. 1956. 59p. diagrs., tab. ARC CP 284.
(Ask for N-48763*)

The water drag, draft, wetted areas, and mean wetted lengths of a one-ninth scale E.6/44 flying boat model hull have been measured for all anticipated take-off loads and attitudes over the take-off run. A method of scaling up model drag, to make allowances for the differences in skin friction, model, and full scale has been used and the results compared with actual full-scale tests. There is not satisfactory agreement between estimated and measured full-scale results, and the tests do not provide sufficient evidence to determine whether the accurate estimation of full-scale water resistance by the methods used is possible.

N-48764*

Aeronautical Research Council (Gt. Brit.)
A GRAPHICAL METHOD OF PREDICTING THE OFF DESIGN PERFORMANCE OF A COMPRESSOR STAGE. J. F. Louis and J. H. Horlock. 1957. 21p. diagrs. ARC CP 320. (Ask for N-48764*)

It has been seen in a previous paper that analytical solutions of compressor stage performance based on actuator disk theory are extremely difficult, and reliable only when the outlet angle distributions from the blade rows are the same at all flow rates. No analytical method is able to describe the flow when the stall is reached. In order to overcome these difficulties a graphical method is developed for predicting stage off-design performance even when the stall occurs. The method is first used to predict the performance of a stage of "constant α_3" design, and experiments confirm the prediction. Next, the method is used as a basis for comparison of different designs of a free-vortex stage.

N-48765*

Aeronautical Research Council (Gt. Brit.)
EXPERIMENTS ON THE GROWTH OF VORTICES IN TURBULENT FLOW. I. M. Titchener and A. J. Taylor-Russell. 1957. 17p. diagrs., photos., tab. ARC CP 316. (Ask for N-48765*)

Measurements of the flow in turbulent line vortices along the center of a pipe have been made to determine the growth of trailing vortices in the wake of an airplane. It is found that the rate of growth is small and of the same order as for a laminar line vortex.

N-48766*

Aeronautical Research Council (Gt. Brit.)
PROBLEMS IN COMPUTATION OF AERODYNAMIC LOADING ON OSCILLATING LIFTING SURFACES. H. C. Garner and A. E. A. Acum. 1957. 15p. ARC CP 309. (Ask for N-48766*)

The linearized theories of oscillating wings in subsonic and supersonic flow are formally discussed. The computability of the subsonic problem is considered when Mach number, frequency, and aspect ratio are arbitrary and also when any one of these parameters takes extreme values. Methods of treating aerodynamic flutter problems are briefly outlined. The most general subsonic problem for a rectangular wing, already solved numerically on a desk machine, should now be examined with a view to mechanized computation. Special theories, particularly suited to high-speed computation, should, if possible, be extended to arbitrary frequency and Mach number.

N-48767*

Aeronautical Research Council (Gt. Brit.)
ACTUATOR DISC THEORIES APPLIED TO THE DESIGN OF AXIAL COMPRESSORS. A. C. Carmichael and J. H. Horlock. 1957. 18p. diagrs., tab. ARC CP 315. (Ask for N-48767*)

A relatively simple method is given for finding the flow conditions in the proximity of blade rows when the variation in whirl or tangential velocity is known. The radial variations in axial velocity that would be attained in radial equilibrium are first estimated using the radial equilibrium equations and then modified to allow for the interference effect of the adjacent blade rows on the axial velocity distribution between the blade rows. The second part of the paper gives some solutions to the radial equilibrium equations for a useful general variation in whirl velocity. This variation gives constant radial work rotors and includes the free vortex and constant reaction designs as particular solutions. The combination of these results gives a design method which should be useful in the design of axial compressors.

N-48768*

Aeronautical Research Council (Gt. Brit.)
SAUNDERS-ROE PRINCESS FLYING BOAT G-ALUN AIR AND WATER PERFORMANCE TESTS. 1956. 38p. diagrs., photo., tabs. ARC CP 279.
(Ask for N-48768*)

The performance test program was planned to obtain the maximum amount of information of the aerodynamic and hydrodynamic characteristics to provide a basis for future development. The Proteus 600-series engines were installed as an interim measure in order to enable flight trials to be carried out on the airframe. Tests included A.S.I. and air thermometer calibration, engine performance calibration, and air and water performance of the aircraft. Water performance was measured in terms of longitudinal accelerations. The basic drag and lifting efficiency values of the Princess, when compared with previous British flying boats, were found to be considerably better.

BRITISH REPORTS

N-48769*

Aeronautical Research Council (Gt. Brit.)
BOUNDARY LAYER SEPARATION IN TWO-DIMENSIONAL SUPERSONIC FLOW. G. E. Gadd and D. W. Holder. 1956. 16p. diagrs. ARC CP 270. (Ask for N-48769*)

Whenever boundary-layer separation occurs in two-dimensional supersonic flow there is a fairly sharp increase of pressure before separation. It is found that the ratio of the pressure at the separation point S to the pressure at the position 0 just upstream of the sharp pressure rise, usually depends primarily on the external-flow Mach number and state of the boundary layer at 0, and is not greatly affected by the nature of the particular agency provoking separation. This is in marked contrast to the state of affairs in subsonic flow, and in fact in this respect conditions in supersonic flow are much simpler than those at low speeds.

N-48770*

Aeronautical Research Council (Gt. Brit.)
SOME ASPECTS OF COMPRESSOR STAGE DESIGN. J. F. Louis and J. H. Horlock. 1957. 18p. diagrs. ARC CP 319. (Ask for N-48770*)

The first section deals with the direct problem of the performance of given compressor stages and indicates how the blade sections of various designs approach the stall point. In the second part, a method is presented which combines the solutions of the indirect and direct problems. This method enables a designer to determine stages which will satisfy the imposed design conditions and to predict their off-design performance up to the stalling point. These stages differ in the distribution of pressure rise between rotor and stator. This choice of reaction is investigated in the off-design performance and may enable the designer to choose the optimum blading. In both sections actuator disk theory is used in the derivation of the equations of the flow.

N-48771*

Aeronautical Research Council (Gt. Brit.)
SOME NOTES ON THE FLOW DURATIONS OCCURRING IN HYPERSONIC SHOCK TUBES. B. D. Henshall. 1956. 15p. diagrs., tab. ARC CP 290. (Ask for N-48771*)

The present paper gives a resume of the aerodynamic principles involved in the production of very strong shock waves and very high Mach numbers flows; subsequently we consider the effects of the deviations from perfect gas theory which occur when strong shock waves are generated. Finally, some calculations of the flow durations occurring in hypersonic shock tubes are presented in tabular and graphical form. It is found that the influence of the gaseous imperfections is such that the flow durations are reduced; this reduction is of the order of 50 percent for very strong shock conditions.

N-48772*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE EFFECT OF SIZE AND POSITION OF END PLATES ON THE LIFT OF A RECTANGULAR WING IN A WIND TUNNEL. A. S. Halliday and D. K. Cox. 1956. 16p. diagrs., tab. ARC CP 305. (Ask for N-48772*)

Experiments have been made in a wind tunnel to determine the minimum size of end plate which would be effective in producing approximately two-dimensional flow conditions past an airfoil at low incidence. It is concluded that the lift distribution at the center section is obtained within 10 percent if (1) the end plates are at least $\frac{4}{3}c$ in chordwise extent, and (2) the height of the end plates is at least 2c above and below the center line. The variation of effective aspect ratio with size of plate is considered. Theoretical and rough experimental aspect-ratio factors are comfirmatory.

N-48773*

Aeronautical Research Council (Gt. Brit.)
REPORT OF THE PRESSURE PANEL ON THE DEFINITIONS OF QUANTITIES HAVING THE DIMENSIONS OF PRESSURE. 1956. 4p. ARC CP 281 (Ask for N-48773*)

Recommendations were made by the Pressure Panel for definitions of quantities having the dimensions of pressure which are related to flow of a continuous fluid. The following terms are defined: static pressure, total pressure, stagnation pressure, dynamic pressure, indicated pressure, kinetic pressure, pitot pressure, momentum pressure, and reaction pressure.

N-48774*

Aeronautical Research Council (Gt. Brit.)
A NOTE ON DERIVATIVE APPARATUS FOR THE N.P.L. 9-1/2 INCH HIGH SPEED TUNNEL. J. B. Bratt. 1956. 10p. diagrs. ARC CP 269. (Ask for N-48774*)

A brief description is given of new equipment for measuring derivatives on finite aspect-ratio models with trailing-edge flaps in the N.P.L. 9-1/2 inch high-speed tunnel. Some account is also given of considerations leading to the choice of method.

N-48775*

Aeronautical Research Council (Gt. Brit.)
AN EXPERIMENTAL INVESTIGATION OF MEKSYN'S TRANSONIC INVISCID FLOW THEORY. C. S. Sinnott. 1956. 14p. diagrs., tab. ARC CP 302. (Ask for N-48775*)

The solution of the two-dimensional transonic flow equations obtained by Meksyn (Proc. Royal Society, A, Vol. 220, pp. 239-254, 1953) is critically examined for the flow past a bicusped airfoil at zero lift. Comparisons with experimental results are made and it is clear from these that the method does not give useful results for mixed subsonic/supersonic flows.

BRITISH REPORTS

N-48776*

Aeronautical Research Council (Gt. Brit.)
ON THE STABILITY OF A LAMINAR WAKE. C. H. McKoen. (Abridged version of author's thesis at the Univ. of London). 1956. 20p. diagr., tab. ARC CP 303. (Ask for N-48776*)

A perturbation method of solving the problem of stability in an unlimited field of flow is developed and used to investigate the stability of the laminar wake formed by a flat plate. The inviscid problem of the wake formed by a flat plate is investigated, and the eigen-value of α for the neutral disturbance is found to be $\alpha_s = 4.0$. A detailed account is given of the perturbation method which is developed. The necessary and sufficient condition that an integral of the small disturbance equation should satisfy the boundary conditions for the wake is established. This condition is found to lead to a simple determination of the (α, R) curve, and this curve is found for the neutral disturbances. The method fails to predict a minimum critical Reynolds number, only because the approximations made in the above conditions are only valid for large Reynolds numbers.

N-48777*

Aeronautical Research Council (Gt. Brit.)
MEASUREMENT OF LIFT, PITCHING MOMENT, AND HINGE MOMENT ON A TWO-DIMENSIONAL CUSPED RAE 102 AEROFOIL. A. S. Batson. 1956. 16p. diagrs., tabs. ARC CP 272. (Ask for N-48777*)

The airfoil, designated RAE 102C, has the rear 39 percent modified to give a cusped trailing edge, and was fitted with 20 percent and 40 percent plain round-nosed control surfaces. Lift, pitching moment, and hinge moment were determined from balance measurements. Usual care was taken in observing or fixing with wires the positions of boundary-layer transition. In general, the derivatives vary only a little with position of transition and the lift and pitching moment are in satisfactory agreement with charts of R & M 2730. Some revision of the charts for hinge moment seems desirable.

N-48778*

Aeronautical Research Council (Gt. Brit.)
SOME EXPERIMENTS ON AN EFFUSION COOLED TURBINE NOZZLE BLADE. S. J. Andrews, H. Ogden, and J. Marshall. 1956. 36p. diagrs., photos. ARC CP 267. (Ask for N-48778*)

An investigation of the chordwise effusion flow required to maintain a turbine nozzle blade at a uniform temperature and the temperature distribution produced on the blade by uniform chordwise effusion has been made over a wide range of Reynolds number, temperature, and Mach number. These experimental results are compared with theoretical predictions based on the most reasonable possible assumption in the light of past experience.

N-48779*

Aeronautical Research Council (Gt. Brit.)
WATER TUNNEL BOUNDARY EFFECTS ON AXIALLY SYMMETRIC FULLY DEVELOPED CAVITIES. I. J. Campbell and G. E. Thomas. 1956. 25p. diagrs., tabs. ARC CP 278. (Ask for N-48779*)

The limitation on cavitation number attainable when axially symmetric cavities are formed in a fixed wall tunnel (Simmons' blockage effect) and related effects are discussed in some detail. Estimates of the way in which the dimensions of cavities formed behind a circular disk depend on the cavitation number and on the ratio of model diameter to tunnel diameter are provided.

N-48780*

Aeronautical Research Council (Gt. Brit.)
THE DIRECTION OF FLOW IN THE LAMINAR BOUNDARY LAYER ON AN INFINITE YAWED CYLINDER. K. D. P. Sinha. 1956. 56p. diagrs., tabs. ARC CP 295. (Ask for N-48780*)

In a previous report the exact solutions of the spanwise laminar boundary layer on an infinite yawed cylinder with distributed suction, were given for all the known exact solutions of the chordwise boundary layer for the chordwise velocity distribution. In this paper the same class of exact solutions has been used to investigate the direction of the velocity vector, and hence the curvature of the streamlines and the secondary flow. In the analysis the curvature of the edge streamline has been taken into account. The investigation includes both positive and negative pressure gradients and a wide range of distributed suctions. Secondary flow instability has been considered in terms of the RN of the secondary flow (Owen's criterion) and curves of the ratio of the secondary flow RN to the primary flow RN are presented for various inclinations of the edge streamline to the chordwise direction.

N-48781*

Aeronautical Research Council (Gt. Brit.)
SAUNDERS-ROE PRINCESS FLYING BOAT G-ALUN ENGINEERING APPRAISAL. 1956. 36p. diagrs., tab. ARC CP 280. (Ask for N-48781*)

The total flying time of the aircraft was 96 hours 50 minutes, and therefore only a limited engineering appraisal is possible. Assessments are, however, given of most of the main installations provided, as well as of ease of launching, beaching, and maintenance. Full reports on each of the main installations have been prepared by Saunders-Roe. The various aircraft systems and services are briefly described and assessed where possible, and items requiring further development and investigation are discussed. The general conclusions are that the launching and beaching facilities are satisfactory and that few difficulties are likely to be encountered with any of the installations. A number of detailed recommendations are made.

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N-48782*

Aeronautical Research Council (Gt. Brit.)
INSTRUMENTATION USED IN MEASUREMENT OF THE THREE DIMENSIONAL FLOW IN AN AXIAL FLOW COMPRESSOR. J. H. Horlock. 1957. 12p. diagrs., photos. ARC CP 321. (Ask for N-48782*)

Measurements of total pressure, static pressure, and yaw angle between the blade rows of an axial-flow compressor have been made with a variety of previously calibrated instruments and the results of these investigations are compared. Good agreement between the instruments is obtained except in the boundary layers near the walls of the compressor.

N-48783*

Royal Aircraft Establishment (Gt. Brit.)
CONTROL SYSTEM FOR TARGET AIRCRAFT CAMERAS. G. L. Davies. November 1956. 21p. diagrs., photos. RAE Tech. Note TD 10.
(Ask for N-48783*)

Cameras in unmanned target aircraft are operated by signals sent through the radio system which controls the aircraft. Switching, timing, and synchronizing information is required by the cameras and to provide this in an acceptable form special camera control equipment is necessary in the aircraft. This equipment is described in detail and there is a more general description, from the camera-control aspect, of the whole system.

N-48785*

Aeronautical Inspection Directorate (Gt. Brit.)
THE PRECISION MEASUREMENT OF THE STRAIGHTNESS AND DIAMETER OF A LONG BORE. E. W. Carter and S. A. Root. November 1956. 10p. diagrs., tabs. AID Metro/6.
(Ask for N-48785*)

A method has been devised for the measurement of the straightness of long bores. The diameters at intermediate positions throughout the lengths of the bores can be derived by combining the results of the straightness tests with diametral measurements obtained near the ends. The method has been used for testing a honed bore 20 in. long and 1.320-in. diameter and the apparatus designed for the test is described together with the test procedure and results.

N-48791*

Royal Aircraft Establishment (Gt. Brit.)
A TRANSISTOR SEQUENTIAL SWITCH. E. S. Mallett and H. W. P. Knapp. November 1956. 12p. diagrs., tab. RAE Tech. Note TD 12.
(Ask for N-48791*)

A 27-position switch using junction transistors is described. The cycling speed is 200 per second and the switch has an amplitude accuracy of one-half percent up to a maximum ambient temperature of 40° C.

N-48792*

Royal Aircraft Establishment (Gt. Brit.)
THE INFLUENCE OF RANGE, SPEED AND LIFT-DRAG RATIO ON THE OPERATING COSTS OF A CIVIL AIRCRAFT. R. G. Thorne. November 1956. 9p. diagrs. RAE Tech. Note Aero 2487.
(Ask for N-48792*)

A simplified approach to the estimation of direct operating costs of jet-propelled civil aircraft has been developed. This permits the presentation of the influence of range, speed, specific fuel consumption, lift-drag ratio, and basic operational weight ratio on such costs in a graphical form. The lift-drag ratio required at a given speed or Mach number to achieve a given operating cost over a given gross still air range can be determined.

N-48793*

Royal Aircraft Establishment (Gt. Brit.)
A PUSH-PULL DIFFERENTIAL ANALYSER. G. C. Tootill and K. Millington. December 1956. 13p. diagrs., photo. RAE Tech. Note MS 33.
(Ask for N-48793*)

This note describes a small electronic analog computer for solving linear differential equations. Push-pull circuits are used throughout to reduce errors due to drift. Cordless plugs are used to simplify setting up so that the operator may readily check his setting, and his mistakes should be few.

N-48800*

Ministry of Supply (Gt. Brit.)
LARGE SCALE FATIGUE TESTS ON COMPLETE SECTIONS OF ALUMINUM AND MAGNESIUM ALLOYS. (1957). 28p. diagrs., photos., tabs. MOS S & T Memo. 2/57. (Ask for N-48800*)

It has been shown by tests on three aluminum alloys and one magnesium-base alloy that conventional methods of fatigue testing using small machined and polished cylindrical specimens or coupons can give results which in no way indicate the fatigue strength of the unmachined sections from which the specimens were cut. The testing techniques employed, that is, rotating cantilever and reversed bending, do not in themselves appear to have contributed markedly to the observed differences in fatigue strength, but there is evidence to support the view that a rectangular-shaped section gives a slightly lower fatigue strength than a round specimen.

N-48801*

Royal Aircraft Establishment (Gt. Brit.)
THE TROPICAL DURABILITY OF WOOD ASSEMBLY ADHESIVES (FINAL NOTE). A. Baker. January 1957. 24p. diagrs., photos., tabs. RAE Tech. Note Chem. 1294. (Ask for N-48801*)

In a five-year tropical trial of six proprietary wood assembly adhesives by the "boxed test-piece" technique, joints made from one of two urea resins showed significant loss of strength, but the other urea adhesive showed good resistance to deterioration in both close-contact and gap joints. Two

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phenolic and two resorcinol resins were also substantially unaffected by the tropical exposure, except that one of the phenolic resins showed poor retention of the gap-filling property; with this exception, all the materials behaved satisfactorily in the temperate indoor storage of joints over the same period.

N-48802*

Royal Aircraft Establishment (Gt. Brit.)
PREDICTION OF TRANSITION IN THE BOUNDARY LAYER ON AN AEROFOIL. L. F. Crabtree. January 1957. 10p. diagrs. RAE Tech. Note Aero 2491. (Ask for N-48802*)

Transition to turbulence in the boundary layer on an airfoil may occur in several different ways, not the least important of which is by bubble separation of the laminar layer. Thus, in establishing an empirical criterion for the limit of existence of a laminar boundary layer the necessary parameters must be able to describe separation and instability, as well as being physically reasonable and simple to calculate and use. It is shown that only two parameters are necessary to fulfill these conditions, and that a universal curve may be constructed of boundary-layer Reynolds number R_{δ_2} against pressure gradient parameter m at transition. This curve may be used to predict transition, and an assessment of its accuracy in comparison with previous methods is given. Theoretically, the method can be extended to the limited case of bodies of revolution at zero incidence.

N-48805*

Royal Aircraft Establishment (Gt. Brit.)
A SYSTEM FOR THE BINARY PRESENTATION OF ELAPSED TIME. E. S. Mallett and Frederick C. Court. January 1957. 13p. diagrs., photos. RAE Tech. Note TD 13. (Ask for N-48805*)

This apparatus has been developed in order to produce a coded timing record along the edge of a cine film. The binary code has been adopted, the numbers being represented by single and double marks. The time at which any pulse occurs relative to a zero firing pulse can be determined without the necessity of counting timing marks along the edge of the film.

N-48806*

Royal Aircraft Establishment (Gt. Brit.)
THE CORROSION OF AIRCRAFT METALS BY ROT-PROOFED TEXTILES. T. R. F. W. Fennell and G. P. Garland. December 1956. 9p. tabs. RAE Tech. Note Chem. 1292. (Ask for N-48806*)

Tests have been carried out to assess the relative corrosive effects on aircraft metals of textiles impregnated with various rot-proofing agents. General conclusions are drawn from the results obtained.

N-48807*

Royal Aircraft Establishment (Gt. Brit.)
SOME LIMITING OXYGEN CONCENTRATIONS FOR DIFFUSION FLAMES IN AIR DILUTED WITH NITROGEN. R. F. Simmons and H. G. Wolfhard. February 1957. 12p. diagrs., tabs. RAE Tech. Note RPD 151. (Ask for N-48807*)

Fuels have been burned at the surface of a porous hemispherical burner of stainless steel, and the nitrogen concentration required to extinguish the flame has been determined. Results are given for a number of fuels in terms of the limiting oxygen index $\left[O_2/(O_2 + N_2)\right]$, and it has been found that these values are close to those obtained for premixed flames. Flame temperatures for these limit mixtures have been calculated, and it is suggested that a given mixture will only burn if its flame temperature exceeds the limiting flame temperature for that fuel.

N-48808*

Royal Aircraft Establishment (Gt. Brit.)
A "WHIRLING ARM" TEST RIG FOR THE ASSESSMENT OF THE RAIN EROSION OF MATERIALS. A. A. Fyall and R. N. C. Strain. December 1956. 33p. diagrs., photos., tabs. RAE Chem. 509. (Ask for N-48808*)

This report deals with the development of the R.A.E. "whirling arm" test rig for assessing the rain erosion characteristics of materials in the speed range 250-500 mph. Details are given of the arm and of the test pieces. Natural rainfall and its simulation is discussed with special reference to the best drop size parameter. A detailed survey is made of a "spinning disk" technique of producing artificial rainfall under controlled conditions of drop size, concentration, and coverage of the test area. Results obtained on a range of typical aircraft materials, including examples from structural, radar, and vision applications are portrayed photographically. Future trends in simulated rain erosion test methods are indicated and discussed.

N-48809*

Royal Aircraft Establishment (Gt. Brit.)
ATMOSPHERIC TURBULENCE ENCOUNTERED BY HERMES AIRCRAFT. J. R. Heath-Smith. January 1957. 20p. diagrs., tabs. RAE Tech. Note Structures 214. (Ask for N-48809*)

Acceleration records were obtained of the turbulence encountered by B.O.A.C. Hermes aircraft in 417,000 miles of operational flying on routes from London to East and West Africa. It is shown that turbulence decreases with increasing altitude. A result of the pilot's discretion in choice of altitude and course is that the gust frequency encountered during most of the cruise is about one-third of the average atmospheric gust frequency. Between 9,500 feet and 14,500 feet gusts were encountered four times as frequently over East and West African sectors as over European sectors.

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N-48810*

Royal Aircraft Establishment (Gt. Brit.)
AN ELECTRICAL ANALOGUE EQUIPMENT FOR GENERATING FUNCTIONS OF TWO VARIABLES. J. J. Gait and R. J. Garvey. January 1957. 59p. diagrs., photos., tab. RAE Tech. Note GW 449. (Ask for N-48810*)

A general need exists in the field of electronic analog computers and simulators for equipment capable of registering and providing an analog of functions of two variables. It is proposed in this note that single-valued functions of two independent variables, X and Y, be derived by suitably energizing an array of electrodes embedded in a flat resistive sheet. A probe, driven to any point (XY) on the sheet by a conventional plotting table, would then yield a voltage proportional to the function of X and Y. This proposition is examined, both theoretically and with a small-scale model, and it is concluded that the method is practicable. The design of a full-scale prototype unit is discussed.

N-48814*

Ministry of Supply (Gt. Brit.)
A REPORT ON THE EFFECT OF GLASS SLIP COATS WHEN EMPLOYED AS DIE LUBRICANTS AND OXIDE BARRIERS IN FORGING. April 1957. 24p. tabs. MOS S & T Memo. 7/57. (Ask for N-48814*)

The object of this investigation was to determine whether glass and ceramic coatings applied to ferrous materials for the purpose of preventing the formation of oxide scale would, after heating, form a sufficiently viscous film to act as a lubricant between the die and the forging stock. The conclusion reached is that the metalized coatings which can be deposited as a spray, plate, or dip are more suitable for forging operations. It is, however, practicable with glass frits to provide a disposable barrier against the formation of oxide scale.

N-48819*

Royal Aircraft Establishment (Gt. Brit.)
LONGITUDINAL STABILITY AND CONTROL OF THE SINGLE-ROTOR HELICOPTER. A. R. S. Bramwell. January 1957. 88p. diagrs., tab. RAE Rept. Naval 1. (Ask for N-48819*)

The equations of motion of the helicopter are presented and reduced to nondimensional form. The force and moment derivatives for the single-rotor helicopter (including tail plane if required) are given as simple formulas or in the form of charts. Comparisons are made with wind-tunnel and flight tests where possible. In the development of the theory, static and maneuver stabilities are introduced in a manner analogous to fixed-wing aircraft practice. It is shown that the static stability of the helicopter is proportional to the coefficient E in the stability quartic while the maneuvering qualities are represented by coefficient C. The NACA "divergence requirement" is expressed in terms of the "short-period" motion. Calculations show that the fitting of even a small tail plane provides a great improvement in stability and control.

N-48820*

Royal Aircraft Establishment (Gt. Brit.)
A TECHNIQUE FOR IMPROVING THE PREDICTIONS OF LINEARISED THEORY ON THE DRAG OF STRAIGHT-EDGED WINGS. D. G. Randall. January 1957. 41p. diagrs. RAE Tech. Note Aero 2474. (Ask for N-48820*)

The curve of drag against Mach number for straight-edged wings, calculated by using the linearized theory of supersonic flow, displays discontinuities in slope at the various Mach numbers for which the edges are sonic. These features, which are not observed in practice, are due to the fact that linearized theory predicts an infinite pressure along a subsonic or sonic edge. It is shown that if the linearized equation of supersonic flow is used to determine the flow over straight-edged wings, but the linearized boundary condition is replaced by the full (nonlinear) boundary condition, these infinities disappear and are replaced by plausible values. On this basis a simple method is derived for improving the linearized predictions of the drag of straight-edged wings which exhibits satisfactory agreement with experimental results. While the technique is not directly applicable to ridge lines, an artifice renders them amenable to similar treatment.

N-48821*

Royal Aircraft Establishment (Gt. Brit.)
CRITICAL FLIGHT CONDITIONS AND LOADS RESULTING FROM INERTIA CROSS-COUPLING AND AERODYNAMIC STABILITY DEFICIENCIES. W. J. G. Pinsker. (Paper presented to Structures & Materials Panel of AGARD, Copenhagen, April 1957.) 44p. diagrs. RAE Tech. Note Aero 2502. (Ask for N-48821*)

The effects of the gyroscopic forces on aircraft with large inertias during rolling maneuvers are discussed and criteria given for the three resulting divergent flight conditions: yaw divergence, pitch divergence, and autorotational rolling. The critical loading cases in practical rolling maneuvers are discussed and methods for the determination of peak loads outlined. Aircraft responses in inadvertent pitch-up are analyzed and data are given for the estimation of peak loads both for uncontrolled conditions and for pitch-up with pilot's counteraction. The principal causes for loss of directional stability are indicated and possible dangerous flight conditions are outlined.

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N-48822*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF PRELOADING UNDER VARIOUS ENVIRONMENTAL CONDITIONS ON THE STRENGTH OF GLASS-FIBRE LAMINATED PLASTICS. M. M. Cornford and W. W. Wright. November 1956. 35p. diagrs., tabs. RAE Tech.Note Chem.1291. (Ask for N-48822*)

The flexural strength of glass-fiber laminated plastics was determined after preloading under conditions of elevated temperature, high humidity, or both. The strength depended on the types of resin and glass cloth, and on the treatment applied to the glass cloth. An epoxy resin was superior to the other resins tested. High alkali glass-cloth polyester laminates were less affected than were similar low alkali glass-cloth laminates, but the latter possessed greater flexural strength. The use of vinyl trichlorosilane treated cloth resulted in improved strength figures with polyester, epoxy, and phenolic resins as compared with other treated cloths. It is recommended that when low alkali glass-cloth polyester laminates may be subjected to elevated temperature and humidity they should not be stressed beyond one-sixth of their ultimate strength. A combination of an epoxy resin with a low alkali glass cloth treated with vinyl trichlorosilane gave laminates having properties markedly superior to those of the other resin glass-cloth combinations tested.

N-48824*

Royal Aircraft Establishment (Gt. Brit.)
FOAMED-IN-PLACE TECHNIQUES WITH SEBALKYD AND FLEXALKYD RESINS. A. C. Cornwell, D. B. V. Parker, and L. N. Phillips. February 1957. 22p. diagrs., photos., tabs. RAE Tech.Note Chem.1295. (Ask for N-48824*)

The purpose of this note is to give the essential technology required to carry out work with both rigid and flexible polyurethanes. The basic formulations and mixing processes are given, followed by an explanation of the variations in foam density and structure which are produced by accelerators and modifiers of different types. In each case, specific examples and working instructions are given. Attention is drawn to the advantage of using prefabricated alkyds and the procedure for making a typical formulation is given in detail. The several alternative foaming methods available to the operator are described and the field of application of each is indicated. The ability of the foam to adhere to, or to part from, a surface is of importance and instructions are given for using a variety of primers and parting agents.

N-48825*

Royal Aircraft Establishment (Gt. Brit.)
THE STRUCTURE OF CHLORINE FLAMES. R. F. Simmons and H. G. Wolfhard. January 1957. 21p. diagrs., photos. RAE Tech.Note RPD 150. (Ask for N-48825*)

The structure and spectral emission of hydrocarbon-chlorine flames have been examined. The most striking feature of these flames is the large amount of carbon formed in the flame, and the radiation from these carbon particles has been used to measure the temperature profile through the flame front. This temperature was found to be considerably lower than the calculated adiabatic flame temperature and it is suggested that this is due to heat losses through radiation. The influence of chlorine on the limits of inflammability and spectral emission of air flames has been noted, and it has been found that, except for carbon monoxide flames, chlorine, unlike bromine, does not act as an inhibitor.

N-48826*

Royal Aircraft Establishment (Gt. Brit.)
AN INVESTIGATION INTO THE FORMULATION OF ANTIMISTING COMPOUND (SPECIFICATION D.T.D.338). T. R. F. W. Fennell and J. R. Webb. February 1957. 8p. tabs. RAE Tech.Note Chem. 1297. (Ask for N-48826*)

The reported failure of the material, described in Appendix I of Specification D.T.D. 338A, on Perspex has been confirmed. The results obtained by systematic variation of the composition are described and discussed.

N-48827*

Royal Aircraft Establishment (Gt. Brit.)
A SHOCK-EXPANSION THEORY APPLICABLE TO WINGS WITH ATTACHED SHOCK WAVES. L. M. Sheppard and K. D. Thomson. January 1957. 17p. diagrs. RAE Tech.Note Aero 2493. (Ask for N-48827*)

An extended shock-expansion theory applicable to three-dimensional wings with attached leading- and trailing-edge shock waves is presented in this note. Although the extended method has been derived for high Mach numbers only, preliminary comparisons of its predictions with those of linearized theory and the one experiment available indicate that it can be applied at quite low Mach numbers. The essential requirement found is that the wing edges must be "highly supersonic," that is, the component of free-stream velocity normal to the edges must not be in the low supersonic range. Tip regions on lifting wings cannot be treated.

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N-48828*

Royal Aircraft Establishment (Gt. Brit.)
THE COMMUNICATIONS SYSTEM AT LARKHILL RANGE. A. Wilson. February 1957. 8p. diagrs. RAE Tech. Note TD 14. (Ask for N-48828*)

A communication system is described which allows conversation between a control room and any or all of 45 remote stations, with good quality and adequate volume.

N-48829*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) AN ASSESSMENT OF THE KELVIN AND HUGHES PERISCOPIC DRIFTMETER. (Period of trials - September - December 1956). March 18, 1957. 12p. photos., tabs. AAEE/Inst/111. (Ask for N-48829*)

Trials have been carried out to assess the Kelvin and Hughes periscopic drift meter which was installed in Avro Ashton Mk. I WB. 490 and to recommend whether it should be accepted in high-altitude high-speed transport aircraft provisioned for the Royal Air Force or whether it should be replaced by the Mk. II drift recorder. The periscopic drift meter was found to have certain shortcomings but with slight modification is considered to be a suitable instrument for introduction into the Royal Air Force. It is considered to be an extremely useful instrument for the rapid determination of ground speed.

N-48830*

Ministry of Supply (Gt. Brit.)
PRESENT KNOWLEDGE OF THE EXPLOSIVE TENDENCIES OF TITANIUM AND ZIRCONIUM (MARCH 1957). U. R. Evans. April 1957. 14p. MOS S & T Memo. 5/57. (Ask for N-48830*)

Information regarding explosions arising from titanium and zirconium is examined. Much of the information given has been derived from two series of reports published by the U. S. Atomic Energy Commission. It has been endeavored to apply to this problem considerable information available regarding the mechanism of the action of nitric acid on other metals.

N-48831*

Royal Aircraft Establishment (Gt. Brit.)
A NOTE ON THE WAVE DRAG OF THE WING OF A RECTANGULAR WING AND BODY COMBINATION. L. M. Sheppard. January 1957. 8p. diagrs. RAE Tech. Note Aero 2494. (Ask for N-48831*)

This note gives a simple relationship between the zero-lift wave drag of the wing of a rectangular wing and body combination and the wave drag of the portion of the gross wing blanketed by the body, both evaluated as if isolated, (that is, ignoring the interference of other parts of the combination). The result is valid only when the tip Mach cones of the wing lie downstream of the blanketed wing. Detailed results are given for the case of wings with double-wedge section, the maximum thickness being at midchord.

N-48832*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) AN ASSESSMENT OF THE GYRO-STABILIZED B6 DRIFTMETER. (Period of trials - August - December 1956). March 12, 1957. 15p. diagrs., photos., tabs. AAEE/Inst/110. (Ask for N-48832*)

Trials have been carried out to assess the B6 drift meter which was installed in Avro Ashton Mk. 1 WB. 490 to determine its suitability for use in the Royal Air Force in maritime operations and high-speed high-altitude transport aircraft. The B6 drift meter was found to suffer from condensation and icing on the inside of the object glass which seriously affected its usefulness. Nevertheless, it was found possible to assess the instrument and determine its accuracy, which was found to be good.

N-48833*

Aeronautical Research Council (Gt. Brit.)
A SUGGESTION FOR A VARIABLE MACH NUMBER SUPERSONIC WIND TUNNEL. P. Bakke. July 1, 1954. 5p. diagrs., photos., tab. ARC 16,906; T.P.432. (Ask for N-48833*)

When a supersonic jet exhausts into a region of lower pressure, part of the resulting flow in the jet is uniform and parallel. The Mach number in this limited portion of the flow is higher than the value attained at the surface of the jet; that is, it is higher than the Mach number reached by a uniform expansion from the pressure at the exit of the jet to the pressure in the region outside the jet. This behavior suggests that it should be possible to achieve an open-jet wind tunnel with a Mach number continuously variable over a certain range by altering the pressure outside the jet. These experiments give some preliminary information on the method of providing the variation in pressure and suggest that it may be obtained with economy in power by using a movable wedge in the tunnel diffuser.

N-48834*

Aeronautical Research Council (Gt. Brit.)
THE USE OF PITOT TUBES TO MEASURE SKIN FRICTION ON A FLAT PLATE. E. F. Relf, R. C. Pankhurst, and W. S. Walker. August 31, 1954. 10p. diagrs., tab. ARC 17,025; FM 2121. (Ask for N-48834*)

The relation between the pressure in a round surface pitot and the local skin-friction coefficient has been established experimentally for the case of a flat plate with turbulent boundary layer. It differs somewhat from that found by Preston in the boundary layer of a pipe.

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N-48835*

Aeronautical Research Council (Gt. Brit.)
EXPERIMENTS WITH AN ELECTRICAL ANALOGUE FOR THE SOLUTION OF PROBLEMS CONCERNING THE EXTENSION AND FLEXURE OF FLAT PLATES.
P. J. Palmer and S. C. Redshaw. September 9, 1954. 30p. diagrs., photos., tab. ARC 17,045; Comp.64; Strut.1734. (Ask for N-48835*)

Details of the design, construction, and use of an electrical resistance network for solving certain of the problems encountered in the flexure and extension of flat plates are given. Some typical experiments have been carried out with the aid of this network and the method of operation of the analogy is described. The results of these experiments are presented and they are compared with the corresponding theoretical values; the comparison is as good as could be expected in view of the limitations imposed by the very coarse mesh which was used; and essentially the same results would have been obtained by the exercise of a relaxation computation. No practical difficulties would be encountered in building a large network having a very fine mesh.

N-53298*

Australian Aeronautical Research Committee.
A METHOD OF CASCADE DESIGN FOR TWO-DIMENSIONAL INCOMPRESSIBLE FLOW.
S. Rosenblat, University of Sydney and L. C. Woods, University of Technology. March 1956. 30p. diagrs., tab. Australian Aeronautical Research Committee ACA-58. (Ask for N-53298*)

A method of designing cascades of airfoils in inviscid incompressible flow is developed having the following advantages over existing methods: Velocity is prescribed directly as a function of perimeter distance; apart from the basic theory the method is essentially numerical; it allows for a finite trailing-edge angle; and it is quicker and more flexible than the analytic method and can be used to calculate the modifications necessary to existing cascade profiles to improve their (experimentally determined) velocity distributions.

MISCELLANEOUS

CN-52434*

Advisory Group for Aeronautical Research and Development. MATCHING OF OPERATIONAL LANGUAGES IN DOCUMENTARY SYSTEMS. R. A. Fairthorne. (Presented at 6th meeting of AGARD Documentation Committee, February 20-25, 1956, Rome, Italy.) February 1956. iv, 12p. AGARD Report 49. (Ask for CN-52434*)

Discusses the problem of clerical tasks as sequences of elementary observations, identifications, and manipulations of marked objects. The basic repertories or "alphabets" of operations and of marks, in association with the vocabularies of permissible sequences, or "words," are given the technical name of "scripts." These scripts can be represented algebraically, and any systematic spelling rules will be reflected in the algebraic structure. It is shown how, with this concept, all clerical tasks, including marshalling and retrieval, can be studied as chains of transcriptions and transliterations.

CN-52435*

Advisory Group for Aeronautical Research and Development. MECHANICAL STORAGE, HANDLING, RETRIEVAL AND SUPPLY OF INFORMATION.
Ralph R. Shaw, Rutgers University. (Presented at 6th meeting of AGARD Documentation Committee held February 20-25, 1956, Rome, Italy.) February 1956. iii, 34p. AGARD Report 50.
(Ask for CN-52435*)

The technical and administrative problems involved in the storage, handling, and retrieval of library information are emphasized throughout this detailed account of the present equipment used. Reference is made to previous studies and suggestions given for future research. Particular attention is paid to the need for fundamental systems studies and for fuller investigation of the requirements of the scholar. The author concludes that the problem has proceeded in a piecemeal and "gadget" fashion and stresses the need for more detailed analysis of the usefulness and economic justification of each separate piece of machinery without, however, losing sight of the problem in its entirety. By way of practical illustration a method for making the resources of Harvard University's Lamont Library available to all colleges is suggested at the end.

N-52436*

Advisory Group for Aeronautical Research and Development. "DEAD STICK" LANDING TESTING TECHNIQUES. Alen R. Holcombe, North American Aviation, Inc. (Presented at 8th meeting of AGARD Flight Test Panel, February 20-25, 1956, Rome, Italy.) February 1956. iv, 10p. diagrs. AGARD Report 28. (Ask for N-52436*)

Information gained during United States Navy experiments with dead-stick landings on 10 different jet aircraft is presented. Testing methods, glide-range determination, and landing techniques are discussed.

N-52437*

Advisory Group for Aeronautical Research and Development. NOTES ON CORRELATION OF MODEL AND FULL-SCALE SPIN AND RECOVERY CHARACTERISTICS. Melvin N. Gough, National Advisory Committee for Aeronautics. (Presented at 8th meeting of AGARD Flight Test Panel, February 20-25, 1956, Rome, Italy.) February 1956. v, 20p. diagrs., photos., tabs. AGARD Report 27. (Ask for N-52437*)

This report calculates the usefulness of spin-tunnel results as an aid to piloting techniques in flight operations. A correlation of spin-tunnel and flight-test results is presented. The need for better correlation through more detailed full-scale flight data

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and more qualified, accurate, and detailed pilot reports is emphasized. Included are notes to pilots emphasizing the value and limitations of existing spin-tunnel information.

N-52438*

Advisory Group for Aeronautical Research and Development. SOME RESULTS OF COMPARISON OF MODEL AND FULL-SCALE SPINNING TESTS. A. J. Marx, National Aeronautical Research Institute. (Presented at joint session of AGARD Flight Test Panel and the Wind Tunnel and Model Testing Panel, February 20-25, 1956, Rome, Italy.) February 1956. iv, 9p. diagrs., tab. AGARD Report 26. (Ask for N-52438*)

Results are presented of comparison of wind-tunnel and full-scale spinning tests for the Fokker S-11 primary trainer. In free flight, under equivalent conditions steady spins were observed with two different types of motion, while in the wind-tunnel tests only one of those types of motion had been recorded. In general, agreement on the steady spin and recovery characteristics between wind tunnel and free flight is satisfactory. Finally, a comparison of yawing-moment coefficients calculated from wind-tunnel and free-flight tests is given.

N-52439*

Advisory Group for Aeronautical Research and Development. THE THEORETICAL DETERMINATION OF NORMAL MODES AND FREQUENCIES OF VIBRATION. I. T. Minhinnick, Royal Aircraft Establishment. (Presented at 3rd meeting of AGARD Structures and Materials Panel, April 10-17, 1956, Washington, D.C.) April 1956. vii, 40p. diagrs., tab. AGARD Report 36. (Ask for N-52439*)

In this paper the various methods that have been devised for the determination of the natural frequencies and normal modes of aircraft are discussed and their accuracy and the amount of work that they entail are compared. An extensive bibliography is given in Appendix I. The discussion is mainly from the point of view of the flutter analyst, who commonly bases his analyses on the normal modes, but the description and comparison of the various methods should be of general interest.

N-52440*

Advisory Group for Aeronautical Research and Development. MODEL SELECTION AND DESIGN PRACTICES APPLICABLE TO THE DEVELOPMENT OF SPECIFIC AIRCRAFT. Donald D. Baals, National Advisory Committee for Aeronautics. (Presented at 8th meeting of AGARD Wind Tunnel and Model Testing Panel, February 20-25, 1956, Rome, Italy.) February 1956. vii, 27p. diagrs., photos. AGARD Report 21. (Ask for N-52440*)

Rapid advances in aircraft performance and the critical nature of transonic and supersonic flows have limited the generalization of research results and led to the need for extensive specific model investigations. Factors pertinent to a specific model development program are discussed together with the major aerodynamic and mechanical requirements of model design. Airframe aerodynamic problems, including the influence of inlets, are considered, but the internal aerodynamics of the engine proper are excluded. Five basic development and five special purpose models are discussed as the typical array necessary for the development of a present-day supersonic fighter.

N-52441*

Advisory Group for Aeronautical Research and Development. DESIGN AND CONSTRUCTION OF WIND TUNNEL MODELS. Joseph J. Muncey and David M. Pote, Cornell Aeronautical Lab., Inc. (Presented at 8th meeting of AGARD Wind Tunnel and Model Testing Panel, February 20-25, 1956, Rome, Italy.) February 1956. iv, 20p. diagrs., photos. AGARD Report 20. (Ask for N-52441*)

The Cornell Aeronautical Laboratory major wind tunnel is prescheduled to operate on an around-the-clock schedule. The achievement of accurate results under pressure of such a schedule has posed many problems in the design and construction of wind-tunnel models. This paper discusses some methods and techniques which have been evolved.

CN-52442*

Advisory Group for Aeronautical Research and Development. PHILOSOPHY OF AIRWORTHINESS. W. Tye, Air Registration Board, United Kingdom. (Presented at 4th meeting of AGARD Structures and Materials Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. iv, 16p. diagrs., tabs. AGARD Report 58. (Ask for CN-52442*)

The matching of airworthiness of the aircraft with the external operational conditions is discussed. The difficulty of establishing what level of airworthiness is acceptable to the community is pointed out, and a possible way of attacking the problem is suggested. Preliminary examination indicates that there is an optimum level of airworthiness. A distinction is drawn between the "accident rate" and "accident probability" approaches to airworthiness, and the moral and technical implications of these are discussed. The present state of certain important structural requirements is examined in the light of the preceding general considerations. The main weaknesses in the current requirements are underlined. Brief reference is made to the problem of airframe fatigue.

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CN-52443*

Advisory Group for Aeronautical Research and Development. A STUDY TOWARD A SYSTEM OF CLASSIFICATION OF UNPREPARED LANDING AREAS. W. Gordon Duncan, Air Research and Development Command. (Presented at meeting of AGARD Flight Test Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. iv, 6p. diagrs. AGARD Report 89. (Ask for CN-52443*)

Describes a study toward a method of classifying unprepared landing areas, undertaken by the Air Research and Development Command, U.S.A.F. Preliminary results show the problem susceptible to solution and indicate several further study areas.

N-52444*

Advisory Group for Aeronautical Research and Development. FACTORS AFFECTING THE FIELD LENGTH OF STOL AIRCRAFT. G. W. Johnston, De Havilland Aircraft of Canada, Ltd. (Presented at 9th meeting of AGARD Flight Test Techniques Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. vi, 18p. diagrs., photos., tab. AGARD Report 81. (Ask for N-52444*)

This note describes qualitatively some of the consequences of extending existing short field aircraft to the STOL class. The note is concerned only with performance implications as reflected by the requirement of operating the aircraft from a 500-foot field. For this note STOL aircraft are defined as those which can land or take off over a 50-foot obstacle in 500 feet.

N-52445*

Advisory Group for Aeronautical Research and Development. NOTE ON STRAIN GAUGE RECORDING EQUIPMENT FOR THE R.A.E. INTERMITTENT SUPERSONIC WIND TUNNELS. K. G. Winter and E. J. Petherick, United Kingdom. (Presented at 9th meeting of AGARD Wind Tunnel and Model Testing Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. iv, 11p. diagrs., photos. AGARD Report 64. (Ask for N-52445*)

A description is given of a simple system for photographing, up to 6 times per second, revolution counters driven from strain-gage balance indicators. A further proposed system using punched cards is also described. Results show that, even with comparatively slow strain-gage balance indicators, satisfactory recording of the loads on a model over a wide incidence range can be obtained in a run of 20 seconds duration.

N-52446*

Advisory Group for Aeronautical Research and Development. RECENT RESEARCH ON THE DETERMINATION OF NATURAL MODES AND FREQUENCIES OF AIRCRAFT WING STRUCTURES. John M. Hedgepeth, National Advisory Committee for Aeronautics. (Presented at 3rd meeting of AGARD Structures and Materials Panel, April 10-17, 1956, Washington, D.C.) April 1956. v, 24p. diagrs., photos., tabs. AGARD Report 37. (Ask for N-52446*)

Summarizes and discusses some recent theoretical and experimental studies of the vibrations of aircraft wing structure. Assesses the importance of various secondary effects and outlines methods of including them. Compares experimental values for natural frequencies of box-beam specimens with theoretical calculations and shows that, particularly for the higher modes, good agreement requires the inclusion of secondary effects.

CN-52467*

Advisory Group for Aeronautical Research and Development. REVIEW OF CURRENT MACHINE SYSTEMS FOR HANDLING INFORMATION. Gwendolyn M. Bedford, University of Pennsylvania. (Presented at 6th meeting of AGARD Documentation Committee, February 20-25, 1956, Rome, Italy.) February 1956. iii, 17p. AGARD Report 46. (Ask for CN-52467*)

Reviews and compares current mechanical systems for processing, storing, and retrieving information and determines criteria for their valuation. Discusses the feasibility of the systems reviewed with respect to the particular project under consideration.

N-53173*

NACA HYPERSONIC ROCKET AND HIGH-TEMPERATURE JET FACILITIES. Paul E. Purser and Aleck C. Bond. (Presented to Wind Tunnel and Model Testing Panel of the Advisory Group for Aeronautical Research and Development, Scheveningen, Holland, July 8-12, 1957). 16p. diagrs., photos. (Ask for N-53173*)

This paper discusses the extension of the rocket-model research of the National Advisory Committee for Aeronautics (NACA) to hypersonic speeds and describes briefly several high-temperature jet facilities assembled by the NACA for research on structures and materials. Of the jets described, one is essentially the exhaust of a ram-jet engine and provides stagnation temperatures up to 3000° F; one is a rocket engine and provides stagnation temperatures up to 4200° F; one is a 4000° F air jet using a ceramic heat exchanger; and one is an electric-arc-heated jet with stagnation temperatures of over 15,000° F.

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N-53242*

INTRODUCTORY REMARKS CONCERNING SOME ASPECTS OF HYPERSONIC RESEARCH AND RESEARCH FACILITY REQUIREMENTS. E. O. Pearson, Jr. (Presented to Wind Tunnel and Model Testing Panel of the Advisory Group for Aeronautical Research and Development, Scheveningen, Holland, July 8-12, 1957). 31p. diagrs., photos., tab. (Ask for N-53242*)

A discussion is given in a general way of some of the background that has been acquired in hypersonic aerodynamic research, the nature of some of the current problems, and the facilities required for experimental research.

UNPUBLISHED PAPERS

N-52311*

Polytechnic Institute of Brooklyn.
THE BLASIUS EQUATION WITH THREE-POINT BOUNDARY CONDITIONS. Luigi G. Napolitano. January 1957. 44p. diagrs., tabs. Polytechnic Institute of Brooklyn. PIBAL Report 319. (Ask for N-52311*)

The occurrence of the Blasius equation subject to three-point boundary conditions in a variety of problems involving the mixing of two uniform streams is shown. A solution of this equation, with the third boundary condition applied to the Blasius function itself, is presented by way of a series in terms of the ratio $\lambda = \frac{u_1 - u_2}{u_1}$ where the u_i's are the inviscid streams' velocities. The first three approximations are explicitly expressed in terms of the repeated integrals of the complementary error function ($i^n\mathrm{erfc}\,\eta$) and of the repeated integrals of the square of the functions $i^n\mathrm{erfc}\,\eta$. Pertinent formulas permitting the rapid evaluation of these functions for positive and negative values of the independent variable are developed.

CN-52538*

A NEW MICROBALANCE OF QUARTZ FOR WORK UNDER HIGHEST VACUUM. (Eine neue Mikrowaage aus Quarz für Arbeiten im Höchstvakuum.) Herbert Mayer and Klaus Behrndt. June 1957. 10p. diagrs. Translation from Zeitschrift für Physik, v.147, no.4, 1957. (Ask for CN-52538*)

A description is given of a microbalance of quartz - the results of suitable developmental work - which, for an accuracy of up to 1×10^{-8} g, can be built into a highest vacuum apparatus and can there be subjected to all necessary processes. The balance is operated from outside. The instrument is so rugged that it withstands all strains unavoidably occurring during installation, fusion, and baking-out. The balance, its manufacture, and all processes to be followed in taring, etc., are described in all details and the operation of the balance is discussed.

DECLASSIFIED NACA RESEARCH REPORTS

NONE. See unclassified version for listing of Declassified NACA Research Reports.

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NO. 118 **AUGUST 16, 1957**

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1297

NONLIFTING WING-BODY COMBINATIONS WITH CERTAIN GEOMETRIC RESTRAINTS HAVING MINIMUM WAVE DRAG AT LOW SUPERSONIC SPEEDS. Harvard Lomax. 1957. ii, 11p. diagrs. (NACA Rept. 1297. Supersedes TN 3667)

Several variational problems involving optimum wing and body combinations having minimum wave drags for different kinds of geometrical restraints are analyzed. Particular attention is paid to the effect on the wave drag of shortening the fuselage and, for slender axially symmetric bodies, the effect of fixing the fuselage diameter at several points or even of fixing whole portions of its shape.

NACA Rept. 1298

AN ANALYSIS OF THE EFFECTS OF AEROELASTICITY ON STATIC LONGITUDINAL STABILITY AND CONTROL OF A SWEPT-WING AIRPLANE. Richard B. Skoog. 1957. ii, 12p. diagrs. (NACA Rept. 1298. Supersedes RM A51C19)

A theoretical analysis of the effects of aeroelasticity on the stick-fixed static longitudinal stability and elevator angle required for balance of an airplane is presented together with calculated effects for a swept-wing bomber of relatively high flexibility. Although large changes in stability due to certain parameters are indicated for example airplane, the overall stability change after considering all parameters was quite small, compared to the individual effects, due to the counterbalancing of wing and tail contributions. The effect of flexibility on longitudinal control for the example airplane was found to be of little real importance.

NACA RM 57E17

EXPERIMENTAL INVESTIGATION OF CREEP BENDING AND BUCKLING OF THIN CIRCULAR CYLINDRICAL SHELLS. Burton Erickson, Sharad A. Patel, Francis W. French, Samuel Lederman, and N. J. Hoff, Polytechnic Institute of Brooklyn. July 1957. 30p. diagrs., photos., tabs. (NACA RM 57E17)

Forty-three cylinders of 40-inch length and 16-inch diameter, made of 5052-0 aluminum-alloy sheets of 0.032-, 0.040-, 0.051-, and 0.064-inch thickness, were subjected to bending moments constant along the cylinder and in time in an oven which maintained a constant temperature of 500° F during the test. All the cylinders failed by buckling. The time that elapsed between load application and collapse was measured.

* AVAILABLE ON LOAN ONLY.

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CURRENT NACA RESEARCH REPORTS

NACA RM A57F03

PRELIMINARY INVESTIGATION OF THE CHARACTERISTICS OF A TWO-DIMENSIONAL WING AND PROPELLER WITH THE PROPELLER PLANE OF ROTATION IN THE WING-CHORD PLANE. David H. Hickey. August 1957. 12p. diagrs. (NACA RM A57F03)

Qualitative results of an investigation of a propeller rotating in the chord plane of a two-dimensional wing are presented. Severe ground effects below a ground-plane distance of two propeller diameters were noted. Induced loading caused large negative pressure peaks on the wing leading edge. Operation of the propeller at forward speed was limited by propeller blade breakage, indicating an increased stress level in the blades.

NACA RM E57A15

FOREIGN-OBJECT RETENTION AND FLOW CHARACTERISTICS OF RETRACTABLE ENGINE-INLET SCREENS. Fred W. Steffen and Lewis A. Rodert. July 1957. 30p. diagrs., photos. (NACA RM E57A15)

Object-retention and pressure-loss tests were made with two production-model full-scale retractable engine-inlet screens. Turbulence, which dislodged objects from the screens during retraction, and extension and after retraction, and large physical clearances, particularly at the hinge line, were the principal factors which caused the loss of foreign objects. About half of the total-pressure loss through the screen station, with the screens either extended or retracted, was caused by the retraction wells. Methods for improving the retention and pressure-loss characteristics are shown and suggested.

NACA RM E57F11

DROP BURNING RATES OF HYDROCARBON AND NONHYDROCARBON FUELS. Arthur L. Smith and Charles C. Graves. August 1957. 22p. diagrs., photos., tabs. (NACA RM E57F11)

Drop burning rates were determined for single drops of 15 hydrocarbon and nonhydrocarbon fuels. Data were compared with the rates predicted by a theoretical analysis and with the combustion efficiencies of a full-scale, single tubular combustor operating with the same fuels, as determined in a previous investigation. The drop burning rates were proportional to drop diameter. The order of burning rates of the various fuels was generally predicted satisfactorily by the theoretical analysis; however, the absolute values of burning rate obtained were not in complete agreement with those predicted. Combustion efficiency in the turbojet combustor was not related to the variations in drop burning rate.

NACA TN 3289

THE MINIMIZATION OF WAVE DRAG FOR WINGS AND BODIES WITH GIVEN BASE AREA OR VOLUME. Max. A. Heaslet. July 1957. 27p. (NACA TN 3289)

The minimization of wave drag for thin aerodynamic shapes carrying no lift is studied for conditions under which either base area or volume is specified. The problem is reduced to one of determining a two-dimensional harmonic function with known boundary conditions. In several examples the theory is applied to the calculation of the minimum drag and to the final determination of the body shape. For a large family of shapes the minimum drag corresponding to given base area can be determined from an undimensional flow analysis in a duct of known shape.

NACA TN 3781

HANDBOOK OF STRUCTURAL STABILITY. PART I - BUCKLING OF FLAT PLATES. George Gerard and Herbert Becker, New York University. July 1957. iii, 102p. diagrs., tabs. (NACA TN 3781)

The various factors governing the buckling of flat plates are critically reviewed and the results are summarized in a comprehensive series of charts and tables. Numerical values are presented for buckling coefficients of flat plates with various boundary conditions and applied loadings. The effects of plasticity are incorporated in nondimensional buckling charts utilizing the three-parameter description of stress-strain curves.

NACA TN 3782

HANDBOOK OF STRUCTURAL STABILITY. PART II - BUCKLING OF COMPOSITE ELEMENTS. Herbert Becker, New York University. July 1957. 72p. diagrs., tabs. (NACA TN 3782)

The local buckling of stiffener sections and the buckling of plates with sturdy stiffeners are reviewed, and the results are summarized in charts and tables. Numerical values of buckling coefficients are presented for longitudinally compressed stiffener sections of various shapes, for stiffened plates loaded in longitudinal compression and in shear, and for stiffened cylinders loaded in torsion. Although the data presented consist primarily of elastic-buckling coefficients, the effects of plasticity are discussed for a few special cases.

CURRENT NACA RESEARCH REPORTS

NACA TN 3985

PROPELLANT VAPORIZATION AS A CRITERION FOR ROCKET ENGINE DESIGN; CALCULATIONS OF CHAMBER LENGTH TO VAPORIZE A SINGLE n-HEPTANE DROP. Richard J. Priem. July 1957. 41p. diagrs., tab. (NACA TN 3985)

Calculations were made for n-heptane drops using various drop sizes, injection velocities, final gas velocities, initial fuel temperatures, and chamber pressures to show how these variables would affect the vaporization rate and the chamber lengths required to vaporize the drops. The calculations indicate that droplet vaporization may be the controlling process in the combustion zone. The results are correlated for ease in using them for design purposes. The results agree with experimental data obtained previously with a liquid oxygen - heptane rocket.

NACA TN 4040

ESTIMATION OF INCREMENTAL PITCHING MOMENTS DUE TO TRAILING-EDGE FLAPS ON SWEPT AND TRIANGULAR WINGS. Harry A. James and Lynn W. Hunton. July 1957. 31p. diagrs., tab. (NACA TN 4040. Supersedes RM A55D07)

A method is shown by which the incremental pitching moment of swept and triangular wings due to flaps at low speeds can be estimated by using two-dimensional data in conjunction with span-loading theory. Comparisons of estimated and experimental values of flap pitching-moment increments for some 58 cases indicate a mean deviation of about 0.02 C_m. Some two-dimensional flap parameters pertinent to the application of the method are summarized in graphical form.

NACA TN 4041

THE SUBSONIC STATIC AERODYNAMIC CHARACTERISTICS OF AN AIRPLANE MODEL HAVING A TRIANGULAR WING OF ASPECT RATIO 3. I - EFFECTS OF HORIZONTAL-TAIL LOCATION AND SIZE ON THE LONGITUDINAL CHARACTERISTICS. Bruce E. Tinling and Armando E. Lopez. July 1957. 85p. diagrs., photo., tabs. (NACA TN 4041. Supersedes RM A53L15)

Wind-tunnel tests were conducted to evaluate the effects of horizontal-tail location and size on the longitudinal aerodynamic characteristics of an airplane model having a thin triangular wing of aspect ratio 3. The model was tested with horizontal tails, which had areas of either 16.7 or 21.9 percent of the wing area, placed -0.10, 0, 0.10, or 0.20 wing semispan above the wing chord plane, and either 1.2 or 1.5 mean aerodynamic chord behind the moment center. The horizontal tails had aspect ratios of 4 and no sweepback of the 50-percent chord lines. The tests were conducted at a Reynolds number of 2.5 million at Mach numbers from 0.25 to 0.95.

NACA TN 4042

THE SUBSONIC STATIC AERODYNAMIC CHARACTERISTICS OF AN AIRPLANE MODEL HAVING A TRIANGULAR WING OF ASPECT RATIO 3. II - LATERAL AND DIRECTIONAL CHARACTERISTICS. Howard F. Savage and Bruce E. Tinling. August 1957. 82p. diagrs., photo., tabs. (NACA TN 4042. Supersedes RM A55B11)

The effects of vertical-tail size and length on the lateral and directional stability characteristics of both mid- and high-wing airplane arrangements were evaluated. Also evaluated were the directional-control effectiveness of a rudder, and the lateral-control effectiveness of ailerons and of differential deflection of the horizontal-tail surfaces. The tests were conducted at a Reynolds number of 2.5 million at Mach numbers from 0.25 to 0.95.

NACA TN 4043

THE SUBSONIC STATIC AERODYNAMIC CHARACTERISTICS OF AN AIRPLANE MODEL HAVING A TRIANGULAR WING OF ASPECT RATIO 3. III - EFFECTS OF TRAILING-EDGE FLAPS. Bruce E. Tinling and A. V. Karpen. July 1957. 37p. diagrs., photos., tabs. (NACA TN 4043. Supersedes RM A54L07)

Wind-tunnel tests were conducted to find the effects of single-slotted flaps on the longitudinal stability at low speed, the rolling effectiveness of trailing-edge ailerons and of differential deflection of the horizontal tail when the flaps were deflected 40°, and the effect of small deflections of the flaps on the lift-drag ratio at Mach numbers up to 0.95.

NACA TN 4044

GROUND EFFECTS ON THE LONGITUDINAL CHARACTERISTICS OF TWO MODELS WITH WINGS HAVING LOW ASPECT RATIO AND POINTED TIPS. Donald A. Buell and Bruce E. Tinling. July 1957. 48p. diagrs., photos., tabs. (NACA TN 4044. Supersedes RM A55E04)

Wind-tunnel tests were conducted to determine the ground effects on a tailless model with a wing of aspect ratio 2 and infinite taper, and on a tailed model with a triangular wing of aspect ratio 3, with flaps. Control-surface hinge moments were measured on the tailless model. The results are compared with the predictions of the theory of Tani, et al.

CURRENT NACA RESEARCH REPORTS

NACA TN 4064

REVIEW AND INVESTIGATION OF UNSATISFACTORY CONTROL CHARACTERISTICS INVOLVING INSTABILITY OF PILOT-AIRPLANE COMBINATION AND METHODS FOR PREDICTING THESE DIFFICULTIES FROM GROUND TESTS. William H. Phillips, B. Porter Brown, and James T. Matthews, Jr. August 1957. 57p. diagrs. (NACA TN 4064. Supersedes RM L53F17a)

A number of examples are presented of control difficulties which appear to result from a tendency for dynamic instability of the combination of the pilot, control system, and airplane. These difficulties have occurred in both conventional and power control systems. Tests of a bomber and a fighter airplane equipped with hydraulic-power controls have been made to study this problem. The effect of friction in the control valves of the power control systems is discussed. An analytical study of the problem and a method of detecting such control difficulties by means of ground simulator tests are presented.

NACA TN 4067

APPROXIMATE ANALYSIS OF EFFECTS OF LARGE DEFLECTIONS AND INITIAL TWIST ON TORSIONAL STIFFNESS OF A CANTILEVER PLATE SUBJECTED TO THERMAL STRESSES. Richard R. Heldenfels and Louis F. Vosteen. August 1957. 36p. diagrs. (NACA TN 4067)

An approximate analysis of the nonlinear effects of initial twist and large deflections ón the torsional stiffness of a cantilever plate subjected to a nonuniform temperature distribution is presented. The Von Kármán large-deflection equations are satisfied through the use of a variational principle. The results show that initial twist and applied moments can have significant effects on the changes in stiffness produced by nonuniform heating, particularly in the region of the buckling temperature difference. Results calculated by this approximate analysis are in satisfactory agreement with measured torsional deformations and changes in natural frequency.

NACA TN 4068

EFFECTS OF BLADE PLAN FORM ON FREE-SPACE OSCILLATING PRESSURES NEAR PROPELLERS AT FLIGHT MACH NUMBERS TO 0.72. Max C. Kurbjun. August 1957. 20p. diagrs., photos., tabs. (NACA TN 4068)

Comparisons are made of the free-space oscillatory pressures near the tips of propellers with rectangular and tapered blade plan forms. Measurements were made at a single radial station and at three axial positions (ahead of, in the plane of, and behind the propeller disk). The effects of propeller blade plan form are shown as comparisons of the noise emitted from the rectangular- and tapered-blade propellers with changes in operating parameters of Mach number, power, and engine speed.

NACA TN 4070

FLIGHT-TEST INVESTIGATION ON THE LANGLEY CONTROL-LINE FACILITY OF A MODEL OF A PROPELLER-DRIVEN TAIL-SITTER-TYPE VERTICAL-TAKE-OFF AIRPLANE WITH DELTA WING DURING RAPID TRANSITIONS. Robert O. Schade. August 1957. 19p. diagrs., photo., tab. (NACA TN 4070)

A flight-test investigation has been made on the Langley control-line facility to determine the longitudinal stability and control characteristics of a model of a propeller-driven tail-sitter-type vertical-take-off airplane with delta wing during rapid transitions from hovering flight to forward flight and back to hovering. The investigation showed that the facility was generally satisfactory for investigating the characteristics of vertical-take-off models during rapid transitions. It was found that rapid transitions from hovering to forward flight could be performed fairly easily and that the transitions from forward flight to hovering flight were more difficult to perform.

NACA TN 4072

EXPERIMENTAL INVESTIGATION OF ATTENUATION OF STRONG SHOCK WAVES IN A SHOCK TUBE WITH HYDROGEN AND HELIUM AS DRIVER GASES. Jim J. Jones. July 1957. 24p. diagrs., photo. (NACA TN 4072)

An experimental investigation has been made of the attenuation of strong shock waves in air in a shock tube. Time-history measurements were made of the static pressure at several stations in the wall of the tube. The internal diameter of the tube is 3.75 inches. Shock-wave-velocity data were taken for a distance along the tube of about 120 feet. The range of the shock-wave Mach number covered was from 5 to 10-1/2 and the initial pressure ahead of the shock wave varied from 5 to 100 millimeters of mercury. Hydrogen and helium were used as driver gases.

BRITISH REPORTS

N-48941*

Royal Aircraft Establishment (Gt. Brit.)
AN INVESTIGATION INTO THE METALLURGICAL FACTORS AFFECTING THE FATIGUE PROPERTIES OF SOME ALUMINIUM ALLOYS. INTERIM REPORT. R. W. George and P. J. E. Forsyth. November 1956. 23p. diagrs., photos., tabs. RAE Tech.Note Met. 254. (Ask for N-48941*)

The fatigue and tensile properties of a number of high purity aluminium alloys have been determined. The compositions of these alloys have been chosen to investigate specific metallographic structures. It was found that additions of iron up to 0.1 percent improved the fatigue and tensile properties of aluminium with little deterioration of the $\frac{F.L.}{U.T.S.}$ ratio. Additions of copper and zinc were made to aluminium 5 percent magnesium alloy resulting in improvements in tensile properties with a corresponding improvement in fatigue properties.

BRITISH REPORTS

N-48942*

Royal Aircraft Establishment (Gt. Brit.)
NOZZLE AND CONTRACTION SHAPES OF THE R.A.E. 3 FT. X 3 FT. SUPERSONIC WIND TUNNEL. A. Stanbrook. February 1957. 9p. diagr., tabs. RAE Tech.Note Aero 2497.
(Ask for N-48942*)

Ordinates of the contraction and of each of the solid liners of the 3-ft by 3-ft supersonic wind tunnel are tabulated.

N-48943*

Royal Aircraft Establishment (Gt. Brit.)
THE WAVE DRAG OF NON-LIFTING COMBINATIONS OF THIN WINGS AND "NON-SLENDER" BODIES. L. M. Sheppard. March 1957. 26p. diagrs. RAE Tech.Note Aero 2496.
(Ask for N-48943*)

The methods of wave drag estimation known as the area rule and transfer rule are restricted to non-lifting combinations of thin wings and slender bodies. The Lomax-Heaslet multipole method is applicable to configurations with "nonslender" fuselages, represented by an axial distribution of multipoles. However, it is not entirely satisfactory and an alternative multipole method is presented here. This is based upon the assumption, fundamental to the area rule and the transfer rule, that the effect on the wave drag of the interference velocity potential, due to the interaction between the exposed wing and the fuselage, is negligible. An investigation of the validity of this fundamental assumption, based on existing theoretical and experimental results, is given. The application of the multipole method to fuselage design for low combination wave drag is discussed with special reference to an elliptic wing-body combination.

N-48944*

Royal Aircraft Establishment (Gt. Brit.)
SOME THICKNESS DISTRIBUTIONS FOR NARROW WINGS. W. T. Lord and Barbara Green. February 1957. 29p. diagrs., tab. RAE Tech.Note Aero 2495. (Ask for N-48944*)

An outline is given of a method for designing thickness distributions for narrow wings, particularly wings with straight unswept trailing edges. The method uses inviscid flow theory to design for lowish zero-lift wave drag in such a way that possible effects of boundary layers are taken into account in accordance with the ideas of Küchemann and Weber. For clarity, only delta wings with diamond cross sections and sharp leading edges are considered in detail here. The essence of the method is that narrow wings should be designed to have specified cross-sectional area distributions; for wings with sharp leading edges it is convenient that these specified area distributions should be given by polynomials, and some examples are described. The method is not founded on a rigorous theoretical analysis, but supporting evidence is provided by some calculations of pressure distributions by Weber, and confirmation is to be sought experimentally.

N-48945*

Aeronautical Research Council (Gt. Brit.)
A THEORY OF THE STABILITY OF PLANE SHOCK WAVES. N. C. Freeman. September 6, 1954. 29p. diagrs. ARC 17,029; FM 2122.
(Ask for N-48945*)

The stability of form of a plane shock, obtained when a "corrugated" piston is moved impulsively from rest with constant velocity, is investigated mathematically. Linearization of the problem is accomplished by assuming the corrugations to be small. The solution is built up by methods of Fourier analysis from "conefield" solutions of the analogous "wedge"-shaped piston problem, solved by methods due to Lighthill. The plane shock is shown to be stable, perturbations from plane decaying with time in an oscillatory manner like $t^{-3/2}$ for large ta_1/λ (where a_1 is the velocity of sound behind the shock and λ the wavelength of the corrugations)

N-48946*

Aeronautical Research Council (Gt. Brit.)
VISCOUS EFFECTS ON FLATTENED PITOT TUBES AT LOW SPEEDS. F. A. MacMillan. October 14, 1954. 5p. diagrs., tab. ARC 17,106; FM 2081a.
(Ask for N-48946*)

Measurements were made of the pressures in flattened, blunt-nosed pitot tubes, in an air stream at Reynolds numbers from 13 to 1,000 (based on the external height of the tube). Three tubes were used having cross sections with ratios of width to height (W/H) of 3, 7, and 11. The results are expressed in terms of a pressure coefficient, C_p. It was found that C_p decreased below 1 for all the tubes, although earlier measurements had shown that this did not occur with circular tubes. The maximum decrease was about 1.6 percent at a Reynolds number of 65.

N-48948*

Royal Aircraft Establishment (Gt. Brit.)
FLEXURAL VIBRATIONS OF A THIN-WALLED CYLINDER OF RECTANGULAR CROSS-SECTION. E. H. Mansfield. February 1957. 22p. diagrs. RAE Structures 219. (Ask for N-48948*)

The natural transverse vibrations of a long cylindrical box of doubly symmetrical rectangular cross section are considered. Explicit stress function solutions are obtained for the webs and the top and bottom surfaces so that the effects of shear lag and shear deflection are inherently included. The results are expressed simply in terms of an effective flexural rigidity.

MISCELLANEOUS

Announcement of film supplement to NACA TN 4024, by Campbell.

UNPUBLISHED PAPERS

N-52740*

MODEL-TESTING METHODS IN AERONAUTICS. (Modell-Messverfahren der Flugtechnik.) Rudolf Schmidt and Paul Klages. January 1957. 92p. diagrs., photos., tabs. Translation from Zeitschrift für Flugwissenschaften, v. 3, no. 7, July 1955, p. 169-205. (Ask for N-52740*)

Beginning with the various techniques of model testing most commonly used in wind tunnels and the test conditions which have to be observed in order to satisfy the law of similitude, the technical equipment required is briefly discussed and the accuracy and reliability that can be expected from such measurements are indicated. A description is given of towing techniques and free-flight methods of various types. Characteristics of the various techniques regarding type of problem, range of applicability, technical requirements, and reliability of measurements are compared with the wind tunnel leading to the conclusion that the model-towing method with carrier sled or carrier airplane offers the greatest possibilities for replacing large-size wind tunnels.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification July 26, 1957.

NACA RM A53G10

FLIGHT MEASUREMENTS OF THE HORIZONTAL-TAIL LOADS ON A SWEPT-WING FIGHTER AIRPLANE AT TRANSONIC SPEEDS. Melvin Sadoff. November 1953. 58p. diagrs., photo., tab. (NACA RM A53G10)

Flight measurements of the horizontal-tail loads on a swept-wing fighter airplane at Mach numbers of 0.6 to 1.03 at 35,000 feet have indicated critical flight regions for balancing, maneuvering, and buffeting tail loads. The critical flight region for balancing loads was at the highest test Mach number of about 1.03 at the highest load factor attained. The maneuvering and buffeting load increments were generally critical at Mach numbers below about 0.90. The buffet tail-load increments were relatively small compared to the balancing and maneuvering tail loads.

NACA RM A55E31

INVESTIGATION OF SOME WAKE VORTEX CHARACTERISTICS OF AN INCLINED OGIVE-CYLINDER BODY AT MACH NUMBER 1.98. Leland H. Jorgensen and Edward W. Perkins. August 1955. 47p. diagrs., photos., tabs. (NACA RM A55E31)

For a body consisting of a fineness-ratio-3 ogival nose tangent to a cylindrical afterbody 7.3 diameters long, pitot-pressure distributions in the flow field, pressure distributions over the body, and downwash distributions along a line through the vortex centers have been measured for angles of attack to 20°. The Reynolds numbers, based on body diameter, were 0.15×10^6 and 0.44×10^6. Comparisons of computed and measured vortex paths and downwash distributions are made.

NACA RM A55G11

DEVELOPMENT OF A HIGH-VELOCITY FREE-FLIGHT LAUNCHER - THE AMES LIGHT-GAS GUN. A. C. Charters, B. Pat Denardo, and Vernon J. Rossow. December 1955. (i), 97p. diagrs., photos., tabs. (NACA RM A55G11)

A light-gas gun has been developed at the Ames Aeronautical Laboratory to launch small models at very high velocities for free-flight aerodynamic tests. The design of the gun and the analysis of its performance are presented. The results of the initial firing trials are discussed. The firing trials showed good agreement between measured and predicted velocities and pressures and a velocity of 15,400 ft/sec was reached. It is concluded that the gun is a satisfactory launcher for high-velocity free-flight tests.

NACA RM A55I21

A DESCRIPTION OF THE AMES 2- BY 2-FOOT TRANSONIC WIND TUNNEL AND PRELIMINARY EVALUATION OF WALL INTERFERENCE. Joseph M. Spiegel and Leslie F. Lawrence. January 1956. 65p. diagrs., photo. (NACA RM A55I21)

The Ames 2- by 2-foot wind tunnel, a research facility in which the Mach number can be varied continuously up to 1.4, is described. It utilizes a flexible nozzle to produce supersonic flow and a form of perforated test section to alleviate wall interference. Wall interference is evaluated from tests of three different sizes of a wing-body model, and it is concluded to be small when the model frontal area is less than 1/2 percent of the test-section cross-sectional area.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM A56E24

FULL-SCALE WIND-TUNNEL TESTS OF A 35° SWEPTBACK-WING AIRPLANE WITH HIGH-VELOCITY BLOWING OVER THE TRAILING-EDGE FLAPS - LONGITUDINAL AND LATERAL STABILITY AND CONTROL. William H. Tolhurst, Jr., and Mark W. Kelly. October 1956. 64p. diagrs., photo., tabs. (NACA RM A56E24)

A wind-tunnel investigation was conducted to determine the effects of a blowing-type boundary-layer-control flap on the longitudinal and lateral stability and control of a 35° sweptback-wing airplane with standard aileron controls. As alternatives for the standard ailerons, tests were also made of the following types of lateral control devices: split-flap-type spoilers, differentially deflected flaps, and differential amounts of blowing over the flaps. The results are presented as six-component force data measured at a Reynolds number of 7.5×10^6.

NACA RM A56G19

WIND-TUNNEL TESTS OF BLOWING BOUNDARY-LAYER CONTROL WITH JET PRESSURE RATIOS UP TO 10 ON THE TRAILING-EDGE FLAPS OF A 35° SWEPTBACK WING AIRPLANE. Mark W. Kelly and Jeffrey H. Tucker. October 1956. 24p. diagrs., photo., tab. (NACA RM A56G19)

A full-scale wind-tunnel investigation on a 35° swept-wing airplane showed that the lift increment due to blowing high-velocity air jets over the wing trailing-edge flaps could be adequately correlated with the jet momentum for various jet nozzle heights and with jet pressure ratios ranging from subcritical to 9.5.

NACA RM E8A30a, by Fleming and Wallner

NACA RM E50G10

EFFECT OF FUEL VOLATILITY ON ALTITUDE STARTING LIMITS OF A TURBOJET ENGINE. H. D. Wilsted and J. C. Armstrong. September 11, 1950. 27p. diagrs., tabs. (NACA RM E50G10)

The effect of fuel volatility on altitude starting limits of an axial-flow-compressor-type turbojet engine was investigated using fuels with Reid vapor pressures of 1.1 and 5.4 pounds per square inch. At flight Mach numbers from 0.40 to 0.85, the AN-F-58 fuel allowed consistent windmilling at altitudes 2000 to 8000 feet higher than was obtained with the 1.1-pound Reid vapor pressure fuel. At a flight Mach number of 0.25, ignition could not be established at any altitude with the lower volatility fuel.

NACA RM E51B12

NACA INVESTIGATIONS OF ICING-PROTECTION SYSTEMS FOR TURBOJET-ENGINE INSTALLATIONS. Uwe von Glahn, Edmund E. Callaghan, and Vernon H. Gray. May 2, 1951. (ii), 83p. diagrs., photos. (NACA RM E51B12)

A summary is presented of the investigations made in flight and in wind tunnels at the NACA Lewis laboratory to determine which components of turbojet engines are most critical in icing conditions and to evaluate several icing-protection methods. Complete removal or retraction of compressor-inlet screens upon entering icing conditions is recommended. Surface heating appears to be the most acceptable icing-protection method, although hot-gas bleedback offers a simple method for obtaining icing protection on some installations.

NACA RM E51G06

INVESTIGATION AT MACH NUMBER 1.88 OF HALF OF A CONICAL-SPIKE DIFFUSER MOUNTED AS A SIDE INLET WITH BOUNDARY-LAYER CONTROL. H. Fred Goelzer and Edgar M. Cortright, Jr. September 1951. 38p. diagrs., photos. (NACA RM E51G06)

Experimental investigation was conducted at Mach number 1.88 to determine performance characteristics of half a 50°-conical-spike inlet mounted on a flat plate. Initial boundary layer was removed upstream of inlet by a ram-type scoop of variable height. Initial boundary-layer thickness was also varied. With complete removal of initial boundary layer, total-pressure recovery of approximately 89 percent was obtained. Allowing all initial boundary layer to flow into the inlet lowered the inlet total-pressure recovery to approximately 70 percent. Several alternative boundary-layer-removal systems were investigated which decreased the adverse effect of operating the ram scoop subcritically.

NACA RM E51G19

EXPERIMENTAL INVESTIGATION OF A 16-INCH IMPULSE-TYPE SUPERSONIC-COMPRESSOR ROTOR. Guy N. Ullman, Melvin J. Hartmann, and Edward R. Tysl. October 1951. 29p. diagrs., photos. (NACA RM E51G19)

Performance data and characteristics of a 16-inch impulse-type supersonic-compressor rotor are presented. The experimental portion of this investigation was conducted in Freon-12. A peak pressure ratio of 3.6 was obtained with an adiabatic efficiency of 0.80 at design conditions. Performance was continuous from impulse operation, at open throttle, to shock-in-rotor operation at the stall condition.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM E52E02

PERFORMANCE CHARACTERISTICS AT MACH NUMBERS TO 2.0 OF VARIOUS TYPES OF SIDE INLETS MOUNTED ON FUSELAGE OF PROPOSED SUPERSONIC AIRPLANE. I - TWO-DIMENSIONAL COMPRESSION-RAMP INLETS WITH SEMICIRCULAR COWLS. Alfred S. Valerino. July 1952. 43p. diagrs., photos., tab. (NACA RM E52E02)

An experimental investigation was conducted at Mach numbers of 0, 0.63, and 1.5 to 2.0 to determine the performance of semicircular inlets located on the fuselage of a proposed aircraft. The inlets utilized two-dimensional compression ramps and ram-type scoops for boundary-layer removal. Results of the investigation indicated that significant gains in pressure recovery with slight increases in drag were obtained by removal of the entire boundary layer upstream of the inlets. At zero forward speed and at a Mach number of 0.63, use of a sharp-lip cowling penalized the pressure recoveries. In the supersonic Mach number range, the rounded-lip and sharp-lip inlets had comparable pressure recoveries. However, serious drag penalties were incurred with the rounded-lip cowling at a Mach number of 2.0. A large part of the losses in pressure recovery at angles of attack was attributed to the decrease in effective boundary-layer removal.

NACA RM E52G02

EFFECTS ON THE WEIGHT-FLOW RANGE AND EFFICIENCY OF A TYPICAL AXIAL-FLOW COMPRESSOR INLET STAGE THAT RESULT FROM THE USE OF A DECREASED BLADE CAMBER OR DECREASED GUIDE-VANE TURNING. Robert J. Jackson. September 1952. 41p. diagrs., photos. (NACA RM E52G02)

A single-stage compressor investigation was made to improve the weight-flow-range characteristics of a typical inlet stage by increasing the usable angle-of-attack range by reduction in camber and by reduction of the rate of change of angle of attack with weight flow. It was found that the range is determined by the static-pressure rise at the rotor-tip section and by the absolute inlet-air angle which determines to a large extent the rate of change of angle of attack with weight flow. It was found that decreased camber had very little effect on weight-flow range, whereas decreased guide-vane turning resulted in a large decrease in the rate of change of angle of attack with weight flow as well as in a reduction of the static-pressure rise across the rotor-tip section.

NACA RM E52G08

PERFORMANCE CHARACTERISTICS AT MACH NUMBERS TO 2.0 OF VARIOUS TYPES OF SIDE INLETS MOUNTED ON FUSELAGE OF PROPOSED SUPERSONIC AIRPLANE. II - INLETS UTILIZING HALF OF A CONICAL SPIKE. J. L. Allen and P. C. Simon. September 1952. 49p. diagrs., photos., tab. (NACA RM E52G08)

The performance of semicone inlets located on a fuselage was investigated at Mach numbers of 0, 0.63, and 1.5 to 2.0. The inlets utilized a half spike for compression and ram-type boundary-layer removal scoops. Peak pressure recoveries from 0.86 to 0.95 were obtained at Mach numbers from 2.0 to 1.5 at an angle of attack of 3° with complete removal of the fuselage boundary layer forward of the inlets. Translating the semicone to an aft position increased the captured mass flow with no change in pressure recovery at a Mach number of 1.5; however, at Mach numbers of 1.9 and 2.0, the stable subcritical operating range of the inlet was severely limited by pulsing. Sweeping back the leading edge of the splitter plate used to separate the boundary layer and flow entering the main inlet increased the stable subcritical operating range of the inlet at a Mach number of 2.0 for angles of attack from 0° to 9°. At a Mach number of 0.63, a pressure recovery of 0.97 was attained for critical flow. At zero forward velocity, a large vena contracta was observed which may limit the performance at take-off unless auxiliary inlets are used.

NACA RM E52G23

INVESTIGATION AT MACH NUMBER 2.93 OF HALF OF A CONICAL-SPIKE DIFFUSER MOUNTED AS A SIDE INLET WITH BOUNDARY-LAYER CONTROL. Thomas G. Piercy and Harry W. Johnson. September 1952. 39p. diagrs., photos. (NACA RM E52G23)

An experimental investigation was conducted at Mach number 2.93 to determine performance characteristics of half of a 60° conical-spike inlet mounted on a flat plate. Initial boundary layer was removed upstream of the inlet by a ram-type scoop of variable height. The inlet was operated in the presence of both turbulent and laminar boundary layers. With removal of the initial boundary layer, total pressure recoveries of 51.5 and 45.8 percent were obtained for the turbulent and laminar boundary layers, respectively. Allowing all the initial boundary layer to enter the inlet reduced the pressure recovery to approximately 40 percent for both cases. Inlet pressure recoveries with the laminar boundary layer were generally lower than those obtained with the turbulent boundary layer because of the reduced scoop-mass-flow capture for the laminar boundary layer.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM E52H20

PERFORMANCE CHARACTERISTICS AT MACH NUMBERS TO 2.00 OF VARIOUS TYPES OF SIDE INLETS MOUNTED ON FUSELAGE OF PROPOSED SUPERSONIC AIRPLANE. III - NORMAL-WEDGE INLET WITH SEMICIRCULAR COWL. Fred T. Esenwein. October 1952. 43p. diagrs., photos. (NACA RM E52H20)

The performance characteristics of side inlets which utilize two-dimensional compression wedges mounted normal to the fuselage surface were investigated with ram-type scoops for partial removal of the boundary layer. The research was conducted over a range of angles of attack at Mach numbers of 0, 0.63, and 1.50 to 2.00. Inlet pressure recoveries measured at the design angle of attack were substantially higher at the supersonic speeds than the recoveries obtained with comparable ramp and spike-type inlets. Sensitivity to cross-flow effects due to the particular circumferential location of the inlets, however, resulted in severe decreases in pressure recovery at angles of attack. At a Mach number of 0.63 pressure recoveries of the order of 0.96 were obtained for mass-flow ratios of approximately unity, whereas at take-off, very large losses in inlet performance were noted over the range of inlet mass flows.

NACA RM E53G09

EFFECT OF CIRCUMFERENTIAL LOCATION ON ANGLE OF ATTACK PERFORMANCE OF TWIN HALF-CONICAL SCOOP-TYPE INLETS MOUNTED SYMMETRICALLY ON THE RM-10 BODY OF REVOLUTION. Alfred S. Valerino, Donald B. Pennington, and Donald J. Vargo. September 1953. 37p. diagrs., photos. (NACA RM E53G09)

An experimental investigation to determine the effects of circumferential inlet location on the performance of twin half-conical scoop-type inlets with and without boundary-layer removal was conducted at Mach numbers 1.49, 1.79, and 1.99 through an angle-of-attack range from 0° to 10°. The twin inlets were mounted symmetrically on the NACA RM-10 body of revolution at four circumferential locations at the station of maximum diameter.

NACA RM E53G10

INVESTIGATION OF TRANSLATING-SPIKE SUPERSONIC INLET AS MEANS OF MASS-FLOW CONTROL AT MACH NUMBERS OF 1.5, 1.8, AND 2.0. Gerald C. Gorton. October 1953. 23p. diagrs., photos., tabs. (NACA RM E53G10)

In order to check the practicability of a translating-spike inlet, an investigation was conducted in the 8- by 6-foot supersonic wind tunnel on a 50° conical-spike inlet at Mach numbers of 1.5, 1.8, and 2.0 over a range of angle of attack from 0° to 9°. The additive drag penalty associated with inlet mass-flow spillage was significantly reduced by using a translating-spike inlet rather than a fixed-geometry inlet. However, the total-pressure recovery of this translating-spike inlet with supersonic spillage was less than the total-pressure recovery of the fixed-geometry inlet at the same mass-flow spillage. Indications of the improvement in performance of a turbojet installation by means of mass-flow control with this specific variable-geometry inlet are included.

NACA RM E53G16

EVALUATION OF EFFECTS OF RANDOM PERMEABILITY VARIATIONS ON TRANSPIRATION-COOLED SURFACES. Jack B. Esgar and Hadley T. Richards. November 1953. 59p. diagrs., photos. (NACA RM E53G16)

An analytical investigation was conducted to evaluate the effects of random permeability variations in transpiration-cooled surfaces on surface temperatures and coolant flows for ranges of temperature and Reynolds number that are of particular interest for gas-turbine blades. Experimental measurements of flow through small orifices and through an experimental blade were used for partial verification of the analytical investigation, which showed that considerable care is required to minimize random permeability variations in gas-turbine blades. In order to keep blade temperature variations to less than ±100° F, random permeability variations of not over ±6 to 10 percent could be tolerated. The results of this and other investigations were used to provide recommended design features for transpiration-cooled turbine blades.

NACA RM E54G27a

INVESTIGATION OF SUPERSONIC-COMPRESSOR ROTORS DESIGNED WITH EXTERNAL COMPRESSION. Lawrence J. Jahnsen and Melvin J. Hartmann. September 1954. 41p. diagrs., photos. (NACA RM E54G27a)

A 16-inch-diameter external-compression shock-in-rotor type supersonic compressor employing the spike diffuser principle, designed with isentropic compression and modified to reduce the external compression, obtained pressure ratios of 2.20 and 2.27, adiabatic efficiencies of 0.72 and 0.76, and equivalent weight flows of 21.4 and 23.2 pounds per second, respectively. A method for computation of the approximate losses at the rotor entrance section of external-compression supersonic compressors is presented.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM E54I03

INVESTIGATION OF POROUS GAS-HEATED LEADING-EDGE SECTION FOR ICING PROTECTION OF A DELTA WING. Dean T. Bowden. January 1955. 54p. diagrs., photos., tab. (NACA RM E54I03)

An investigation was conducted in the NACA Lewis icing research tunnel to determine heating requirements and characteristics of a gas-heated porous leading-edge system for anti-icing of a delta wing. Adequate icing protection was obtained for all icing conditions investigated. Large savings in gas flow may be realized by sealing half the upper-surface porous area. Gas flow through the porous area caused only a slight increase in airfoil drag and had no appreciable effect on airfoil pressure distribution. Glaze-ice formations on the unheated airfoil caused rapid increases in section drag.

NACA RM E56B23

HEAT REQUIREMENTS FOR ICE PROTECTION OF A CYCLICALLY GAS-HEATED, 36° SWEPT AIRFOIL WITH PARTIAL-SPAN LEADING-EDGE SLAT. Vernon H. Gray and Uwe H. von Glahn. May 1956. 73p. diagrs., photos., tabs. (NACA RM E56B23)

Heating requirements for satisfactory cyclic de-icing over a wide range of icing and operating conditions have been obtained for a gas-heated, 36° swept airfoil with a partial-span leading-edge slat. Comparisons of heating requirements were made between the slatted and unslatted portions of the airfoil and between cyclic de-icing and continuous anti-icing. Cyclic de-icing systems with and without leading-edge ice-free parting strips were also evaluated.

NACA RM L51G27

FREE-FLIGHT MEASUREMENTS AT MACH NUMBERS FROM 0.7 TO 1.6 OF SOME EFFECTS OF AIRFOIL-THICKNESS DISTRIBUTION AND TRAILING-EDGE ANGLE ON AILERON ROLLING EFFECTIVENESS AND DRAG FOR WINGS WITH 0° AND 45° SWEEPBACK. E. M. Fields and H. Kurt Strass. October 1951. 63p. diagrs., photos., tab. (NACA RM L51G27)

Symmetrical 6-percent-thick circular-arc airfoils, having an aspect ratio of 3.7 and 0.2-chord full-span plain flap-type sealed ailerons, were modified in thickness distribution to produce a range of trailing-edge angles from 0° to about 30°. Wing-aileron rolling effectiveness and drag, for unswept and 45° sweptback wings, were obtained over the Mach number range from 0.7 to 1.6 by means of rocket propelled test vehicles in free flight. In addition, data from previous tests are presented to show the effect of trailing-edge angle on wing-aileron rolling effectiveness for various profile shapes and for thickness ratios of 3 percent, 6 percent, and 9 percent.

NACA RM L51H10

CHARACTERISTICS OF A TRANSONIC TEST SECTION WITH VARIOUS SLOT SHAPES IN THE LANGLEY 8-FOOT HIGH-SPEED TUNNEL. Ray H. Wright and Virgil S. Ritchie. October 1951. 35p. diagrs., photo. (NACA RM L51H10)

A description is presented of the design and operational characteristics of a large slotted transonic wind tunnel for Mach numbers continuously variable up to approximately 1.14. The flow characteristics for a number of slot shapes are discussed.

NACA RM L51K14

CALIBRATION OF THE SLOTTED TEST SECTION OF THE LANGLEY 8-FOOT TRANSONIC TUNNEL AND PRELIMINARY EXPERIMENTAL INVESTIGATION OF BOUNDARY-REFLECTED DISTURBANCES. Virgil S. Ritchie and Albin O. Pearson. July 1952. 87p. diagrs., photos. (NACA RM L51K14)

The surveys and calibration of the nearly uniform transonic flow in the slotted test section of the Langley 8-foot transonic tunnel at stream Mach numbers up to about 1.14 are described. The flow characteristics with a typical nonlifting model in the slotted test section are illustrated. The effects of boundary interference on pressure distributions and body-drag coefficients measured for the model in the slotted test section are shown to be negligible at subsonic Mach numbers and at the higher supersonic Mach numbers attained; the nature and approximate magnitude of boundary-interference effects at low supersonic Mach numbers are discussed. Experimental information concerning model lengths for interference-free supersonic testing and locations of detached shock waves ahead of axially symmetric bodies are presented.

NACA RM L52E01

AIR-FLOW AND POWER CHARACTERISTICS OF THE LANGLEY 16-FOOT TRANSONIC TUNNEL WITH SLOTTED TEST SECTION. Vernon G. Ward, Charles F. Whitcomb, and Merwin D. Pearson. July 1952. 50p. diagrs., photos. (NACA RM L52E01)

The operational and flow characteristics of the redesigned and repowered Langley 16-foot transonic tunnel are presented through the transonic Mach number range continuously variable to 1.08. The effects of slot plan form, wall divergence, and diffuser entrance shape upon the flow and power characteristics are presented.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM L52E20

AN INVESTIGATION OF THE STREAM-TUBE POWER LOSSES AND AN IMPROVEMENT OF THE DIFFUSER-ENTRANCE NOSE IN THE LANGLEY 8-FOOT TRANSONIC TUNNEL. Richard T. Whitcomb, Melvin M. Carmel, and Francis G. Morgan, Jr. August 1952. 70p. diagrs., photos., tabs. (NACA RM L52E20)

Total-pressure, total-temperature, and static pressure surveys have been obtained at a number of stations in the slotted test section and diffuser of the Langley 8-foot transonic tunnel with early and improved diffuser-entrance noses installed at the ends of the slots. The results of these surveys and the development of the improved noses are described.

NACA RM L52G09

PRELIMINARY INVESTIGATION OF THE LOW-AMPLITUDE DAMPING IN PITCH OF TAILLESS DELTA- AND SWEPT-WING CONFIGURATIONS AT MACH NUMBERS FROM 0.7 TO 1.35. Charles T. D'Aiutolo and Robert N. Parker. August 1952. 27p. diagrs., photos., tab. (NACA RM L52G09)

A flight test was conducted using four tailless rocket-propelled models of low-aspect-ratio configurations, a 45° delta-wing configuration having NACA 63A010 airfoil sections, a 45° delta-wing configuration having NACA 63A006 airfoil sections, a 37.5° swept-tapered-wing configuration having NACA 64_1A012 airfoil sections, and a 39° swept-tapered-wing configuration having NACA 64A006 airfoil sections. Static and dynamic longitudinal stability and drag characteristics are presented throughout a Mach number range of 0.70 to 1.35.

NACA RM L52G14a

A PRESSURE-DISTRIBUTION INVESTIGATION OF A FINENESS-RATIO-12.2 PARABOLIC BODY OF REVOLUTION (NACA RM-10) AT M = 1.59 AND ANGLES OF ATTACK UP TO 36°. Morton Cooper, John P. Gapcynski, and Lowell E. Hasel. October 1952. 89p. diagrs., photos., tabs. (NACA RM L52G14a)

A pressure-distribution investigation of a parabolic body of revolution with a fineness ratio of 12.2 has been conducted in the Langley 4- by 4-foot supersonic tunnel at a Mach number of 1.59 and a Reynolds number of 3.6×10^6 for angles of attack from 0° to 36°. The data are presented in terms of pressures, local section coefficients, and overall body coefficients. In the low-incidence range, the pressures were well predicted by potential theory except on the leeward side of the body above an angle of attack of 5° where the pressures were affected by cross-flow separation. In the low-incidence range, the normal-force coefficient of the body was underestimated and the axial force predicted reasonably well by potential theory. Application of viscous-cross-flow concepts improved the agreement. The center of pressure was rearward of either the potential or cross-flow estimate.

NACA RM L52G23

EFFECTS OF WING ELASTICITY ON THE AERODYNAMIC CHARACTERISTICS OF A 45° SWEPTBACK-WING-FUSELAGE COMBINATION MEASURED IN THE LANGLEY 8-FOOT TRANSONIC TUNNEL. Robert S. Osborne and John P. Mugler, Jr. September 1952. 27p. diagrs., photos. (NACA RM L52G23)

A 45° sweptback-wing-fuselage configuration has been tested with identical aluminum and steel wings at Mach numbers from 0.6 to 1.13 for angles of attack up to 20° to determine effects of wing elasticity. Dynamic pressures varied from 400 to 850 pounds per square foot. Lift, drag, pitching moment, and base pressure were measured and some comparisons with calculated results are included.

NACA RM L52H22

AN INVESTIGATION OF SOME FACTORS AFFECTING THE DRAG OF RELATIVELY LARGE NONLIFTING BODIES OF REVOLUTION IN A SLOTTED TRANSONIC WIND TUNNEL. Robert E. Pendley and Carroll R. Bryan. January 1953. 52p. diagrs., photos., tabs. (NACA RM L52H22)

In a study of some factors affecting the drag of relatively large nonlifting bodies of revolution in a slotted transonic wind tunnel, measurements of tunnel wall and model surface-pressure distributions and comparisons of pressure and force drags are presented for a 66-inch body of revolution of 8-inch diameter and a half-scale model of that body. Effects of tunnel boundary interference on the data are discussed for an angle of attack of 0° and for a Mach number range of 0.60 to 1.125. Boundary interference was found to be negligible at subsonic Mach numbers, but large boundary effects were found at some supersonic Mach numbers.

NACA RM L53D30b

INVESTIGATION OF A HALF-CONICAL SCOOP INLET MOUNTED AT FIVE ALTERNATE CIRCUMFERENTIAL LOCATIONS AROUND A CIRCULAR FUSELAGE. PRESSURE-RECOVERY RESULTS AT A MACH NUMBER OF 2.01. Lowell E. Hasel, John L. Lankford, and A. W. Robins. June 1953. 41p. diagrs., photos., tab. (NACA RM L53D30b)

The effects of inlet circumferential position around the fuselage on the characteristics of a half-conical scoop inlet having a 24.6° half-angle cone have been investigated in the Langley 4- by 4-foot supersonic pressure tunnel. Pressure-recovery results have been obtained at a Mach number of 2.01 for a fixed boundary-layer-bleed height which was 60 percent of the boundary-layer thickness at an angle of attack of 0°, and for cowling position parameters of 42.4° and 38.0°. The inlet had a capture area equal to 24.9 percent of the basic-fuselage frontal area. The angle of attack was varied from 0° to 12°. The most favorable pressure-recovery characteristics at angles of attack were obtained with the inlet located on the bottom of the fuselage where the maximum recovery increased from a value of 81 percent at an angle of attack of 0° to 87 percent at 12°. In general,

the pressure recovery decreased with increasing angle of attack for all other inlet locations. At a given angle of attack the pressure recovery decreased as the inlet location was progressively moved from the bottom to the top of the fuselage. Stable subcritical operation of the inlet with nearly constant pressure recovery was obtained for inlet mass-flow ratios from 1.0 to about 0.76 at an angle of attack of 0° with the central body in the design position.

NACA RM L53G10a

INVESTIGATION OF WING FLUTTER AT TRANSONIC SPEEDS FOR SIX SYSTEMATICALLY VARIED WING PLAN FORMS. George W. Jones, Jr., and Hugh C. DuBose. August 1953. 32p. diagrs., photos., 3 tabs. (NACA RM L53G10a)

An investigation of the effects of systematic variations in wing plan form on the flutter speed at Mach numbers from 0.7 to 1.4 and at zero angle of attack has been conducted in the 26-inch Langley transonic blowdown tunnel. The angle of sweepback was varied from 0° to 60° on wings of aspect ratio 4, and the aspect ratio was varied from 2 to 6 on wings with 45° of sweepback. The results are presented as ratios between the experimental flutter speed and the reference flutter speed calculated on the basis of incompressible two-dimensional flow. This ratio, designated as the flutter-speed ratio, is plotted as a function of Mach number for the various wings.

NACA RM L53G13a

NOTES ON DAMPING IN ROLL AND LOAD DISTRIBUTIONS IN ROLL AT HIGH ANGLES OF ATTACK AND HIGH SUBSONIC SPEED. Richard E. Kuhn. August 1953. 18p. diagrs., tab. (NACA RM L53G13a)

This report presents some recent information on the damping-in-roll-derivative C_{l_p} of swept, unswept, and triangular plan forms at angles of attack up to 13° and Mach numbers up to 0.91, including some effects of fences and leading-edge notches. Some experimental information on span-load distribution of a 45° swept wing while rolling and a procedure for estimating the rolling load distribution are included.

NACA RM L53G16

EXPERIMENTAL INVESTIGATION OF AN AXIAL-FLOW SUPERSONIC COMPRESSOR HAVING ROUNDED LEADING-EDGE BLADES WITH AN 8-PERCENT MEAN THICKNESS-CHORD RATIO. Theodore J. Goldberg, Emanuel Boxer, and Peter T. Bernot. December 1953. 43p. diagrs., photos., tab. (NACA RM L53G16)

Details are presented of the results of tests in Freon-12 gas of an axial-flow supersonic compressor having rounded leading-edge blades. Tests were made for a range of tip speeds from 515 to 810 fps in Freon-12 which corresponds to a range from 1130 to 1760 fps in air. At the design tip speed of 730 fps (1600 fps in air) with guide vanes, the rotor produced a total-pressure ratio of 1.84 with an efficiency of 68 percent at an equivalent weight flow of 48.4 lb/sec of Freon-12; without guide vanes, the values were 2.06, 71.5, and 49.8, respectively.

NACA RM L53G29

A FLIGHT INVESTIGATION AT MACH NUMBERS FROM 0.67 TO 1.81 OF THE LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A 60° DELTA-WING MISSILE CONFIGURATION HAVING AN ALL-MOVABLE TAIL. Martin T. Moul and Hal T. Baber, Jr. October 1953. 43p. diagrs., photo. (NACA RM L53G29)

A flight investigation of a 60° delta-wing missile configuration having a small 60° all-movable tail was conducted. Longitudinal stability, control, and tail hinge-moment characteristics are presented for a Mach number range of 0.67 to 1.81. Comparisons were made with the data of a delta-wing missile having half-delta wing-tip controls and with approximate theories.

NACA RM L53J09

EFFECTS OF SLOT LOCATION AND GEOMETRY ON THE FLOW IN A SQUARE TUNNEL AT TRANSONIC MACH NUMBERS. William J. Nelson and James M. Cubbage, Jr. November 1953. 46p. diagrs., photos., tab. (NACA RM L53J09)

Data from an investigation of the effects of slot location and slot geometry on the flow in a square tunnel are presented for a Mach number range up to 1.4. These data are presented as curves of center-line static-to-stagnation pressure ratio plotted as a function of the distance from the plane of the slot origin with the slots located in one, two, or four walls or in the corners of a square tunnel. Calculated static pressure and angle-of-flow distributions along the slotted boundary are presented for several slot configurations investigated in a tunnel with two opposite walls slotted. Knowledge of the static-pressure difference across the slots is shown to be inadequate to define the flow rate across the boundary. The data show that, by maintaining a given distribution of open area, slots developed in one configuration may be applied to another with but minor changes in pressure distribution.

NACA RM L53J28

AN EXPERIMENTAL INVESTIGATION OF THE TRANSONIC-FLOW-GENERATION AND SHOCK-WAVE-REFLECTION CHARACTERISTICS OF A TWO-DIMENSIONAL WIND TUNNEL WITH 24-PERCENT-OPEN, DEEP, MULTISLOTTED WALLS. Thomas B. Sellers, Don D. Davis, and George M. Stokes. December 1953. 37p. diagrs., photos. (NACA RM L53J28)

The results of tests to determine the shock-wave-reflection and flow-generation characteristics of a two-dimensional wind tunnel with 24-percent-open, deep, multislotted walls are presented. The wave-reflection tests were made at a free-stream Mach number of 1.278. Center-line Mach number distributions were determined over a Mach number range from 0.80 to 1.32 and at wall-divergence angles of $0'$, $20'$, and $40'$. The suction outflows required for flow generation were measured over the Mach number and divergence-angle range.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM L53K19

EFFECTS OF AUXILIARY AND EJECTOR PUMPING ON THE MACH NUMBER ATTAINABLE IN A $4\frac{1}{2}$ - BY $4\frac{1}{2}$ -INCH SLOTTED TUNNEL AT LOW PRESSURE RATIOS. John S. Dennard and Barney H. Little, Jr. January 1954. 29p. diagrs., photos. (NACA RM L53K19)

The test-section Mach number was measured as a function of total pressure, slot flow removed by an auxiliary pump, and slot flow removed using the main stream as an ejector (as controlled by a variable ejector area and slot-flow reentry flaps at the downstream end of the slots) in a 4-1/2 by 4-1/2 inch slotted tunnel at Mach numbers up to 1.2 and Reynolds numbers from 4×10^6 to 7×10^6 per foot. Without auxiliary bleed the maximum Mach number was fixed by the position of the slot-flow reentry flaps and the ejector area, because these components fixed a choking station downstream of the test section. With auxiliary bleed a constant increase in Mach number of 0.1 for each 3.5 percent of main-stream flow bled off was measured and was little affected by flap position, ejector area, and Mach number. The results of this investigation when applied to a practical problem showed that substantial power savings could be realized in a slotted tunnel by the use of auxiliary-powered slot bleed.

NACA RM L54G13

SOME EFFECTS OF AILERON SPAN, AILERON CHORD, AND WING TWIST ON ROLLING EFFECTIVENESS AS DETERMINED BY ROCKET-POWERED MODEL TESTS AND THEORETICAL ESTIMATES. H. Kurt Strass and Warren A. Tucker. September 1954. 29p. diagrs., photos., tabs. (NACA RM L54G13)

The variation of rolling effectiveness with spanwise aileron extent has been determined for full-chord ailerons, and these data have been correlated with the results of a previous investigation concerning partial-chord trailing-edge ailerons. A limited check upon the principle of aerodynamic superposition was made by comparing estimates based on these data with data from tests employing twisted wings. These results are compared with values calculated by means of linear theory.

NACA RM L54G21a

FLIGHT DETERMINATION OF THE DRAG OF CONICAL-SHOCK NOSE INLETS WITH VARIOUS COWLING SHAPES AND AXIAL POSITIONS OF THE CENTER BODY AT MACH NUMBERS FROM 0.8 TO 2.0. Charles F. Merlet and Leonard W. Putland. September 1954. 41p. diagrs., photos., tabs. (NACA RM L54G21a)

External-drag data are presented for conical-shock nose inlet models with conic, parabolic, and 1-series profiles operating at both supercritical and subcritical flow rates. The tests were made at an angle of attack of 0°, using rocket-propelled models in free flight at Mach numbers from 0.8 to 2.0, and for Reynolds numbers based on body maximum diameter from 2×10^6 to 7×10^6. At a Mach number of approximately 1.1, the external drag appeared to be independent of profile shape. As the Mach number increased, the drag coefficients of the conic cowls became progressively lower than that of either the parabolic or the 1-series. Changing the external lip angle of the conic cowls from 5° to 17° had little effect on the external drag at maximum flow rates.

NACA RM L55B03

AN INVESTIGATION OF THE EFFECTS OF RAPID SKIN HEATING ON BOX BEAMS LOADED IN BENDING. Richard A. Pride. March 1955. 24p. diagrs., photos., tabs. (NACA RM L55B03)

Two beams of each of three web types were loaded in bending and subjected to rapid skin heating at rates of about 50° F to 70° F per second. Skin buckling, which can be predicted by a simplified analysis, occurred in channel-web beams because of thermal stresses superimposed on bending stresses. Skin buckling due to thermal stresses did not occur when the supporting web structure was changed to either corrugated webs or truss webs. In spite of the large variations in skin-buckling effects, thermal stresses appeared to have little influence on failing strength.

NACA RM L55F13

TESTS OF AERODYNAMICALLY HEATED MULTIWEB WING STRUCTURES IN A FREE JET AT MACH NUMBER 2. TWO ALUMINUM-ALLOY MODELS OF 20-INCH CHORD WITH 0.064- AND 0.081-INCH-THICK SKIN. George E. Griffith, Georgene H. Miltonberger, and Richard Rosecrans. August 1955. 39p. diagrs., photos., tabs. (NACA RM L55F13)

Two multiweb wing structures (MW-2 and MW-3) were tested at a Mach number of 2 under simulated supersonic flight conditions, and temperatures and strains were measured. One model failed dynamically toward the end of its test because of the combined action of aerodynamic heating and loading. The other model, with thicker skin, survived tests up to an angle of attack of 3.5° but failed statically at 5°.

NACA RM L55G22

FLIGHT MEASUREMENTS OF THE LOADS AND MOMENTS ON AN EXTERNAL STORE MOUNTED UNDER THE WING OF A SWEPT-WING FIGHTER-TYPE AIRPLANE DURING YAWING AND ROLLING MANEUVERS. Harold A. Hamer and Thomas C. O'Bryan. September 1955. 37p. diagrs., photo., tab. (NACA RM L55G22)

Flight measurements to determine the effects of maneuvering on external-store characteristics have been obtained with the use of a 245-gallon auxiliary fuel tank mounted under the wing of a North American

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F-86A airplane. The external-store normal- and side-load distributions, as well as the pylon side-load distributions, were measured during continuous sideslips, rudder kicks, and abrupt aileron rolls by means of an integrating pressure system at speeds up to the maximum Mach number obtainable and at lift coefficients up to about the airplane buffet boundary. The results are presented in the form of aerodynamic load-coefficient distributions and their corresponding overall force and moment coefficients in conjunction with a brief summary of the inertia loads experienced by the store.

NACA RM L55J13a

A METHOD FOR THE DESIGN OF POROUS-WALL WIND TUNNELS. George M. Stokes. January 1956. 50p. diagrs., photo., tabs. (NACA RM L55J13a)

This report contains a description of a general method for the design of a porous-wall wind tunnel which can be applied to the design of low-supersonic wind tunnels. This design method is concerned with the development of a uniform supersonic flow in the wind tunnel and the selection of the proper test-section open ratio necessary to give minimum shock-wave-reflection interference. The main feature of the method is its ability to indicate how design requirements and wall porosity characteristics can be combined to achieve a good flow for desired conditions. A limited amount of experimental data have been obtained to show that the method can successfully produce a suitable flow field for model testing.

NACA RM L56C07

AN EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF SEVERAL DIFFUSERS AND DIFFUSER-ENTRANCE—MIXING SECTION COMBINATIONS ON THE POWER REQUIREMENTS OF A $4\frac{1}{2}$-INCH BY $4\frac{1}{2}$-INCH SLOTTED TRANSONIC WIND TUNNEL. John S. Dennard. June 1956. 65p. diagrs., tabs. (NACA RM L56C07)

A $4\frac{1}{2}$-inch-square tunnel in which two opposite walls were slotted has been tested to determine the effects of various slot exit shapes, mixing sections, and diffusers on power requirements. Information obtained included measurements of the required overall pressure ratio to operate the tunnel, the effects of auxiliary bleed flow, diffuser static pressure ratios and distributions, and diffuser total pressure distributions. Power parameters were determined from the integrated values of the total pressures at the diffuser exit together with the auxiliary bleed-flow rate.

NACA RM L56G02

EFFECT OF A FUSELAGE ON THE LOW-SPEED LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A 45° SWEPTBACK WING WITH DOUBLE SLOTTED FLAPS. Rodger L. Naeseth. September 1956. 31p. diagrs., tabs. (NACA RM L56G02)

A low-speed investigation has been made to determine the effect of a fuselage on the longitudinal aerodynamic characteristics of a 45° sweptback wing equipped with 0.35-semispan double-slotted flaps. The wing had an aspect ratio of 3.7, a taper ratio of 0.41, and a streamwise thickness ratio of 0.086. The cylindrical fuselage had an ogival nose and ratio of diameter to wingspan of 0.12. The double-slotted flaps consisted of a 0.213-wing-chord main flap and either a 0.500-flap-chord vane or a 0.266-flap-chord vane. The tests, in general, were made at a Reynolds number of 1.8×10^6; however, tests for one deflection of the double-slotted flaps were made over a range of Reynolds numbers of 0.93×10^6 to 3.35×10^6. The fuselage had a favorable effect on the lift characteristics of the double-slotted flaps. However, the fuselage had an adverse effect on the lift characteristics of an extended plain flap.

#NACA RM SE50G12, by Blivas and Taylor

National Advisory Committee for Aeronautics
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CURRENT NACA RESEARCH REPORTS

NACA RM L57G02

AIRPLANE MEASUREMENTS OF ATMOSPHERIC TURBULENCE FOR ALTITUDES BETWEEN 20,000 AND 55,000 FEET OVER THE WESTERN PART OF THE UNITED STATES. Thomas L. Coleman and Emilie C. Coe. August 1957. 16p. diagrs., photo., tab. (NACA RM L57G02)

An analysis of a sample of data on atmospheric turbulence obtained from NACA VGH records taken on Lockheed U-2 airplanes during research flights covering approximately 40,000 miles for altitudes between 20,000 and 55,000 feet over the western part of the United States is presented. The results for the variation of intensity and amount of turbulence with altitude are compared with turbulence data previously obtained from similar operations over England and Western Europe and with earlier estimates of average turbulence conditions over the United States.

NACA TN 3783

HANDBOOK OF STRUCTURAL STABILITY. PART III - BUCKLING OF CURVED PLATES AND SHELLS. George Gerard and Herbert Becker, New York University. August 1957. iii, 154p. diagrs., tabs. (NACA TN 3783)

Available theories and test data on buckling of curved plates and shells are reviewed. The test data for torsion and external-pressure loadings are correlated in terms of linear buckling theories for both the elastic and inelastic ranges. The cases which exhibit a marked disagreement between linear theory and test data have been analyzed by a unified semi-empirical approach which is satisfactory for analysis and design purposes.

NACA TN 3784

HANDBOOK OF STRUCTURAL STABILITY. PART IV - FAILURE OF PLATES AND COMPOSITE ELEMENTS. George Gerard, New York University. August 1957. ii, 93p. diagrs., tabs. (NACA TN 3784)

Available theories on failure of flat plates are reviewed, and test data on the postbuckling behavior, effective width, and failure of flat and curved plates are correlated. Test data on the crippling strength of various formed and extruded shapes are reviewed, from which a generalized method of crippling analysis is formulated. This analysis is then applied to a variety of sections and materials in common use.

NACA TN 3785

HANDBOOK OF STRUCTURAL STABILITY. PART V - COMPRESSIVE STRENGTH OF FLAT STIFFENED PANELS. George Gerard, New York University. August 1957. ii, 89p. diagrs., tabs. (NACA TN 3785)

A generalized crippling analysis for short monolithic panels with formed or extruded stiffeners is presented. Methods are presented for determining if riveted panels act in a monolithic manner and for determining the strength of those which do not. The failure modes of intermediate-length and long stiffened panels are discussed and methods given for estimating column strength. Theory and test data on optimum stiffened panels are presented and the various factors of importance in box types of construction are considered.

NACA TN 3988

EXPERIMENTAL AND CALCULATED HISTORIES OF VAPORIZING FUEL DROPS. R. J. Priem, G. L. Borman, M. M. El Wakil, O. A. Uyehara, and P. S. Myers, University of Wisconsin. August 1957. 66p. diagrs. (NACA TN 3988)

The results of an experimental and theoretical investigation of the vaporization of fuel droplets in heated air under atmospheric pressure are presented. First, an experimental investigation of the temperature and mass histories of single droplets, with emphasis on small drops down to 500 microns, was made. Second, a comparison of experimental with calculated temperature and mass histories was made. Third, the time taken by a droplet vaporizing in high-temperature air to form a mixture of fuel vapor and air of combustible strength in the film of the droplet and at the self-ignition temperature is calculated. In addition, the vaporization of fuel droplets in a spray under conditions where one droplet influences another is investigated theoretically.

CURRENT NACA RESEARCH REPORTS

NACA TN 4031

STABILITY LIMITS AND BURNING VELOCITIES FOR SOME LAMINAR AND TURBULENT PROPANE AND HYDROGEN FLAMES AT REDUCED PRESSURE. Burton Fine. August 1957. 49p. diagrs., tabs. (NACA TN 4031)

The stability behavior for propane-oxygen-nitrogen, hydrogen-argon-"air," and hydrogen-helium-"air" burner flames is similar to that previously found for hydrogen-air flames. The propane-oxygen-nitrogen system shows greater reactivity based on flashback than does the hydrogen-air system, but less stability toward reduced pressures. The pressure exponent of burning velocity was nearly the same as for hydrogen-air flames. Critical boundary velocity gradients for laminar and turbulent flashback and turbulent blowoff were correlated with pressure; however, those for laminar blowoff were not. Critical flashback gradients for several fuel-oxidant systems follow the reciprocal of the adiabatic flame temperature exponentially, like a reaction rate.

NACA TN 4065

TENSILE PROPERTIES OF INCONEL X SHEET UNDER RAPID-HEATING AND CONSTANT-TEMPERATURE CONDITIONS. Ivo M. Kurg. August 1957. 20p. diagrs., tabs. (NACA TN 4065)

Results of rapid-heating tests of Inconel X sheet are presented for nominal temperature rates of 0.2° F to 100° F per second under constant tensile load conditions. Yield and rupture stresses obtained under rapid-heating conditions are compared with the results of conventional tensile stress-strain tests at elevated temperatures. A marked increase in strength is observed with increased temperature rates. A temperature-rate parameter was used to construct master curves from which stresses and temperatures for yield and rupture can be predicted under rapid-heating conditions.

NACA TN 4074

COMPRESSIVE STRESS-STRAIN PROPERTIES OF 17-7 PH AND AM 350 STAINLESS-STEEL SHEET AT ELEVATED TEMPERATURES. Bland A. Stein. August 1957. 21p. diagrs., photo., tabs. (NACA TN 4074)

Results of compressive stress-strain tests on 17-7 PH and AM 350 stainless-steel sheet in the heat-treated and in the annealed conditions are presented for temperatures up to 1,200° F. The 17-7 PH stainless steel was heat-treated to Condition TH 1,050; the AM 350, to the double-aged condition. Representative compressive stress-strain curves are given for each material at the test temperatures. From these curves significant data such as 0.2-percent-offset yield stress, Young's modulus, and secant and tangent moduli are presented.

NACA TN 4078

A DISCUSSION OF CONE AND FLAT-PLATE REYNOLDS NUMBERS FOR EQUAL RATIOS OF THE LAMINAR SHEAR TO THE SHEAR CAUSED BY SMALL VELOCITY FLUCTUATIONS IN A LAMINAR BOUNDARY LAYER. Neal Tetervin. August 1957. 25p. diagrs. (NACA TN 4078)

By use of the linear theory of boundary-layer stability and Schlichting's formula for the maximum amplification of a disturbance, an approximate relation is derived between the Reynolds number on a cone and the Reynolds number on a flat plate for equal closeness to transition. The indication is that the ratio of the cone Reynolds number for transition, based on the distance to the cone apex, to the plate Reynolds number for transition, based on the distance to the leading edge, is not in general equal to 3, as has been suggested by other investigators, but varies from 3 when transition occurs at the minimum critical Reynolds number to unity when transition occurs at a large multiple of the critical Reynolds number.

BRITISH REPORTS

N-48947*

Aeronautical Research Council (Gt. Brit.)
AN APPROXIMATE SOLUTION OF SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS. P. E. W. Grensted. September 17, 1954. 3p. ARC 17,160; S & C 2953. (Ask for N-48947*)

N-48957*

Aeronautical Research Council (Gt. Brit.)
LOADS ON A MODEL DURING STARTING AND STOPPING OF AN INTERMITTENT SUPERSONIC WIND TUNNEL. K. G. Winter and C. S. Brown. 1957. 17p. diagrs., photos. ARC CP 335. (Ask for N-48957*)

Measurements are given of the loads on a model during starting and stopping of an intermittent supersonic wind tunnel at Mach numbers of 2.00 and 2.48. Qualitative agreement is obtained with a simple theory, but a need is evident for further measurements at higher Mach numbers. The use of a model loading coefficient in terms of tunnel stagnation pressure is proposed.

BRITISH REPORTS

N-48958*

Aeronautical Research Council (Gt. Brit.)
BRIEF DESCRIPTION OF THE R. A. E. INTERMITTENT SUPERSONIC WIND TUNNEL PLANT. K. G. Winter. 1957. 15p. diagrs., photos. ARC CP 336. (Ask for N-48958*)

The plant is vacuum operated on a closed circuit with storage of the air in a flexible container. The useful Mach number range is up to about 4.5. For the largest of the tunnels (15 in. by 16 in.) the maximum running time is of the order of 20 seconds over the whole Mach number range. Runs of 10 to 15 seconds duration can be made every five minutes.

N-48959*

Aeronautical Research Council (Gt. Brit.)
TABLES OF CHARACTERISTICS SLOPES FOR USE IN THE DESIGN OF NOZZLES FOR SUPERSONIC WIND TUNNELS. K. G. Winter. 1957. 12p. diagr., tabs. ARC CP 337. (Ask for N-48959*)

Tables are given which are of use in the calculation of characteristic networks appropriate to two-dimensional nozzles for Mach numbers up to 4.5. The tabulated characteristics slopes enable the co-ordinates of a characteristics intersection each to be evaluated in one operation on a desk calculating machine.

N-48960*

Aeronautical Research Council (Gt. Brit.)
ATMOSPHERIC TURBULENCE ENCOUNTERED BY HERMES AIRCRAFT. J. R. Heath-Smith. 1957. 20p. diagrs., tabs. ARC CP 334. (Ask for N-48960*)

Acceleration records were obtained of the turbulence encountered by B. O. A. C. Hermes aircraft in 417,000 miles of operational flying on routes from London to East and West Africa. It is shown that turbulence decreases with increasing altitude. A result of the pilot's discretion in choice of altitude and course is that the gust frequency encountered during most of the cruise is about one-third of the average atmospheric gust frequency. Between 9,500 feet and 14,500 feet gusts were encountered four times as frequently over East and West African sectors as over European sectors.

N-48961*

Aeronautical Research Council (Gt. Brit.)
A GENERALISATION OF THE NYQUIST STABILITY CRITERION WITH PARTICULAR REFERENCE TO PHASING ERROR. R. H. Merson. 1957. 9p. diagr. ARC CP 330. (Ask for N-48961*)

The effect of phasing error on the stability of a two-dimensional linear servomechanism is considered and it is shown that the system will be stable if the phase margin at the cutoff frequency exceeds the phasing error. The more general case of a number of identical servos with cross coupling is investigated and a generalization of the Nyquist criterion for stability is formulated.

N-48962*

Aeronautical Research Council (Gt. Brit.)
FLUTTER CALCULATIONS ON A SUPERSONIC AIRCRAFT WING. Ll. T. Niblett. 1957. 16p. diagrs. ARC CP 328. (Ask for N-48962*)

Flutter calculations have been made on a straight-tapered unswept wing of low-aspect ratio both with and without wing engines to discover the stiffness necessary to avoid flutter up to a Mach number of 2 and to find whether wing engines can be used to mass balance the wing effectively. Simple arbitrary modes of flexure and torsion were assumed and calculations were made using subsonic, transonic, and supersonic derivatives. It has been found that the stiffness required to prevent flutter of the bare wing is not excessive and that wing engines have a powerful mass balancing effect if placed forward on the wing. The transonic case is the most critical, but as the transonic derivatives used were two-dimensional this conclusion must be regarded as tentative.

N-48963*

Aeronautical Research Council (Gt. Brit.)
THE VARIATION OF GUST FREQUENCY WITH GUST VELOCITY AND ALTITUDE. N. I. Bullen. 1957. 13p. ARC CP 324. (Ask for N-48963*)

Information on atmospheric turbulence obtained from counting accelerometer records is examined and relations giving the variation of gust frequency with gust velocity and altitude are obtained. The results are summarized in a form convenient for use in estimating the fatigue life of an aircraft.

N-48964*

Aeronautical Research Council (Gt. Brit.)
RESULTS OF A FLIGHT INVESTIGATION ON CLEAR AIR TURBULENCE AT LOW ALTITUDE USING A METEOR MK: 7 AIRCRAFT. R. M. Allan. 1957. 16p. diagrs., photo., tabs. ARC CP 329. (Ask for N-48964*)

Low-level runs were made over a given route at heights below 1000 ft above ground and at an airspeed of 400 knots. A distance of 6080 nautical miles was covered and the accelerations due to gusts were recorded by a continuous trace accelerometer. The results of all the runs showed that, on the average, a 1g gust or greater occurred every 7.06 minutes. Comparison with other information on this subject showed that the results from this investigation fitted in with existing data. There were considerably more positive than negative gusts, the factor being 18 at 1.2g or greater. It would appear that for the

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area in which the flights were made, turbulence near the ground is not isotropic. A consideration of meteorological factors showed that on this route wind is far more powerful in producing turbulence at low altitude than the effect of sun.

N-48965*

Aeronautical Research Council (Gt. Brit.)
HEAT TRANSFER TO TURBINE BLADES. S. J. Andrews and P. C. Bradley. 1957. 23p. ARC CP 294. (Ask for N-48965*)

Results of tests on two typical cascades, together with other collected results, are given. The two cascades investigated experimentally were of the nozzle and impluse type, respectively, tested at a single incidence. The results obtained showed that the main factor governing the magnitude of the heat-transfer coefficient is the character of the flow; whether it is laminar or turbulent. An attempt was also made to decide on what temperatures and pressures to base the physical quantities, conductivity, viscosity, etc., using the correlation of the experimental points as a criterion.

N-48966*

Aeronautical Research Council (Gt. Brit.)
MULTHOPP'S SUBSONIC LIFTING-SURFACE THEORY OF WINGS IN SLOW PITCHING OSCILLATIONS. H. C. Garner. 1956. 49p. diagrs., tabs. ARC R & M 2885. Supersedes ARC 15,096; S & C 2665; 0.1004; FM 1768. (Ask for N-48966*)

This report is an extension of Multhopp's subsonic lifting-surface theory from steady flow to harmonic pitching oscillations of low frequency. The method is applicable to wings of arbitrary plan form. The theory is remarkably consistent with the pitching derivatives measured at low speeds and predicts fairly well the effect of compressibility up to a Mach number of about 0.9. Instructions for the computer are given in an appendix.

N-48968*

Aeronautical Research Council (Gt. Brit.)
THEORETICAL RELATIONSHIPS BETWEEN COMBUSTION INTENSITY AND PRESSURE DROP FOR ONE-STREAM COMBUSTION CHAMBERS. D. B. Spalding. April 10, 1957. 14p. diagrs. ARC 19,181; CF 393. (Ask for N-48968*)

Theoretical combustion performance is worked out for some two-dimensional and spherical combustion chambers employing recirculation. Account is taken of the variation of temperature and composition through the chamber. The fuel and air are assumed premixed. It is shown that a high recirculation ratio brings good combustion performance but high pressure drop. These effects are calculated quantitatively. Comparison is made with results obtained by electric analog and with a theoretical model employing random turbulence. The recirculation chambers are superior to most of those tried on the analog and greatly superior to the random-turbulence model.

N-48970*

Aeronautical Research Council (Gt. Brit.)
THE QUENCHING OF FLAMES BY DILUENTS. J. H. Burgoyne. September 11, 1954. 9p. diagr., tabs. ARC 17,037; CF 299. (Ask for N-48970*)

Contains general influence of diluents on limits of inflammability, inert and reactive additives, quenching of flames of burning liquids, quenching of flames at a wick, and quenching of mist flames.

N-48971*

Aeroplane and Armament Experimental Establishment (Gt. Brit.) DROPPING OF APPARATUS SEA RESCUE TYPE 'A' MK. 2 (LINDHOLME) FROM THE ENTRANCE DOORS OF HASTINGS AND VALETTA AIRCRAFT BY MANUAL DESPATCH. March 29, 1957. 6p. photos. AAEE/Tech/139/P. (Ask for N-48971*)

The method presently in use of dispatching the apparatus from these aircraft is not entirely satisfactory but can be used in an emergency with a reasonable chance of success. This report describes how an improved method of preparation and dispatch of the apparatus evolved for the Varsity and Pembroke aircraft has been applied satisfactorily to the Hastings and Valetta aircraft. The prepared equipment is interchangeable between the Pembroke, Valetta, and Hastings aircraft with the exception only of floor fittings to clamp the apparatus into position for dispatch.

N-48983*

Aeronautical Research Council (Gt. Brit.)
LOADING CONDITIONS OF TAILED AIRCRAFT IN LONGITUDINAL MANOEUVRES. T. Czaykowski. 1956. 59p. diagrs. ARC R & M 3001; ARC 17,687. Supersedes RAE Structures 177. (Ask for N-48983*)

An analysis of aircraft response and loading conditions in symmetrical maneuvers is presented with a particular recognition of the designer's needs. The analysis is based on the theory of aircraft response to elevator-induced longitudinal maneuvers. Basic response functions have been derived for the chosen, exponential type of elevator motion, and from these general expressions have been obtained for various derived response quantities, such as tail-plane loads, elevator hinge moments, normal accelerations at the tail, etc. A computational method which reduces the calculations to a routine is included.

BRITISH REPORTS

N-48984*

Aeronautical Research Council (Gt. Brit.)
VELOCITIES ON TWO-DIMENSIONAL CLOSED AND SEMI-INFINITE AEROFOILS AT ZERO INCIDENCE. S. Neumark and B. Thwaites. 1957. 14p. diagrs. ARC R & M 2994; ARC 17,440. Supersedes RAE Tech. Note Aero 2362. (Ask for N-48984*)

An attempt is made to clarify the position as to the comparative two-dimensional velocity distributions on a thin doubly symmetrical airfoil and on the corresponding semi-infinite body, the front part being the same in the two cases. It is shown that the approximate linear method may be used with advantage to investigate the problem. The method provides a simple general proof that the supervelocity at the midchord station of a closed doubly symmetrical profile of any shape is approximately halved when the rear half is replaced by a semi-infinite parallel body.

N-48985*

Aeronautical Research Council (Gt. Brit.)
THE OSCILLATING AEROFOIL IN SUBSONIC FLOW. W. P. Jones. 1956. 16p. tab. ARC R & M 2921. Supersedes ARC 15,642; 0.1043; FM 1862; S & C 2737. (Ask for N-48985*)

A relatively simple method for calculating the aerodynamic forces on an oscillating airfoil is developed and used to derive the aerodynamic coefficients for M = 0.7, 0.8, and 0.9 for a range of frequency parameter values.

N-48986*

Aeronautical Research Council (Gt. Brit.)
TESTS AT HIGH SUBSONIC SPEEDS ON A 10 PER CENT THICK PRESSURE-PLOTTING AEROFOIL OF RAE 104 SECTION. E. W. E. Rogers, C. J. Berry, and R. F. Cash. 1956. 49p. diagrs., photos., tabs. ARC R & M 2863. Supersedes ARC 13,509; Perf. 709; ARC 13,789; Perf. 709a & ARC 13,947; Perf. 709b. (Ask for N-48986*)

This is part of a series of tests on this airfoil. Results are given of a determination of the force coefficients, surface pressures, and flow patterns for the airfoil through a range of Mach numbers at angles of attack up to 8°.

N-48987*

Aeronautical Research Council (Gt. Brit.)
LOCAL COEFFICIENTS OF SKIN FRICTION AND HEAT TRANSFER FOR TURBULENT BOUNDARY LAYERS IN TWO-DIMENSIONAL DIFFUSERS. J. N. Hool, Oxford University. 1957. 12p. diagrs. ARC R & M 2986; ARC 17,079. (Ask for N-48987*)

Considers the changes of local coefficients of skin friction and heat transfer for turbulent boundary layers in two-dimensional subsonic airstreams under rising pressure gradients. Values of the local coefficients of skin friction and heat transfer are compared on the basis of Reynolds analogy, Von Kármán's improvement to Reynolds analogy, and on the basis of similar velocity and temperature boundary-layer profiles. Test on diffusers at total angles of 4° and 7° showed that local coefficients of heat transfer, based on the measured heat-transfer values, increased with increase of the stream velocity and diffuser angle relative to the local coefficients of heat transfer, based on Reynolds analogy and on Von Kármán's improvement to Reynolds analogy. Local coefficients of heat transfer calculated on an assumed similarity of velocity and temperature distributions were unsatisfactory.

N-48988*

Aeronautical Research Council (Gt. Brit.)
WIND-TUNNEL FLUTTER TESTS ON A DELTA WING WITH AN ALL-MOVING TIP CONTROL SURFACE. D. R. Gaukroger. 1956. 17p. diagrs., tab. ARC R & M 2978; ARC 16,595. Supersedes RAE Structures 157. (Ask for N-48988*)

Wind-tunnel tests on a half-span model delta wing, fitted with an all-moving tip control surface, are described. The model, which is flexible, has a leading-edge sweepback of 45° and the control surface, which is rigid, has an area 9.3 percent of the gross wing area. The control surface is hinged at 47.4 percent of its root chord. Provision is made for varying the circuit stiffness and the position of the center of gravity of the control surface and its pitching moment of inertia. Tests show that certain combinations of control-surface inertia and circuit stiffness produce very low flutter speeds. The effect of reducing the control-surface area by cropping the tip is examined and in general is found to be beneficial.

N-48989*

Aeronautical Research Council (Gt. Brit.)
THE AERODYNAMIC DERIVATIVES WITH RESPECT TO A RATE OF YAW FOR A DELTA WING WITH DIHEDRAL AND AT INCIDENCE AT SUPERSONIC SPEEDS. J. H. Hunter-Tod. 1957. 23p. diagrs. ARC R & M 2887. Supersedes ARC 14,338; S & C 2562; FM 1737. (Ask for N-48989*)

The assumptions of the linearized theory of flow are made throughout; only first-order terms in the rate of turn are considered. The terms dependent on the dihedral alone are continuous and decrease numerically with rising Mach number. The remaining terms are discontinuous at a Mach number at which a leading edge becomes supersonic; in particular the rolling-moment component due to incidence changes sign; the other derivatives may do likewise in certain circumstances. The approximate theory developed in the paper breaks down as a leading edge nears the Mach wave from the vertex of the wing. The yawing amplitude for which the results quoted present reasonable approximations decreases rapidly as this condition is approached; in particular the contributions of the leading-edge suction become defined.

BRITISH REPORTS

N-48990*

Aeronautical Research Council (Gt. Brit.)
AN INVESTIGATION OF THE HIGH ALTERNATING STRESSES IN THE BLADES OF AN AXIAL-FLOW COMPRESSOR. J. R. Forshaw. 1957. 19p. diagrs., photos., tab. ARC R & M 2988; ARC 17,132. Supersedes NGTE R.157. (Ask for N-48990*)

A vibration investigation of the first-, second-, and third-stage stator blades of an axial-flow compressor gave high values of the alternating stresses of the order of 10,000 lb/sq in. On three runs excessive values of the alternating stress of 24,000, 27,500, and 48,000 lb/sq in. were obtained, and for these and for some of the other maximums the incidence was estimated to equal the stalling incidence. There is excitation at all speeds of low orders showing dissimilar flow in different parts of the stage and this excitation increases in a critical manner at or near stalling incidence indicating a partial stall which is localized in parts of the stage. At greater incidence the flow deteriorates, the contrast between various parts of the stage is reduced, and the level of the alternating stress falls to a value slightly higher than that at incidences lower than the partial stall.

N-48991*

Aeronautical Research Council (Gt. Brit.)
THE REFLECTION EFFECT OF FENCES AT LOW SPEEDS. J. Weber and J. A. Lawford. 1956. 14p. diagrs. ARC R & M 2977; ARC 17,060. Supersedes RAE Tech. Note Aero 2308. (Ask for N-48991*)

This note considers the effect on the flow over a swept wing of vertical plates of small height - commonly called "fences." It is shown, as might be expected, that the nature of this effect is that of a partial-reflection plate. The effect of this partial reflection on the pressure distribution over the wing on either side of the fence has been investigated theoretically and by means of pressure measurements at low speeds on an untapered 45° swept-back wing.

N-48992*

Aeronautical Research Council (Gt. Brit.)
THEORETICAL LOAD DISTRIBUTIONS ON FIN-BODY-TAILPLANE ARRANGEMENTS IN A SIDE-WIND. J. Weber and A. C. Hawk. 1957. 58p. diagrs., tabs. ARC R & M 2992; ARC 17,413. Supersedes RAE Aero 2518. (Ask for N-48992*)

A theory has been developed for calculating the distributions of side force and lift on fin-fuselage-tailplane arrangements in a side wind but with the tail plane set at zero incidence. The analysis is limited to incompressible flow and has been further simplified by assuming that the geometrical arrangement is in each case such as to give constant induced sidewash. The results, which can be extended to other arrangements and to compressible subcritical flow, are required for stability and stressing analyses.

N-48993*

Aeronautical Research Council (Gt. Brit.)
EFFECT OF YAW ON THE COMPRESSIBLE LAMINAR BOUNDARY LAYER. J. Tinkler. 1957. 14p. diagrs., tab. ARC R & M 3005. Supersedes ARC 17,717; FM 2269. (Ask for N-48993*)

The equations governing the laminar compressible boundary layer on a yawed body of infinite span are transformed to give three nondimensional equations defining two velocity components and the enthalpy. Assuming that the Prandtl number is unity and that there is zero heat transfer, a relation is obtained between the stream Mach number and the angle of yaw for flows which give the same boundary-layer equations. The further assumption of viscosity proportional to the absolute temperature is made and "similar" solutions are found to be given by a family of surface Mach number distributions normal to the leading edge. "Similar" solutions, obtained from a differential analyzer, are presented for a range of two controlling parameters.

N-48994*

Aeronautical Research Council (Gt. Brit.)
THE THREE-DIMENSIONAL BOUNDARY-LAYER EQUATIONS AND SOME POWER SERIES SOLUTIONS. L. C. Squire, University of Bristol. 1957. 17p. diagr., tabs. ARC R & M 3006; ARC 17,967. (Ask for N-48994*)

The boundary-layer equations are derived for a very general coordinate system, and various theorems hitherto only proved in more restrictive systems are extended to this general system. The particular case of streamlines of zero geodesic curvature is investigated in detail and a solution of such a flow found by a power-series method. Finally Howarth's stagnation-point solution is extended to second-order terms by numerical investigation.

N-48996*

Aeronautical Research Council (Gt. Brit.)
MEASUREMENTS OF THE THRUST PRODUCED BY CONVERGENT-DIVERGENT NOZZLES AT PRESSURE RATIOS UP TO 20. P. F. Ashwood, G. W. Crosse, and Jean E. Goddard. 1957. 25p. diagrs. ARC CP 326. (Ask for N-48996*)

In continuation of a previous investigation, tests have been made on a series of convergent-divergent nozzles having an included divergence angle of 20° to obtain performance data at pressure ratios applicable to jet engines operating in the flight speed range $M = 2$ to $M = 3$. A new test technique has been used which, by utilizing the ejector action of the jet from the test nozzle to reduce the exit pressure, enables the range of pressure ratios obtainable across the nozzle to be extended threefold. This technique, which has proved simple to apply and control, is described in detail.

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N-48997*

Aeronautical Research Council (Gt. Brit.)
THE INFLUENCE OF PRESSURE RATIO AND DIVERGENCE ANGLE ON THE SHOCK POSITION IN TWO DIMENSIONAL, OVER-EXPANDED, CONVERGENT-DIVERGENT NOZZLES. P. F. Ashwood and G. W. Crosse. 1957. 27p. diagrs., tab. ARC CP 327. (Ask for N-48997*)

Tests have been made to determine the influence of divergence angle and applied pressure ratio on the shock position in overexpanded, Laval-type, convergent-divergent nozzles. The tests covered a range of design pressure ratios between 3.5 and 17.0 and included divergence angles of from 5° to 40°. An empirical expression has been derived which enables the limiting pressure ratio at which the nozzle just runs full to be calculated and curves are presented from which the shock position within the nozzle can be obtained. The variation with design pressure ratio of the maximum pressure ratio obtainable across the exit shock has been determined and the results compared with those predicted using a semiempirical formula derived from shock-wave boundary-layer interaction experiments. Good agreement has been obtained.

N-48998*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF HEAT TRANSFER ON INTERACTIONS INVOLVING LAMINAR BOUNDARY LAYERS. K. N. C. Bray. 1957. 7p. diagr., tab. ARC CP 339. (Ask for N-48998*)

A theory is developed to allow for heat-transfer effects in interactions between laminar boundary layers and shock waves and on boundary-layer separation. As a simple example of the use of this theory, the effect of wall temperature on the Mach number change to cause separation of a laminar boundary layer has been found for large Reynolds numbers. Suggestions are made for further calculations, based on the method.

N-48999*

Aeronautical Research Council (Gt. Brit.)
FLOW INSTABILITY OF CENTRE-BODY DIFFUSERS AT SUPERSONIC SPEEDS. D. Beastall. 1956. 12p. diagrs., photos. ARC R & M 2933; ARC 14,519; ARC 16,599. Supersedes RAE Tech. Note Aero 2128 and RAE Tech. Note Aero 2128a. (Ask for N-48999*)

This note offers explanations for certain types of flow instability which occur with center-body diffusers at supersonic speeds. These instabilities manifest themselves as oscillations of the shock pattern ahead of the diffuser and the flow through the diffuser for certain conditions of operation and are likely to affect seriously the performance. Two main types of oscillations have been distinguished: a violent oscillation which occurs when the flow through the diffuser is throttled below a certain value; and a less severe oscillation which occurs when the vortex sheet from the intersection of the shock waves ahead of the diffuser or a separated boundary layer strikes the cowl. The explanations of the oscillations are substantiated by schlieren photographs of two- and three-dimensional model diffuser tests in a wind tunnel. It seems possible, in the light of the explanation given in this note, to be able to predict the range of instability of any center-body diffuser configuration by fairly simple model tests.

N-50000*

Aeronautical Research Council (Gt. Brit.)
CONTROL EFFECTIVENESS TESTS AT TRANSONIC SPEEDS ON AN EC.1250 SECTION WITH 0.25 CHORD CONCAVE CONTROL. T. Lawrence. 1955. 7p. diagrs., photos., tab. ARC R & M 2809; ARC 13,906. Supersedes RAE Tech. Note Aero 2089. (Ask for N-50000*)

Control-effectiveness tests, using the ground-launched rocket-boosted model technique, have been made on rectangular wings of aspect ratio 4, EC.1250 section, and fitted with a 25-percent chord concave control flap. Tests were done from $M = 0.73$ to $M = 1.5$, and at $R = 3.5 \times 10^{6}$ and 7×10^{6} at $M = 1$. There is a sudden and large reversal in control effectiveness at $M = 0.9$, but the measured effectiveness below $M = 0.8$ and above $M = 1.1$ is in good agreement with theory. These tests confirm and extend to higher Reynolds numbers and Mach numbers previous tunnel tests on the same section.

N-50001*

Aeronautical Research Council (Gt. Brit.)
ESTIMATION OF THE CHANGE IN PERFORMANCE CHARACTERISTICS OF A TURBINE RESULTING FROM CHANGES IN THE GAS THERMODYNAMIC PROPERTIES. D. G. Ainley. 1956. 13p. diagrs., tabs. ARC R & M 2973; ARC 14,353. Supersedes NGTE Memo. M. 118. (Ask for N-50001*)

Frequently turbines are tested in a laboratory with cool air which has thermodynamic properties different from those of the hot gas for which the turbine is designed. This note presents methods for correcting such tests to allow for a difference in gas thermodynamic properties.

BRITISH REPORTS

N-50002*

Aeronautical Research Council (Gt. Brit.)
THE INTERACTION BETWEEN SHOCK WAVES AND BOUNDARY LAYERS AT THE TRAILING EDGE OF A DOUBLE-WEDGE AIRFOIL AT SUPERSONIC SPEED. B. D. Henshall and R. F. Cash. 1957. 10p. diagrs., photos. ARC R & M 3004; ARC 17,428. (Ask for N-50002*)

The shock-wave boundary-layer interaction occurring near the trailing edge of a double-wedge airfoil at supersonic speeds is qualitatively similar to that occurring when the shock is generated by a wedge attached to a plate. Both these phenomena show large differences of upstream effect from the interaction of an externally generated shock with boundary layers of the same type.

N-50003*

Aeronautical Research Council (Gt. Brit.)
PUBLISHED REPORTS AND MEMORANDA OF THE AERONAUTICAL RESEARCH COUNCIL. 1957. 7p. ARC R & M 2750. (Ask for N-50003*)

N-50004*

Aeronautical Research Council (Gt. Brit.)
PROBLEMS OF LONGITUDINAL STABILITY BELOW MINIMUM DRAG SPEED, AND THEORY OF STABILITY UNDER CONSTRAINT. S. Neumark. 1957. 37p. diagrs. ARC R & M 2983; ARC 16,825. Supersedes RAE Aero 2504. (Ask for N-50004*)

Practical difficulties in cruising below minimum drag speed have long been known but not fully explained. The reasoning proposed by Painlevé in 1910 purported that flight below minimum drag speed should be fundamentally unstable, so that any speed error would lead to a divergence. This reasoning is shown to be invalid on the ground of the general theory of dynamic stability in uncontrolled flight, Painlevé's criterion being a grossly inadequate approximation to the condition of phugoid stability. However, the criterion may be fully vindicated for the case of flight controlled by the elevator in such a way as to maintain constant height.

N-50005*

Aeronautical Research Council (Gt. Brit.)
PRELIMINARY REPORT ON A GUST ALLEVIATOR INVESTIGATION ON A LANCASTER AIRCRAFT. J. Zbrozek, K. W. Smith, and D. White. 1957. 42p. diagrs., photo. ARC R & M 2972; ARC 16,572. Supersedes RAE Tech. Note Aero 2244. (Ask for N-50005*)

The investigation of gust alleviator effectiveness is limited to an analysis of statistical measurements of c. g. accelerations. The measured alleviation is much smaller than was initially expected and in some cases is even negative. Theoretical analysis, supported by experiment, indicates that the loss of gust alleviator effectiveness is mainly due to the large pitching moment contributed by the ailerons. The aircraft with gust alleviator in operation suffers a considerable loss of stability and calculations show that with increasing gust length alleviator effectiveness decreases and eventually becomes negative. Airframe flexibility also has some detrimental effect. The effectiveness of the alleviator in terms of wing root bending stress alleviation is considered to be more favorable, but no experimental data are yet available.

N-50006*

Aeronautical Research Council (Gt. Brit.)
THE COMPONENT PRESSURE LOSSES IN COMBUSTION CHAMBERS. H. A. Knight and R. B. Walker. 1957. 34p. diagrs. ARC R & M 2987; ARC 16,617. Supersedes NGTE R.143. (Ask for N-50006*)

This report summarizes the available knowledge of the component losses in a combustion chamber. The information given in this report should enable the pressure drops through swirlers, primary baffles, cooling systems, etc., to be calculated. Most of the data were abstracted and collected from the various reports listed in the bibliography. In certain cases (for example, mixing losses) the information is incomplete and in these circumstances the limited experimental results available are supplemented by hypotheses which require proof. A specimen calculation of the pressure drop and air-flow distribution of a typical chamber is given in Appendix II. The calculated and measured values of pressure drop (cold) agreed within 4 percent.

N-50007*

Aeronautical Research Council (Gt. Brit.)
ONE-DIMENSIONAL TREATMENT OF NON-UNIFORM FLOW. R. D. Tyler. 1957. 20p. diagrs., tab. ARC R & M 2991; ARC 17,186. (Ask for N-50007*)

This paper illustrates the errors likely to arise when the simple one-dimensional flow methods are applied to a circular section duct in which a boundary layer exists. Graphical results are presented, for the case of a 1/7-power law boundary-layer velocity profile, showing the ratio of the true mean values calculated with allowance for the boundary layer, to quantities derived from the simple one-dimensional calculation. Various boundary-layer thicknesses and a range of Mach numbers are dealt with.

BRITISH REPORTS

N-50008*

Aeronatical Research Council (Gt. Brit.)
THE MEASUREMENT OF HIGH FREQUENCY ALTERNATING PRESSURES IN GAS TURBINES. J. R. Forshaw and H. Taylor. 1957. 14p. diagrs., photos. ARC R & M 2990; ARC 17,134. Supersedes NGTE Memo. M. 213. (Ask for N-50008*)

Capacity-type pressure elements have been developed to record the alternating pressures in the casings of gas turbines. Thin stretched diaphragms are used to obtain adequate sensitivity. The lower natural frequencies of the diaphragm assembly occur in the required frequency range but the damping introduced permits an adequate compromise to be made. Connecting passages have been almost eliminated by having the diaphragm near the gas stream. A filtered balance air supply behind the diaphragm has been incorporated to permit calibration during the investigation and part equalization of pressures across the diaphragm so that higher sensitivities can be used. Cooling arrangements have been developed for application of element to investigate the pressures in turbine casings. The alternating pressures decrease sharply with distance from the source and special arrangements will be required to record the pressures at points other than at the limits of the gas stream.

N-50009*

Aeronautical Research Council (Gt. Brit.)
CONTROL SURFACES RESTRAINED BY VISCOUS FRICTION AS A MEANS OF DAMPING AIRCRAFT OSCILLATIONS. W. J. G. Pinsker. 1957. 26p. diagrs., tabs. ARC R & M 2962; ARC 16,338. Supersedes RAE Aero 2486. (Ask for N-50009*)

A method is described of controlling the phase of the free motion of control surfaces by viscous friction and geared masses. Substantial improvements in the damping of aircraft oscillations can be achieved if such devices are applied to existing or additional control surfaces or to tabs attached to such controls. The merits of various arrangements are discussed and formulas for the determination of optimum conditions are derived.

N-50010*

Aeronautical Research Council (Gt. Brit.)
THE STRESS DISTRIBUTION IN PANELS BOUNDED BY CONSTANT-STRESS EDGE MEMBERS. E. H. Mansfield. 1957. 15p. diagrs. ARC R & M 2965; ARC 16,810. Supersedes RAE Structures 162. (Ask for N-50010*)

Exact solutions are given for the stress distributions in long panels bounded by constant-stress edge members. The influence of closely spaced stringers and ribs on the peak shear stresses is investigated.

N-50011*

Aeronautical Research Council (Gt. Brit.)
AN EMPIRICAL ANALYSIS OF THE PLANING LIFT CHARACTERISTICS OF RECTANGULAR FLAT-PLATES AND WEDGES. P. Ward Brown. 1957. 23p. diagrs., tabs. ARC R & M 2998; ARC 17,456. Supersedes Short Brothers & Harland Ltd. Hydrodynamics Note 47. (Ask for N-50011*)

The fluid flow about planing plates and wedges is briefly described and discussed, and on the basis of theoretical and physical considerations of this flow empirical formulas are presented for the lift developed by these planing surfaces. The formulas are mutually compatible and cover the whole range of planing of zero and finite dead-rise surfaces including the chine-dry and chine-wet conditions. The lift formulas are extensively compared with experimental data, over a range of trim angles from 2° to 30° and dead-rise angles from 0° to 40°, and very good agreement obtained.

N-50012*

Aeronautical Research Council (Gt. Brit.)
THE CALCULATION OF THE PRESSURE DISTRIBUTION OVER THE SURFACE OF TWO-DIMENSIONAL AND SWEPT WINGS WITH SYMMETRICAL AEROFOIL SECTIONS. J. Weber. 1956. 63p. diagrs., tabs. ARC R & M 2918; ARC 16,124. Supersedes RAE Aero 2497. (Ask for N-50012*)

A simple method is described for calculating the pressure distribution on the surface of a thick two-dimensional airfoil section, at any incidence, in incompressible potential flow. It is particularly suitable for practical applications, since knowledge of the section ordinates only is required. This paper gives a complete derivation of the theory including a detailed discussion of the approximations made and their effect on the accuracy of the results. The pressure distributions calculated by the present method are identical with the exact values for airfoils of elliptic cross section, and the numerical values for Joukowsky airfoils agree well with the exact solutions. Calculations for a typical practical airfoil show good agreement with the results from S. Goldstein's method. The method is extended to sheared wings of infinite span and to the center section of swept wings.

N-50013*

Aeronautical Research Council (Gt. Brit.)
THE CALCULATION OF THE PRESSURE DISTRIBUTION ON THICK WINGS OF SMALL ASPECT RATIO AT ZERO LIFT IN SUBSONIC FLOW. J. Weber. 1957. 45p. diagrs., tabs. ARC R & M 2993; ARC 17,465. Supersedes RAE Aero 2519. (Ask for N-50013*)

A method of expressing the velocity increment over airfoils directly in terms of the section ordinates (refs. 1 and 2) is extended to cover also straight and

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swept wings of finite aspect ratio. The wings considered are untapered in plan form but may be tapered in thickness. The section can be of any given shape. The coefficients required in the calculation are tabulated for the center section of straight and sweptback wings ($\varphi = 0^{o}$, $\varphi = 45^{o}$, and $\varphi = 60^{o}$) of aspect ratios 0.5, 1, 2, and 4, the wing of infinite aspect ratio having already been treated. The remaining calculations can be made very quickly. Since wings of very small aspect ratio can be treated also by the method of slender-body theory, the relations between linear theory, slender-body theory, and linearized slender-body theory are discussed. For the special case of ellipsoids, the results obtained from the various methods are compared with the exact solution.

N-50014*

Aeronautical Research Council (Gt. Brit.)
THEORETICAL LOAD DISTRIBUTION ON A WING WITH VERTICAL PLATES. J. Weber. 1956. 43p. diagrs., tabs. ARC R & M 2960; ARC 16,817. Supersedes RAE Aero 2500. (Ask for N-50014*)

The spanwise load distribution is calculated for wings with plates normal to the wing and parallel to the main stream, or inclined to it at a small angle. The calculations are made for configurations having minimum induced drag. The results are used to obtain an approximation for wings of any plan form (where the condition of minimum induced drag no longer applies), including wings with sweepback. Wings with plates of equal height on the upper and lower surfaces of the wing, and wings with plates on the upper surface only, are considered. Charts and tables for the additional load distribution with plates of different heights and at various spanwise positions are given. Side-force distributions on the plates, as well as integrated side forces and the moments of the side force, are calculated. In an appendix is a method for calculating the load distribution on wings with a discontinuity in chord, sectional lift slope, or geometric incidence.

N-50015*

Aeronautical Research Council (Gt. Brit.)
THE FLOW AT THE MOUTH OF A STANTON PITOT. A. Thom. 1956. 6p. diagrs. ARC R & M 2984. Supersedes ARC 15,228; FM 1796. (Ask for N-50015*)

An arithmetical calculation is made of the flow at the mouth of a Stanton pitot as the Reynolds number tends to zero. A stationary eddy is found under the lip of the pitot. A figure is found for the height of the effective center of the pitot rather greater than the experimental value determined by Sir Geoffrey Taylor.

N-50016*

Aeronautical Research Council (Gt. Brit.)
THE TIME VECTOR METHOD FOR STABILITY INVESTIGATIONS. PART I. BASIC INFORMATION. PART II. LONGITUDINAL MOTION. K. H. Doetsch. 1957. 36p. diagrs., tab. ARC R & M 2945; ARC 16,275. Supersedes RAE Aero 2495. (Ask for N-50016*)

A semigraphical method for the analysis of aircraft stability oscillations is described. It is based on the concept of rotating time vectors representing the forces and moments acting on the aircraft. Rules are developed for the application to damped and divergent oscillations. The method is iterative, simple, and rapid. It emphasizes the phase and amplitude relationship of the variables of the motion. Thus, at each step in the analysis, close correlation with the physical facts of the motion is maintained and the contribution of each force or moment can be visualized. The immediate deduction of approximation formulas and their limitations is demonstrated and the application of the method to automatic control is discussed.

N-50017*

Aeronautical Research Council (Gt. Brit.)
THE TORSIONAL RIGIDITY OF SOLID CYLINDERS OF DOUBLE-WEDGE SECTION. E. H. Mansfield. 1956. 7p. diagrs. ARC R & M 2959; ARC 16,812. Supersedes RAE Structures 163. (Ask for N-50017*)

The torsional rigidity of solid cylinders of double-wedge section is considered theoretically. Minimum energy methods are used to determine close upper and lower limits to the rigidity. The results are presented in graphical form.

N-50018*

Aeronautical Research Council (Gt. Brit.)
SOME REMARKS ON MULTHOPP'S SUBSONIC LIFTING-SURFACE THEORY. K. W. Mangler and B. F. R. Spencer. 1956. 9p. tabs. ARC R & M 2926; ARC 15,597. Supersedes RAE Tech. Note Aero 2181. (Ask for N-50018*)

This note contains an alternative method to that proposed by Multhopp in his subsonic lifting-surface theory for dealing with the spanwise integration of the downwash. The method consists of arranging the series form of the influence function near the inducing section so that the logarithmic term may be integrated, instead of introducing an artificial correction function as Multhopp does. Multhopp's scheme for the solution of the system of linear equations is retained and there is no increase in the amount of computer work involved.

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N-50019*

Aeronautical Research Council (Gt. Brit.)
THE FORWARD TAKE-OFF OF A HELICOPTER.
F. O'Hara. 1957. 16p. diagrs. ARC R & M 2937; ARC 16,025. Supersedes AAEE/Res/276.
(Ask for N-50019*)

A theoretical analysis is given of the accelerated motion of a single-rotor helicopter for estimation of the forward take-off performance. The motion is considered in stages during which either the disk attitude to the horizontal or the flight speed is constant. Equations are derived for the motion along and normal to the flight path and solutions are given assuming constant mean values for the aerodynamic forces on the rotor and fuselage. The equations of motion for constant disk attitude have a simple solution for motion from rest (and for special initial conditions) giving a straight flight path, and a general solution giving a curved flight path. Charts of the various solutions are given covering a representative range of the variables.

N-50020*

Aeronautical Research Council (Gt. Brit.)
AN ANALYSIS OF AVAILABLE DATA ON THE LOCAL AERODYNAMIC CENTRES OF AEROFOILS IN TWO- AND THREE-DIMENSIONAL FLOW.
A. S. Taylor. 1957. 52p. diagrs., tabs. ARC R & M 3000; ARC 13,997. Supersedes RAE Aero 2407. (Ask for N-50020*)

Reviews the existing information regarding the behavior of the local aerodynamic centers of airfoils, with a view to exposing the more important gaps in our knowledge and indicating the lines along which future research might most profitably be directed.

N-50021*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF A SPIKE PROTRUDING IN FRONT OF A BLUFF BODY AT SUPERSONIC SPEEDS.
D. Beastall and J. Turner. 1957. 26p. diagrs., photos., tabs. ARC R & M 3007; ARC 14,892. Supersedes RAE Tech.Note Aero 2137.
(Ask for N-50021*)

Wind-tunnel tests at $M = 1.5$, 1.6, and 1.8 are described in which the effect of mounting a stem, with different nose pieces, on the forward face of a bluff-nosed body is studied. The drag on the front face of the body was derived from pressure measurements for different projections of the stem. Schlieren equipment was used and several interesting phenomena observed in the flow are discussed, in particular a flow oscillation resembling that which sometimes occurs with center-body intakes.

N-50022*

Aeronautical Research Council (Gt. Brit.)
R.A.E. HIGH-SPEED WIND-TUNNEL TESTS OF THE TRAILING-EDGE CONTROLS ON A DELTA WING WITH 52-DEG SWEEPBACK. K. W. Newby. 1957. 22p. diagrs., tab. ARC R & M 2999; ARC 17,428. Supersedes RAE Aero 2451.
(Ask for N-50022*)

Three plain controls were tested - an inboard control, an outboard control, and the two combined. For a trimmed C_L of 0.2 to 0.3 there is no appreciable reduction of effectiveness on any control below $M = 0.87$. For $M = 0.94$, all controls have at least 50 percent of their low-speed effectiveness in pitch and roll. At higher incidence reductions in effectiveness occur, particularly near $M = 0.87$, but are mostly associated with the effects of control deflection on tip stalling. The tests were made at $R = 1.8 \times 10^6$. The pitching-moment characteristics show that cropping the pointed wing tip alleviates the tip stalling, as expected.

N-50023*

Aeronautical Research Council (Gt. Brit.)
TUNNEL-WALL EFFECT ON AN AEROFOIL AT SUBSONIC SPEEDS. A. Thom and Laura Klanfer. 1957. 19p. diagrs., tabs. ARC R & M 2851. Supersedes ARC 12,173; FM 1337; TP 271; ARC 12,476; FM 1374 and ARC 14,222; FM 1598.
(Ask for N-50023*)

This is a detailed study of the effect of the presence of walls on the flow past a symmetrical airfoil at zero incidence. The low-speed case is considered first, followed by solutions at a Mach number of 0.7. The methods used are essentially arithmetical, but a new approach is used for the compressible case. The manner in which the walls affect the pressure distribution is clearly shown.

N-50024*

Aeronautical Research Council (Gt. Brit.)
MEASUREMENT AND SUPPRESSION OF TENSION WAVES IN ARRESTING GEAR ROPE SYSTEMS.
J. M. N. Willis, S. W. Chisman, and N. I. Bullen. 1957. 26p. diagrs., photos., tabs. ARC R & M 2981. Supersedes RAE Tech.Note NA 204.
(Ask for N-50024*)

Experiments were carried out in order to measure the effect of the tension waves which are induced in an arresting-gear rope system after engagement, and to try out means of suppressing these waves with a view to application to projected arresting gears suitable for entry speeds of up to 120 and 150 knots. Rope tensions were recorded for a series of tests covering a range of entry speeds up to 117 knots with a test vehicle weight of 5,400 pounds and up to 151 knots at a weight of 2,450 pounds.

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N-50025*

Aeronautical Research Council (Gt. Brit.)
LOW-SPEED TUNNEL TESTS OF SOME SPLIT FLAP ARRANGEMENTS ON A 48-DEG DELTA WING. PARTS I AND II. PART I. The Tunnel Staff. PART II. J. F. Holford and J. W. Leathers. 1957. 30p. diagrs., tabs. ARC R & M 2996; ARC 14,734; ARC 15,629. Supersedes RAE Tech. Note Aero 2124 and RAE Tech. Note Aero 2188. (Ask for N-50025*)

A series of low-speed wind-tunnel tests have been made to investigate the behavior of split flaps on one or both surfaces of a delta wing. The investigation is split into two parts described separately in the body of the report. Part I deals mainly with the estimation of the drag of such flaps with special reference to their use as air brakes on aircraft. Part II deals with an investigation into the phenomena of flow reattachment behind the flaps and its effect on the flap characteristics.

N-50026*

Aeronautical Research Council (Gt. Brit.)
THE FLUTTER PROPERTIES OF A SIMPLE AERO-ISOCLINIC WING SYSTEM. N. C. Lambourne and A. Chinneck. 1956. 16p. diagrs., photo., tabs. ARC R & M 2869. Supersedes ARC 12,900; 0.858. (Ask for N-50026*)

The work dealt with in this report is of an exploratory nature primarily intended to provide some understanding of the flutter characteristics of a Hill aero-isoclinic wing. Essentially, this is a sweptback wing elastically designed so that the lifting loads do not affect the aerodynamic incidence. Flutter critical speeds and frequencies were measured over a range of the ratio of the bending and torsion frequencies. A subsidiary part of the report deals with a method of flutter-speed calculation in which the aerodynamic terms are restricted to static derivatives only.

N-50027*

Aeronautical Research Council (Gt. Brit.)
KINETIC TEMPERATURE OF PROPELLER BLADES IN CONDITIONS OF ICING. J. K. Hardy and C. D. Brown. 1954. 12p. diagrs. ARC R & M 2806; ARC 10,696. Supersedes RAE Mech. Eng. 2. (Ask for N-50027*)

The kinetic temperature of a section of a propeller blade has been calculated for a blade with high thermal conductivity, and also for a blade which is non-conducting. Calculations have been made for clear air, and for conditions of icing to find the extent to which kinetic heating is effective against ice.

N-50028*

Aeronautical Research Council (Gt. Brit.)
A METHOD OF CALCULATING THE SHORT-PERIOD LONGITUDINAL STABILITY DERIVATIVES OF A WING IN LINEARISED UNSTEADY COMPRESSIBLE FLOW. K. W. Mangler. 1957. 36p. diagrs. ARC R & M 2924; ARC 15,316. Supersedes RAE Aero 2468. (Ask for N-50028*)

A method is developed for the calculation of the pressure distribution and the aerodynamic forces and moments on a wing performing harmonic pitching and heaving oscillations. The calculation is based on the assumption of inviscid potential flow without shock waves and is restricted to small incidence, so that the linearized theory is valid. In contrast to other work in the field the theory applies to all Mach numbers. It is restricted to small values of the reduced frequency and should be valid for the usual range of short periods occurring at present in flight.

N-50029*

Aeronautical Research Council (Gt. Brit.)
TESTS CONCERNING NOVEL DESIGNS OF BLADES FOR AXIAL COMPRESSORS. PART I. BLADES DESIGNED FOR INCREASED WORK AT ROOT AND TIP. PART II. BLADES DESIGNED TO OPERATE IN A PARABOLIC AXIAL VELOCITY DISTRIBUTION. S. J. Andrews, R. A. Jeffs, and E. L. Hartley. 1956. 22p. diagrs. ARC R & M 2929; ARC 12,623; ARC 14,671. Supersedes NGTE Memo. M.54 and NGTE R. 104. (Ask for N-50029*)

The results obtained from low-speed tests of the first set of blades show that although the boundary-layer thickness was considerably reduced, this was achieved only at the expense of 2 percent in maximum efficiency as compared with conventional blades. The drop in efficiency is attributed to the stator blade rows which stall at incidences well below the design value, but the effect is probably not uniquely associated with variable work done. The blades designed for a variable axial-velocity profile also failed to give an improved performance. The maximum efficiency was 3 percent below that of the equivalent conventional blades and the axial-velocity profile instead of remaining approximately as assumed, deteriorated still further.

N-50030*

Aeronautical Research Council (Gt. Brit.)
AN EXTENSION OF MULTHOPP'S METHOD OF CALCULATING THE SPANWISE LOADING OF WING-FUSELAGE COMBINATIONS. J. Weber, D. A. Kirby, and D. J. Kettle. 1956. 24p. diagrs., tab. ARC R & M 2872; ARC 14,830. Supersedes RAE Aero 2446. (Ask for N-50030*)

A simple method is described for calculating the spanwise loading over wing-fuselage combinations. It is based on Multhopp's method, which is extended here to cover wings of finite thickness, large root chords compared with the body diameter, and also

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swept wings. The method is restricted to wings of moderate and large aspect ratios (above about 2). The effect of different junction shapes above and below the wing in off-center positions of the wing cannot yet be calculated. The calculation can be performed in about one computer day, and comparisons with experimental results show good agreement in the symmetrical case.

N-50031*

Aeronautical Research Council (Gt. Brit.)
CRITERIA FOR THE PREVENTION OF FLUTTER OF TAB SYSTEMS. H. Wittmeyer and H. Templeton. 1956. 44p. diagrs., tabs. ARC R & M 2825; ARC 13,063. Supersedes RAE Structures 57. (Ask for N-50031*)

An investigation has been made into the flutter characteristics of an idealized tab system in which the three-degrees-of-freedom normal translation of the lifting surface, rotation of the control surface, and rotation of the tab are represented. Specific cases of this idealized system represent similar idealized forms of the standard trimming, spring, servo, and geared tab systems. From a consideration of the relationships existing between the systems, criteria for flutter prevention have been developed from the criteria evolved earlier for trimming tabs.

N-50032*

Aeronautical Research Council (Gt. Brit.)
TECHNIQUE FOR FLUTTER TESTS USING GROUND-LAUNCHED ROCKETS, WITH RESULTS FOR UNSWEPT WINGS. W. G. Molyneux, F. Ruddlesden, and P. J. Cutt. 1956. 19p. diagrs., photos., tabs. ARC R & M 2944; ARC 13,562; ARC 14,606. Supersedes RAE Structures 72 and RAE Structures 118. (Ask for N-50032*)

A technique for the investigation of wing flutter by means of ground-launched rockets is described. An important feature of the technique is that it can be used at high speeds, including the transonic range. Model wings are attached to a solid-fuel rocket which has a miniature telemetry set housed in a detachable nose fairing. A vibration pickup and break wires are fitted in the flutter model and these modulate the output of the telemetry set to transmit flutter information to a ground station. The rocket is fired over an open artillery range and its velocity-time curve is obtained by radio reflection Doppler equipment. Results are given of tests on flutter models of unswept, untapered wings at $M = 0.4$ to 1.

N-50033*

Aeronautical Research Council (Gt. Brit.)
THE R.A.E. 4-FT X 3-FT EXPERIMENTAL LOW-TURBULENCE WIND TUNNEL. PART II. MEASUREMENTS OF TURBULENCE INTENSITY AND NOISE IN THE WORKING-SECTION. H. Schuh and K. G. Winter. 1957. 19p. diagrs. ARC R & M 2905; ARC 14,164. Supersedes RAE Aero 2412. (Ask for N-50033*)

With all the screens in the tunnel, intensities of lateral components are of the same order as the longitudinal component and range from about 0.01 percent to 0.03 percent of the mean speed. Frequency analyses have shown the longitudinal components to consist of fan frequencies and a low-frequency contribution at about 5 to 10 cps. The lateral components consist almost entirely of a similar low-frequency contribution. The low level of turbulence is confined to a restricted area near the center of the tunnel with flashes of high-intensity turbulence spreading a considerable distance from the walls. Noise measurements with the hot-wire microphone in the middle of the working section showed that above a tunnel speed of 150 ft/sec the longitudinal component consisted mainly of noise. Some measurements were also made with the hot-wire microphone in the turbulent boundary layer on the walls.

N-50034*

Aeronautical Research Council (Gt. Brit.)
FORCE AND MOMENT MEASUREMENTS ON A CONICAL BODY AND A RECTANGULAR WING, SEPARATELY AND IN COMBINATION, AT MACH NUMBER 1.94. J. R. Anderson and D. Treadgold. 1956. 25p. diagrs., photos., tabs. ARC R & M 2864; ARC 14,641. Supersedes RAE Aero 2433. (Ask for N-50034*)

Results are given of wind-tunnel measurements at $M = 1.94$ of lift, drag, and pitching moment at small α on two cones, three rectangular wings, and on the six derived cone-wing combinations. Agreement between theory and experiment for the lift of the isolated cones and wings is good; however, for drag and center of pressure, agreement is a little less satisfactory. Measured lift of the cone-wing combination exceeded that estimated, whereas the measured center-of-pressure position agreed remarkably well with the estimated position.

N-50035*

Aeronautical Research Council (Gt. Brit.)
SECOND HARMONIC CONTROL ON THE HELICOPTER ROTOR. W. Stewart. 1957. 15p. diagrs. ARC R & M 2997; ARC 15,407. Supersedes RAE Aero 2472. (Ask for N-50035*)

The application of second harmonic control on a helicopter rotor causes a redistribution of the loading over the disk. This can be utilized to postpone the

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forward speed limitations imposed by stalling of the retreating blade. This report develops the theory for second harmonic control. The resultant flapping motion and subsequent incidence distribution depend mainly on blade-inertia number. A practical check on the flapping with a full-scale rotor on a testing tower gave excellent agreement with the theory.

N-50036*

Aeronautical Research Council (Gt. Brit.)
THE SPINNING OF MODEL AIRCRAFT AND THE PREDICTION OF FULL-SCALE SPIN AND RECOVERY CHARACTERISTICS. G. E. Pringle and D. J. Harper. 1956. vii, 104p. diagrs., photos., tabs. ARC R & M 2906; ARC 15,152. Supersedes RAE Aero 2456. (Ask for N-50036*)

The report discusses some technical aspects of a long series of tests made with dynamic scale model aircraft for the purpose of studying their spinning characteristics. Data accumulated up to the end of 1947 are included and mention is made, where appropriate, of any further work done up to the end of 1949. There is some discussion of the sensitivity of the spinning model to applied forces including those that upset the spin to produce recovery and those that alternatively generate a new spin. The difference between model- and full-scale spins is analyzed with a view to correcting the model data, and some attention is given to power-on spins. A chapter is given to special aspects of the spin of tailless aircraft and another to safety devices.

N-50037*

Aeronautical Research Council (Gt. Brit.)
THE PROBLEM OF STRUCTURAL FAILURE DUE TO JET NOISE. Alan Powell. March 29, 1955. 32p. diagrs. ARC 17,514; 0.1177. (Ask for N-50037*)

The problem is surveyed and a general approach is suggested, depending on independence of the modes of vibration. The solution to Lagrange's equation is expressed in terms of frequency spectra: the generalized force depends on the pressure spectrum and the structure of the pressure field, expressible as correlation functions, in conjunction with the form of the modes, their joint relationship being called "modal acceptance;" some simple cases are analyzed for sound waves and a plane wall and the results suggest that modes having wavelengths approximating to those of the most intense sound will have the largest excitation forces. For practical structure the frequencies for which this happens may well lie close to the natural frequencies of vibration, resulting in relatively large amplitudes of vibration. Acoustical radiation damping as well as structural damping must be assessed, and this relates the problem to that of "panting" noise from boundary layers; virtual inertia of the air may be appreciable for large modes. The effect of the resultant stresses in terms of cumulative fatigue damage is also commented upon.

N-50038*

Aeronautical Research Council (Gt. Brit.)
DYNAMICS OF A DISSOCIATING GAS. III. NON-EQUILIBRIUM THEORY. N. C. Freeman. April 25, 1957. 21p. diagrs., tab. ARC 19,216; FM 2538; TP 528. (Ask for N-50038*)

The equilibrium theory of an "ideal dissociating" gas discussed by Lighthill (1956) is extended to non-equilibrium thermodynamic conditions by postulating a rate equation for the dissociation process (including the effects of recombination). The behavior of the gas in flow through strong normal shock waves and past bluff bodies is studied under nonequilibrium conditions.

N-50039*

Royal Aircraft Establishment (Gt. Brit.)
THE DEFORMATION OF A LONG SWEPT WING WITH CHORDWISE VARIATION OF THE THICKNESS. E. C. Capey. March 1957. 33p. diagrs. RAE Tech. Note Structures 221. (Ask for N-50039*)

The stress distribution in a long, swept-back, solid, thin wing under a bending moment or a torsional moment is calculated using the inextensional theory for thin flat plates. Solutions are given for all sweepback angles for strips whose cross sections are rectangular, diamond shaped, parabolic, and double wedge shaped.

N-50040*

Royal Aircraft Establishment (Gt. Brit.)
SOME RESULTS ON THE CRAZING OF PERSPEX INCLUDING THE EFFECT OF HUMIDITY. B. A. Blythe and W. W. Wright. February 1957. 19p. diagrs., tabs. RAE Tech. Note Chem. 1298. (Ask for N-50040*)

The effect of humidity on the stress crazing of Perspex by four crazing agents has been investigated. A quantitative value for the change in threshold crazing stress with change in relative humidity has been derived. A table of threshold crazing stresses for Perspex with a range of liquids has been compiled.

N-50041*

Aeronautical Research Council (Gt. Brit.)
THE ROLE OF FLAME STRUCTURE STUDIES IN THE INVESTIGATION OF HIGH TEMPERATURE KINETICS. F. J. Weinberg, Imperial College of Science. May 24, 1957. 7p. diagrs. ARC 19,293; CF 401. (Ask for N-50041*)

In an approach to the study of the flame propagation mechanism, premixed flames stabilized in laminar flow on burners are used to measure the distribution, perpendicular to the flame front, of one or several variables together with such other quantities as are required for subsequent calculations. This report assesses the extent to which such results yield relevant information to flame kinetics. It discusses temperature distribution, heat release rate, and distribution of composition.

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N-50042*

Aeronautical Research Council (Gt. Brit.) THE REACTION OF FUEL-AIR MIXTURES BY RAPID COMPRESSION IN A MOTORED ENGINE. N. P. W. Moore and D. G. Martin, Imperial College. May 30, 1957. 7p. diagrs. ARC 19,301; CF 402. (Ask for N-50042*)

A motored engine supplied with a premixed and preheated fuel airstream has been used to study the course and rate of reaction of weak methane and propane-air mixtures. The reaction has been followed spectroscopically and by gas analysis. The rate of pressure rise at constant volume has been taken as an indication of reaction rate.

N-50043*

Aeronautical Research Council (Gt. Brit.) BRIEF REPORT OF THE RESEARCHES ON "RATES OF COMBUSTION REACTIONS IN FLOWING STREAMS OF GASES." Alfred C. Egerton. May 16, 1957. 15p. diagrs. ARC 19,277; CF 399. (Ask for N-50043*)

The results obtained during the past two years encompass studies of methane concerning the state of mixture and the residence time needed for mixing; the rate at which the sampled gas had to be withdrawn; oxidation and oxidation products; ignition; the effect of adding carbon monoxide, carbon monoxide-oxygen and formaldehyde; and the determination of the amounts of formaldehyde formed.

MISCELLANEOUS

N-52990*

Advisory Group for Aeronautical Research and Development. COMBUSTION RESEARCHES AND REVIEWS, 1957. (Papers presented at AGARD 10th Combustion Panel meeting, Oslo, Norway, May 1956.) 1957. viii, 204p. diagrs., photos., tabs. AGARDograph 15.

Contents: STATIONARY FLAMES AT PRESSURES ABOVE ONE ATMOSPHERE. G. A. McD. Cummings, Royal Aircraft Establishment. HYDROGEN-HALOGEN FLAMES. R. C. Anderson, University of Texas. FLAME-SPREADING CHARACTERISTICS IN COMBUSTION. N. R. L. Maccallum. ETUDE DE LA FLAMME DES MELANGES AIR-KEROSENE. J. Rappeneau, Office National d'Etudes et de Recherches Aeronautiques. BUBBLE-POINTS, FLAMMABILITY LIMITS AND FLASH-POINTS OF PETROLEUM PRODUCTS. B. P. Mullins. A THEORETICAL ANALYSIS OF REACTION RATE CONTROLLED SYSTEMS - PART I. M. V. Herbert. REMARQUES SUR LES PULSOREACTEURS. J. Ducarme. QUELQUES RESULTATS OBTENUS A LA S.N.E.C.M.A. DANS L'ETUDE DES PULSOREACTEURS. J. Bertin and B. Salmon. AN INTRODUCTION TO THE USE OF THE SHOCK TUBE FOR THE DETERMINATION OF PHYSICO-CHEMICAL PARAMETERS. S. S. Penner, F. Harshbarger, California Institute of Technology, and V. Vali, Lockheed Aircraft Corp. AN OUTLINE OF A METHOD FOR PREPARING ENTHALPY CHARTS FOR DISSOCIATING GAS MIXTURES IN THE TEMPERATURE RANGE 600°-4000° K. O. Lutz.

(May be purchased from Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, New York, at $5.60)

UNPUBLISHED PAPERS

N-40645*

THE AERODYNAMICS OF THE VERTICAL TAIL. (L'Aerodynamique de l'empennage vertical.) W. Just. May 1957. 45p. diagrs. Translation of Société Nationale de Constructions Aeronautiques du Sud-Est, Dossier Divers 294, October 1952, 41p. (Ask for N-40645*)

An estimate is given of the peculiarities of the flow about a vertical tail and several methods of calculation are discussed by which one can determine the lateral forces and the yawing moment of the vertical tail subject to interaction by the fuselage, the wing, etc. The problem of the determination of the magnitude and the geometric characteristics of the vertical tail is also treated.

CN-49504*

THE DEVELOPMENT OF A RATIONAL VAPOR-PRESSURE FORMULA. (Der Aufbau einer rationellen Dampfdruckformel.) R. Plank. June 1957. 18p. tabs. Translation from Chemie-Ingenieur-Technik, v. 22, no. 20, 1950, p. 433-436. (Ask for CN-49504*)

In the technical literature we find, for the representation of vapor-pressure curves up to the critical point, generally very different, arbitrarily chosen formulas which are frequently not easily reconcilable with the measured values. In accordance with a criterion established a long time ago, we find that the vapor-pressure curve in the neighborhood of the critical point may be represented very accurately by a simple power function. Starting from this function and adding further appropriate terms, we can develop a rational vapor-pressure formula for the entire temperature range which, in spite of its simple structure, perfectly renders the variation of experimentally determined vapor-pressure curves.

UNPUBLISHED PAPERS

N-54229*

THE KINETICS OF THE GROWTH OF CRACKS IN THE PROCESS OF RUPTURE OF SOLID BODIES. (K voprosu o kinetike rosta treshchin v protsesse razrusheniya tverdykh tel.) V. R. Regel. 15p. diagrs., photos. Translation from Zhurnal Tekhnicheskoi Fiziki, v. 26, no. 2, February 1956, p. 359-370. (Ask for N-54229*)

Utilizing microphotography, the rate of growth of both the number of cracks (n/cm^2) and their lengths was determined for concentration up to 30 percent of the plasticizer, dibutylphthdlate in polymethyl, methacrylate, as a function of applied stress, which was varied from 1.75 to 5 kg/mm^2. Equations are given relating stress to (1) the length of time before appearance of cracks, (2) the stress-rupture time of the specimen, and (3) the rate of growth of n. Some of the data are given at both 25° and 45° C.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification August 16, 1957.

NACA RM A53H03

AN ANALYTICAL STUDY OF THE COMPARATIVE PERFORMANCE OF SIX AIR-INDUCTION SYSTEMS FOR TURBOJET-POWERED AIRPLANES DESIGNED TO OPERATE AT MACH NUMBERS UP TO 2.0. Earl C. Watson. October 1953. 46p. diagrs. (NACA RM A53H03)

A study is presented of inlet designs and aerodynamic characteristics of air-induction systems intended for operation with a turbojet engine operating with a constant-volume air-flow process. Two-dimensional inlet designs similar to those discussed in NACA RM A52C14, plus a fixed-geometry inlet with a convergent-divergent diffuser, and an additional variable-geometry inlet are considered for Mach numbers from 0.85 to 2.0 from sea level to the stratosphere. For best performance throughout this range of Mach numbers and altitudes, it was shown that the geometry of the inlet must be such as to insure a high pressure recovery, as well as to provide for a variable entrance area. The inlets are compared on the basis of a drag evaluation neglecting viscosity.

NACA RM A54J20

EFFECT OF TAPER RATIO ON LIFT, DRAG, AND PITCHING-MOMENT CHARACTERISTICS OF THIN WINGS OF ASPECT RATIO 3 WITH 53.1° SWEEPBACK OF LEADING EDGE AT SUBSONIC AND SUPERSONIC SPEEDS. Benton E. Wetzel. January 1955. 25p. diagrs., photo., tabs. (NACA RM A54J20)

The effect of taper ratio on the lift, drag, and pitching moment of thin wings of aspect ratio 3 and with 53.1° sweepback is presented. Taper ratio was varied from 0 (a triangular wing) to 0.4. Force measurements were obtained throughout an angle-of-attack range of -4° to +17° at Mach numbers of 0.6 to 0.9 and 1.2 to 1.9. Most of the tests were at Reynolds numbers of about 3 million based on the mean aerodynamic chords of the models.

#NACA RM E9H29, by Cook and Koch

NACA RM E51A02

DESIGN AND PERFORMANCE OF AN EXPERIMENTAL AXIAL-DISCHARGE MIXED-FLOW COMPRESSOR. III - OVER-ALL PERFORMANCE OF IMPELLER AND SUPERSONIC-DIFFUSER COMBINATION. Ward W. Wilcox and William H. Robbins. April 30, 1951. 26p. diagrs., photo. (NACA RM E51A02)

An axial-discharge impeller with a convergent-divergent supersonic-diffuser cascade was investigated over a range of flow conditions and equivalent tip speeds. Diffuser-inlet Mach numbers were in the low supersonic range. At no tip speed were the requirements for starting of the cascade met nor was the design value of weight flow obtained. Application of 9-percent flow bleedoff between the impeller and the diffuser was insufficient to allow starting of the diffuser. Indications are that a diffuser with an external shock configuration would perform as well as or better than the convergent-divergent type in this range of Mach numbers.

NACA RM E51C22

INVESTIGATION OF OFF-DESIGN PERFORMANCE OF SHOCK-IN-ROTOR TYPE SUPERSONIC BLADING. Robert C. Graham, John F. Klapproth, and Frank J. Barina. May 7, 1951. 25p. diagrs., photos. (NACA RM E51C22)

An analysis of the off-design performance of shock-in-rotor type supersonic blading is presented. The overall losses are assumed divided into two groups; normal-shock losses and external-wave losses. Throughout the range of relative entrance Mach numbers from 1.35 to starting, the largest losses can be attributed to the normal shock. An improvement in performance would be expected with a reduction of the normal-shock losses by the introduction of external compression waves.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM E51G18

A TWO-DIMENSIONAL CASCADE STUDY OF THE AERODYNAMIC CHARACTERISTICS OF A TURBINE-ROTOR BLADE SUITABLE FOR AIR COOLING. Henry W. Plohr and Cavour H. Hauser. September 1951. 15p. diagrs., photos. (NACA RM E51G18)

Flow conditions at the exit of a cascade of turbine-rotor blades, suitable for use in air-cooled turbines by virtue of their relatively low solidity and thick blade profiles, were experimentally determined from static-pressure measurements using the conservation of momentum principle and schlieren photographs of the flow past the blades. Supersonic velocities were obtained over the greater portion of the blade suction surface and resulted in high blade loading without an appreciable decrease in efficiency from that obtained using blades with lower velocities.

NACA RM E51H08

INVESTIGATION OF A 24-INCH SHOCK-IN-ROTOR TYPE SUPERSONIC COMPRESSOR DESIGNED FOR SIMPLE RADIAL EQUILIBRIUM BEHIND NORMAL SHOCK. Harold Lown and Melvin J. Hartmann. December 1951. 25p. diagrs., photo. (NACA RM E51H08)

A 24-inch-diameter shock-in-rotor supersonic compressor rotor designed to obtain simple radial equilibrium behind the normal shock obtained a maximum total-pressure ratio of 2.02 at an adiabatic efficiency of 0.74 and a weight flow of 61.5 pounds per second at design speed. Although this design method considerably reduced the radial forces, there was no apparent reduction in the radial redistribution of mass flow over the radial redistribution obtained in the previous investigation. This investigation indicates that the shock boundary-layer interaction pattern and associated effects have a very large effect on the radial redistribution of mass flow through the shock-in-rotor supersonic compressor rotor.

#NACA RM E51H15, by Dugan, Rebeske, and Finger
#NACA RM E51H27, by Nussdorfer, Obery, and Englert
#NACA RM E51H29, by Obery, Englert, and Nussdorfer

NACA RM E52A25

COLD-AIR INVESTIGATION OF A TURBINE WITH NONTWISTED ROTOR BLADES SUITABLE FOR AIR COOLING. Thomas R. Heaton, William R. Slivka, and Leonard F. Westra. March 1952. 34p. diagrs., photos. (NACA RM E52A25)

An experimental investigation of a turbine with nontwisted rotor blades suitable for air cooling was conducted; the turbine-design requirements were the same as those of the turbine of a contemporary turbojet engine. The overall performance and the flow surveys obtained at the stator and rotor exits of a scale model of this turbine in a cold-air rig are presented. A brake internal efficiency of 0.82 was obtained at the design equivalent shaft work and design equivalent tip speed. Brake internal efficiencies of the order of 0.845 occurred at stagnation-pressure ratios and equivalent tip speeds greater than design.

NACA RM E52B27

AN EXPERIMENTAL CASCADE STUDY OF THE EFFECTS OF A SOLIDITY REDUCTION ON THE TWO-DIMENSIONAL AERODYNAMIC CHARACTERISTICS OF A TURBINE-ROTOR BLADE SUITABLE FOR AIR COOLING. Henry W. Plohr and William J. Nusbaum. May 1952. 17p. diagrs., photos. (NACA RM E52B27)

Flow conditions at the exit of a cascade of turbine-rotor blades, suitable for use in air-cooled turbines by virtue of their low solidity and thick blade profiles, were experimentally determined from static-pressure measurements using the conservation-of-momentum principle and schlieren photographs. A comparison of these results with similar published cascade data on the same blade profile at a higher solidity indicated that for the low-solidity configuration reduced turning and higher blade profile losses were obtained, along with very high blade suction-surface velocities.

NACA RM E52G01

AN ANALYTICAL METHOD FOR EVALUATING FACTORS AFFECTING APPLICATION OF TRANSPIRATION COOLING TO GAS TURBINE BLADES. Jack B. Esgar. September 1952. ii, 68p. diagrs., tabs. (NACA RM E52G01)

An analytical investigation was conducted to develop a method for evaluating factors affecting the application of transpiration cooling to aircraft gas-turbine blades. Calculations were made to determine the effects of off-design flight and engine conditions on the coolant flow and coolant supply pressure requirements for blades designed for a variety of conditions. It was found that the use of orifices at the blade base for partially metering the cooling air to local positions around the blade periphery provided blades that used a minimum of coolant at off-design conditions and in addition permitted a great simplification in the blade fabrication.

DECLASSIFIED NACA RESEARCH REPORTS

#NACA RM E52H06, by Prince and Schulze

NACA RM E52H08

PERFORMANCE CHARACTERISTICS OF CANARD-TYPE MISSILE WITH VERTICALLY MOUNTED NACELLE ENGINES AT MACH NUMBERS 1.5 TO 2.0. Leonard J. Obery and Howard S. Krasnow. September 1952. 25p. diagrs. (NACA RM E52H08)

The forces, moments, and internal engine performance of a complete missile configuration were determined at Mach numbers from 1.5 to 2.0, angles of attack from 0° to 10°, and canard-control deflections from 0° to 9-1/2°. The missile had a canard-type control surface with nacelle engines mounted above and below the fuselage. The wing shock fell behind the inlets at the design Mach number of 2.0. The overall performance of the missile and the component performances are presented. Prediction of the forces by existing theory is shown to agree reasonably well with the experimental data over the Mach number and angle-of-attack range.

NACA RM E52H29

PERFORMANCE CHARACTERISTICS AT MACH NUMBERS TO 2.0 OF VARIOUS TYPES OF SIDE INLETS MOUNTED ON FUSELAGE OF PROPOSED SUPERSONIC AIRPLANE. IV - RECTANGULAR-COWL INLETS WITH TWO-DIMENSIONAL COMPRESSION RAMPS. Paul C. Simon. October 1952. 35p. diagrs., photos. (NACA RM E52H29)

Inlet flow and drag characteristics are presented for a rectangular-cowl side inlet having an external two-dimensional compression ramp and boundary-layer bleed scoop. The effects on inlet performance resulting from the installation of sweptback cowl side fairings are also included. The investigation was conducted in the 8- by 6-foot supersonic tunnel for a range of Mach number from 0 to 2.0 and fuselage angles of attack from 0° to 12°. A critical pressure recovery of 0.83 and a supersonic mass-flow spillage of 4 percent of theoretical maximum were obtained at the inlet design Mach number of 2.0. The addition of side fairings increased the critical recovery to 0.88 and reduced the spillage to zero. The rectangular inlet without fairings exhibited stable operation for the range of variables investigated. Side fairings caused inlet instability at angle of attack.

NACA RM E52J29

ANALYTICAL COMPARISON OF TURBINE-BLADE COOLING SYSTEMS DESIGNED FOR A TURBOJET ENGINE OPERATING AT SUPERSONIC SPEED AND HIGH ALTITUDE. I - LIQUID-COOLING SYSTEMS. Wilson B. Schramm, Alfred J. Nachtigall, and Vernon L. Arne. January 1953. 52p. diagrs., tabs. (NACA RM E52J29)

The operation and effectiveness of turbine-blade liquid-cooling systems as applied to high-altitude turbojet powered supersonic interceptor aircraft are evaluated analytically. The problems encountered with each of several liquid-cooling systems using water or fuel as coolants were investigated with respect to the medium to which heat is rejected. The water-cooling system appears inadequate for the interceptor mission because of its inability to reject heat to ram air at high flight Mach number and because of considerable installation complexity. A fuel-cooling system with heat rejection to the afterburner fuel appears promising because of negligible weight and performance penalties and relatively simple installation. A regenerative liquid-cooling system, which rejects heat to compressor-discharge air, can be provided for nonafterburning engines as well as for afterburning engines if suitable fluids can be found. This system provides a "package" installation entirely contained within the engine and capable of operation without external systems in the aircraft.

NACA RM E52J30

ANALYTICAL COMPARISON OF TURBINE-BLADE COOLING SYSTEMS DESIGNED FOR A TURBOJET ENGINE OPERATING AT SUPERSONIC SPEED AND HIGH ALTITUDE. II - AIR-COOLING SYSTEMS. Wilson B. Schramm, Vernon L. Arne, and Alfred J. Nachtigall. January 1953. 50p. diagrs., tabs. (NACA RM E52J30)

The operation and effectiveness of air- and liquid-cooling systems in high-altitude, supersonic, turbojet-powered interceptor aircraft were investigated. The results obtained from analysis of the air-cooling system were presented and compared with a similar study of liquid-cooling systems presented in a companion report of this analysis. Results of the analysis showed that the simple, nonrefrigerated, air-cooling system was adequate for turbine-blade cooling at flight Mach numbers to 2.5 at an altitude of 50,000 feet. Air-cooling systems with bleed aftercooling or refrigeration based on heat rejection to afterburner fuel provide a greater margin of safety than the simple system and extend operation to higher permissible flight Mach numbers. A comparison with liquid-cooling systems indicated that the fuel-cooling system using afterburner fuel is the most desirable alternate choice for supersonic application. Regenerative liquid-cooling systems and regenerative air-bleed expansion refrigeration systems are promising long-range developments that are capable of operation over the desired range of flight conditions without affecting other aircraft installations and systems.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM E52K03

PERFORMANCE OF A SWEPT LEADING EDGE ROTOR OF THE SUPERSONIC TYPE WITH MIXED FLOW. Arthur W. Goldstein and Ralph L. Schacht. January 1953. 34p. diagrs., photo., tab. (NACA RM E52K03)

An experimental investigation with Freon-12 as the working fluid was made of a 14-inch-diameter supersonic mixed-flow axial-discharge rotor of the impulse type. The whole series of tests was made twice - once with a set of guide vanes that underturned the air and gave a somewhat lower relative inlet velocity than the design value, and once with a set that gave approximately the design values for velocity and direction. At the design tip speed of 686 feet per second (equivalent value for air, 1564 ft/sec), the weight flow was about 43.5 pounds per second (equivalent air value, 23.7 lb/sec), the pressure ratio was 6.25, and the efficiency was 80.4 percent with the first set of guide vanes. With the second set the figures are 43.3 pounds per second, 6.6, and 78.0 percent. The leading edges of the blades were sufficiently swept to give subsonic velocities normal to the leading edge and in the plane of the blade surface. This permitted large variations of weight flow but did not permit shock surfaces to be formed on the leading edge. Work output was adequately equalized at the discharge end. High tip losses indicated that tip loading and axial length are critical factors. Inadequacy of the axisymmetric design system or blade-to-blade two-dimensional flow analysis is indicated.

NACA RM E53A23

INVESTIGATION OF WATER-SPRAY COOLING OF TURBINE BLADES IN A TURBOJET ENGINE. John C. Freche and William J. Stelpflug. March 1953. 45p. diagrs., photos., tab. (NACA RM E53A23)

An analytical and experimental investigation was made with a J33-A-9 engine to determine the effectiveness of spray cooling as a means of increasing thrust by permitting engine operation at inlet-gas temperatures and speeds above rated. With the assumption of adequate spray cooling at a coolant-to-gas flow ratio of 3 percent, calculations for the sea-level static condition indicated a thrust increase of 40 percent over rated thrust may be achieved by engine operation at an inlet-gas temperature of 2000° F and an overspeed of 10 percent. Of the water-injection configurations investigated experimentally, those located in the inner ring of the stator diaphragm provided the best cooling at rated engine speed.

NACA RM E53E21

MECHANICAL DESIGN ANALYSIS OF SEVERAL NONCRITICAL AIR-COOLED TURBINE DISKS AND A CORRUGATED-INSERT AIR-COOLED TURBINE ROTOR BLADE. Merland L. Moseson, Morton H. Krasner, and Robert R. Ziemer. July 1953. 49p. diagrs., photos., tabs. (NACA RM E53E21)

As a part of the NACA investigations of air-cooled turbines, a series of turbine wheel designs was made for a turbojet engine with an axial-flow compressor. These designs were made to determine the influence of air cooling on overall engine design, weight, critical-material content, and complexity as well as to provide necessary information for the construction of research model full-scale turbines. The effect of air cooling on these factors is illustrated by the five designs presented in this report, which include the principal variations in methods of cooling-air introduction and distribution. The mechanical design, construction, and stresses of the corrugated-insert air-cooled blade utilized in all the disk designs are included. The disk designs considered are both the split-type disk and the single disk with a cooling-air shroud. All parts were designed for use of noncritical materials for applications using current turbine-inlet temperature levels. Component and total turbine wheel weights are also presented. Reductions of critical-material content as compared with uncooled designs were shown to be approximately 93 percent.

NACA RM E53H27

PERFORMANCE OF A SUPERSONIC MIXED-FLOW ROTOR WITH A SWEPT LEADING EDGE AND 0.52 INLET RADIUS RATIO. Arthur W. Goldstein and Ralph L. Schacht. November 1953. 34p. diagrs., photos., tab. (NACA RM E53H27)

A 14-inch supersonic mixed-flow rotor of high specific mass flow and an inlet radius ratio of 0.52, designed for impulse operation and uniform output, was tested in Freon-12. At the design tip speed of 686 feet per second (equivalent value for air, 1480 ft/sec), the pressure ratio, adiabatic efficiency, and equivalent weight flow were, respectively, 7.2, 76.9 percent, and 63.8 pounds per second (equivalent air value, 31.5 lb/sec/sq ft frontal area). At 70 percent speed these parameters had the values 2.9, 84.0 percent, and 51.1 pounds per second, respectively. This speed gave one of the highest efficiencies for impulse operation even though the pressure variations along the casing were the greatest. Friction with the casing appeared to be a substantial factor in affecting efficiency. Other losses were approximately 13 percent of the work input and were nearly a constant percentage of the inlet relative kinetic energy.

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NACA RM E53H28

PERFORMANCE CHARACTERISTICS OF A DOUBLE-CYLINDRICAL-SHROUD EJECTOR NOZZLE. Eli Reshotko. November 1953. 57p. diagrs., tab. (NACA RM E53H28)

The performance characteristics of a double-shroud ejector were investigated for the purpose of evaluating its effectiveness as an exit nozzle. Calculations based on ejector performance data, taken with the ejector discharging into quiescent air, indicate that thrust performance on the order of ideal nozzle thrust may be obtained over a Mach number range of 0.8 to 2.3 from a double-shroud ejector. Maximum thrust is obtained with maximum pressure recovery of the secondary- and tertiary-air inlets. Short secondary shrouds, high secondary weight flows, and low (not necessarily zero) tertiary weight flows are desirable. The results of a simplified theoretical analysis are in fair agreement with those experimentally obtained.

NACA RM E55F27a

PRELIMINARY INVESTIGATION OF HOLLOW-BLADED TURBINES HAVING CLOSED AND OPEN BLADE TIPS. Gordon T. Smith and Robert O. Hickel. August 1955. 18p. diagrs., photo., tab. (NACA RM E55F27a)

The effect of using closed or open rotor blade tips on the performance of a turbine having hollow rotor blades was investigated in a 4000-pound-thrust turbojet engine. The open-tip rotor blades did not reduce turbine efficiencies and may have been responsible for a small increase in turbine efficiencies over the turbine having closed-tip blades.

NACA RM E56E16

VISUALIZATION OF ROTOR TIP SECONDARY FLOWS WITH BLADE TIP AIR DISCHARGE AND SUCTION IN A LOW-SPEED TURBINE. Milton G. Kofskey and Hubert W. Allen. August 1956. 28p. diagrs., photos. (NACA RM E56E16)

Smoke was used to visualize outer-wall secondary flows in a low-speed turbine utilizing rotor tip air discharge and suction. Photographs as well as visual observations of the effect of tip air discharge and suction were made by independently varying the direction and quantity of the tip air discharge and suction, and varying tip clearance, and main-stream airspeed. In addition, the cross-sectional area of the hollow blade discharge opening was varied for the case of tip air discharge.

NACA RM L50H02

A COMPARISON OF THE AERODYNAMIC CHARACTERISTICS AT TRANSONIC SPEEDS OF FOUR WING-FUSELAGE CONFIGURATIONS AS DETERMINED FROM DIFFERENT TEST TECHNIQUES. Charles J. Donlan, Boyd C. Myers, II, and Axel T. Mattson. October 4, 1950. 66p. diagrs., photos., tabs. (NACA RM L50H02)

A comparison is made of the high-speed aerodynamic characteristics of a family of four wing-fuselage configurations of 0°, 35°, 45°, and 60° sweepback as determined from transonic-bump model tests in the Langley high-speed 7- by 10-foot tunnel, sting-supported model tests in the Langley 8-foot high-speed tunnel and in the Langley high-speed 7- by 10-foot tunnel, and rocket model tests conducted by the Langley Pilotless Aircraft Research Division. A complementary study of the effect of Mach number gradients and streamline curvature on bump results is also included.

NACA RM L51H01

ANALYSIS OF LONGITUDINAL STABILITY AND TRIM OF THE BELL X-1 AIRPLANE AT A LIFT COEFFICIENT OF 0.3 TO MACH NUMBERS NEAR 1.05. Hubert M. Drake, John R. Carden, and Harry P. Clagett. October 1951. 30p. diagrs., photo., tab. (NACA RM L51H01)

An analysis has been made of the flight test data obtained with two X-1 airplanes having 10-percent-thick wings and an 8-percent-thick tail and 8-percent-thick wings and a 6-percent-thick tail. The variation with Mach number of the rate of change of downwash angle of attack, the static stability, and the airplane trim were obtained at a lift coefficient of 0.3.

NACA RM L52B08

A TRANSONIC WIND-TUNNEL INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS OF THREE 4-PERCENT-THICK WINGS OF SWEEPBACK ANGLES 10.8°, 35°, AND 47°, ASPECT RATIO 3.5, AND TAPER RATIO 0.2 IN COMBINATION WITH A BODY. Ralph P. Bielat. July 1952. 33p. diagrs., photos., tab. (NACA RM L52B08)

An investigation was conducted in the Langley 8-foot transonic tunnel of the effects of sweepback angle on wing-body characteristics at Mach numbers varying from 0.50 to approximately 1.12. Sweepback angles of 10.8°, 35°, and 47°, based on the 0.25-chord line were investigated. All the wing models had 4-percent-thick sections parallel to the model plane of symmetry, an aspect ratio of 3.5, and a taper ratio of 0.2.

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NACA RM L52H06a

FREE-FLIGHT MEASUREMENTS OF SOME EFFECTS OF SPOILER SPAN AND PROJECTION AND WING FLEXIBILITY ON ROLLING EFFECTIVENESS AND DRAG OF PLAIN SPOILERS ON A TAPERED SWEPTBACK WING AT MACH NUMBERS BETWEEN 0.6 AND 1.6. Eugene D. Schult and E. M. Fields. October 1952. 30p. diagrs., photo., tab. (NACA RM L52H06a)

Spoiler rolling effectiveness and drag as affected by spoiler projection, spoiler span, spoiler spanwise location, and wing flexibility were measured over the Mach number range from 0.6 to 1.6 by utilizing rocket-propelled test vehicles in free flight. The test wing was swept back 45° along the quarter chord, had an aspect ratio of 4.0, taper ratio of 0.6, NACA 65A006 profiles, and solid sharp-edged spoilers located along the 70-percent-chord line. Spoiler heights of 2-percent and 5-percent chord were tested at various spanwise positions. The results showed that the full-span spoiler had the highest rolling effectiveness for a given projection of all configurations at all speeds tested and that the inboard half-span spoiler was approximately twice as effective as the outboard half-span spoiler. The outboard quarter-span spoiler was ineffective as a roll-producing device. Increasing the spoiler span gave more rolling effectiveness per unit drag than did increasing the spoiler height. Comparison of spoilers and ailerons at the same rolling effectiveness indicated that the spoiler had lower wing twisting moments but greater drag than the aileron; however, for the inboard control, the difference in drag between spoilers and ailerons became small at supersonic speeds.

NACA RM L53H14

AN ENGINEERING METHOD FOR THE DETERMINATION OF AEROELASTIC EFFECTS UPON THE ROLLING EFFECTIVENESS OF AILERONS ON SWEPT WINGS. H. Kurt Strass and Emily W. Stephens. November 1953. 82p. diagrs., tabs. (NACA RM L53H14)

A method is presented for calculating the steady-state rolling effectiveness of flexible sweptback wings at subsonic and supersonic speeds. The method is a procedure which possibly is as simple as can be devised and which, based on comparisons with experiment, still apparently is capable of providing estimates of the changes in aileron rolling effectiveness for a wide range of wing-aileron configurations within the experimental accuracy. As an aid to rapid calculation, the results of this investigation are presented in nondimensional form and have been calculated for a wide range of tapered wings varying from 0 to 1.0 in taper ratio, for wing-span—body-diameter ratios of 0, 0.2, and 0.4 and for ailerons of any spanwise extent and location. These calculations were made assuming that the wings were of homogeneous construction.

NACA RM L53H17

INVESTIGATION OF THE EFFECT OF SPANWISE POSITIONING OF A VERTICALLY SYMMETRIC OGIVE-CYLINDER NACELLE ON THE HIGH-SPEED AERODYNAMIC CHARACTERISTICS OF A 45° SWEPTBACK TAPERED-IN-THICKNESS WING OF ASPECT RATIO 6 WITH AND WITHOUT A FUSELAGE. H. Norman Silvers and Thomas J. King, Jr. October 1953. 62p. diagrs., tabs. (NACA RM L53H17)

Results show the effect of spanwise and vertical positioning of an ogive-cylinder nacelle on the high-speed aerodynamic characteristics of a small-size 45° sweptback wing alone and in combination with a fuselage over a Mach number range from 0.70 to 1.08. The nacelle was solid and had a fineness ratio of 9.34. Nacelle spanwise locations of 0.20, 0.46, 0.70, and 0.96 of the semispan were investigated.

NACA RM L53H18b

RELATIONSHIP OF FLOW OVER A 45° SWEPTBACK WING WITH AND WITHOUT LEADING-EDGE CHORD-EXTENSIONS TO LONGITUDINAL STABILITY CHARACTERISTICS AT MACH NUMBERS FROM 0.60 TO 1.03. F. E. West, Jr., and James H. Henderson. October 1953. 47p. diagrs., photos. (NACA RM L53H18b)

In this paper is presented a study of the effect of leading-edge chord-extensions on the flow phenomena existing over a thin 45° sweptback wing at Mach numbers from 0.60 to 1.03 and of the relationship of these flow phenomena to the longitudinal stability characteristics of the wings. The study is based on chordwise pressure distributions, tuft and ink-flow studies, shadowgraph surveys, and force data.

NACA RM L53H20

TRANSONIC FLIGHT TESTS TO DETERMINE ZERO-LIFT DRAG AND PRESSURE RECOVERY OF NACELLES LOCATED AT THE WING ROOT ON A 45° SWEPTBACK WING AND BODY CONFIGURATION. Sherwood Hoffman and Austin L. Wolff. September 1953. 31p. diagrs., photos., tabs. (NACA RM L53H20)

The zero-lift drag of a high-aspect-ratio 45° sweptback wing and body combination with nacelles having the NACA 1-50-250 nose inlet located at the wing root was determined by flight tests of rocket-propelled models from Mach number 0.8 to 1.3. The inlet pressure recovery at transonic speeds was determined from flight tests and at supersonic speeds by preflight jet tests. The results are compared with tests of nacelles located at the wing tip.

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NACA RM L53H25

INVESTIGATION AT MACH NUMBERS OF 1.62, 1.93, AND 2.41 OF THE EFFECT OF OSCILLATION AMPLITUDE ON THE DAMPING IN PITCH OF DELTA-WING—BODY COMBINATIONS. Arthur Henderson, Jr. October 1953. 28p. diagrs., photos. (NACA RM L53H25)

Tests were made of four delta-wing and body combinations at Mach numbers of 1.62, 1.93, and 2.41 and covered a Reynolds number range of 0.44×10^6 to 1.69×10^6. The wings had 25°, 30°, 35°, and 45° semiapex angles. Results indicate that, in general, the variation of damping with amplitude is small, and that the damping may be satisfactorily approximated by theory.

NACA RM L53H26

RECENT EXPERIENCES WITH FLUTTER FAILURE OF SWEPTBACK, TAPERED WINGS HAVING OUTBOARD, PARTIAL-SPAN SPOILER CONTROLS. H. Kurt Strass and Edward T. Marley. October 1953. 20p. diagrs., photos., tabs. (NACA RM L53H26)

The Langley Pilotless Aircraft Research Division has conducted an investigation by means of rocket-propelled test vehicles in free flight to determine the nature of repeated wing failures encountered by some spoiler-equipped, flexible, sweptback, tapered wings. The results of this investigation show that the cause of the repeated failures was spoiler-induced flutter of the bending-torsion type. The portions of the telemeter records showing the onset of flutter and resulting failure of two models are presented.

NACA RM L53H27

LOW-SPEED STATIC STABILITY AND CONTROL CHARACTERISTICS OF A 1/4-SCALE MODEL OF THE BELL X-1 AIRPLANE EQUIPPED WITH A 4-PERCENT-THICK, ASPECT-RATIO-4, UNSWEPT WING. William C. Moseley, Jr., and Robert T. Taylor. November 1953. 53p. diagrs., photos., tab. (NACA RM L53H27)

This paper presents the results of an investigation to determine the low-speed static stability and control characteristics of a 1/4-scale model of the Bell X-1 airplane equipped with a thin, low-aspect-ratio wing. The tests in the Langley 300 MPH 7- by 10-foot tunnel were made at a dynamic pressure of 25.86 pounds per square foot which corresponds to a Mach number of about 0.13 and a Reynolds number of about 1.2×10^6.

NACA RM L55B18a

EFFECT OF A WING LEADING-EDGE FLAP AND CHORD-EXTENSION ON THE HIGH SUBSONIC CONTROL CHARACTERISTICS OF AN AILERON LOCATED AT TWO SPANWISE POSITIONS. Robert F. Thompson and Robert T. Taylor. May 1955. 59p. diagrs., photo., tabs. (NACA RM L55B18a)

Incremental force and moment coefficients due to aileron deflection are presented for a wind-tunnel investigation at high subsonic speeds and angles of attack up to 24° to determine the effects of a wing leading-edge modification on the control characteristics of a flap-type aileron located at two spanwise positions. The wing was modified by a leading-edge chord-extension over the outboard 35 percent of the semispan in combination with a full-span leading-edge flap deflected 6°. The wing-fuselage model tested had a wing of aspect ratio 4, taper ratio 0.3, 45° sweepback, and NACA 65A006 airfoil sections.

NACA RM L55F14

COLLECTION AND SUMMARY OF FLAP-TYPE-AILERON ROLLING-EFFECTIVENESS DATA AT ZERO LIFT AS DETERMINED BY ROCKET-POWERED MODEL TESTS AT MACH NUMBERS BETWEEN 0.6 AND 1.6. H. Kurt Strass, Emily W. Stephens, E. M. Fields, and Eugene D. Schult. September 1955. 95p. diagrs., photos., tabs. (NACA RM L55F14)

A collection and summary are presented of the wing-aileron rolling-effectiveness data which have been obtained during a general investigation of lateral control being conducted by the Langley Pilotless Aircraft Research Division. Some effects of trailing-edge angle, aileron chord ratio, spanwise extent and location of aileron, aspect ratio, wing sweepback, and wing-tail interference are presented. Rough design charts have been prepared to show some effects of aileron trailing-edge angle at two sweepback angles, aileron chord ratio, wing aspect ratio, and spanwise extent and location of aileron. Data were measured over the Mach number range from 0.6 to 1.6, and ailerons were differentially deflected 3° to 7°.

NACA RM L55H02

FREE-FLIGHT TESTS TO DETERMINE THE POWER-ON AND POWER-OFF PRESSURE DISTRIBUTION AND DRAG OF THE NACA RM-10 RESEARCH VEHICLE AT LARGE REYNOLDS NUMBERS BETWEEN MACH NUMBERS 0.8 AND 3.0. Sherwood Hoffman. September 1955. 55p. diagrs., photos., 3 tabs. (NACA RM L55H02)

The effect of a propulsive jet on the drag and pressure distribution of the NACA RM-10 missile configuration at large Reynolds numbers has been determined by flight tests between Mach numbers 0.8 and 3.0. The jet pressure ratio and exit Mach number were about 1.5 and 3.5. The transonic jet effects produced large increases in the pressures at the base and rearmost stations on the afterbody and fins. Favorable jet interference at the base reduced the

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drag at supersonic speeds. The results are compared with those obtained from linearized theory and wind-tunnel tests.

NACA RM L55H04

EFFECTS OF LEADING-EDGE RADIUS ON THE LONGITUDINAL STABILITY OF TWO 45° SWEPTBACK WINGS INCORPORATING LEADING-EDGE CAMBER AS INFLUENCED BY REYNOLDS NUMBERS UP TO 8.00×10^6 AND MACH NUMBERS UP TO 0.290. Gerald V. Foster. October 1955. 44p. diagrs. (NACA RM L55H04)

This paper presents the low-speed lift and pitching-moment characteristics of two cambered 45° sweptback wings, one of aspect ratio 3, the other of aspect ratio 5, both having airfoil sections of 9-percent thickness with a modified NACA 230 mean line. The effects of camber, leading-edge radius, Reynolds number, and Mach number on the longitudinal stability characteristics are indicated.

NACA RM L55H05a

EXPERIMENTAL STUDY OF A METHOD OF DESIGNING THE SWEPTBACK-WING—FUSELAGE JUNCTURE TO REDUCE THE DRAG AT MODERATE SUPERSONIC SPEEDS. Robert R. Howell. January 1956. 20p. diagrs., photos., tabs. (NACA RM L55H05a)

A wind-tunnel investigation has been made of the drag reductions attainable in the Mach number range between 0.81 and 1.42 by contouring the sides of the fuselage to conform to the streamline shape over a sweptback wing of infinite span. The drag of the sweptback-wing—body configuration whose body was axisymmetrically indented according to the supersonic area rule for a design Mach number of 1.2 was reduced in the Mach number range between about 1.2 and 1.4 when the fuselage side was contoured in this manner. A comparison of the variation of drag coefficient with Mach number for configurations having the fuselage axisymmetrically indented in accordance with the supersonic and transonic area rules showed no large differences in drag coefficient except at Mach numbers greater than 1.25 where the body indented according to the transonic area rule had the higher drag.

NACA RM L55H19

A SYSTEMATIC STUDY OF THE EFFECTS OF LEADING-EDGE CHORD-EXTENSIONS ON THE LOW-SPEED LONGITUDINAL STABILITY CHARACTERISTICS OF THREE 45° SWEPTBACK WINGS. H. Neale Kelly. October 1955. 113p. diagrs., photo., tabs. (NACA RM L55H19)

The results of tests to determine the influence of chord-extension geometry on the effectiveness of leading-edge chord-extensions are presented. The tests were conducted in the Langley 19-foot pressure tunnel at a Reynolds number of 4.6×10^6 and a corresponding Mach number of 0.11 on three 45° sweptback wings of aspect ratio 5 and taper ratio 0.28 designed to exhibit different types of flow separation.

NACA RM L55H24

STATISTICAL MEASUREMENTS OF LANDING CONTACT CONDITIONS OF THE BOEING B-47 AIRPLANE. Joseph J. Kolnick and Garland J. Morris. October 1955. 11p. diagrs., tabs. (NACA RM L55H24)

The landing contact conditions of the Boeing B-47 airplane were determined from photographs taken with a specially built motion-picture camera of 222 landings during daytime operations at Barksdale Air Force Base, La. From these photographs, sinking speeds and horizontal speeds were evaluated and a statistical analysis of the results was made.

NACA RM L55H26

TRANSONIC WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF INCIDENCE AND BODY INDENTATION ON THE WING LOADS OF A 45° SWEPTBACK WING-BODY COMBINATION. Robert J. Platt, Jr. January 1956. 24p. diagrs., photos., tab. (NACA RM L55H26)

The effects of an angle of incidence of 4° and body indentation on the wing loads of a sweptback wing-body combination have been investigated at Mach numbers from 0.6 to 1.2. The wing had an aspect ratio of 4, taper ratio of 0.3, sweepback of 45°, and NACA 65A006 airfoil sections parallel to the plane of symmetry. The effects of incidence were found to be nearly independent of Mach number and normal-force coefficient below the beginning of separation.

NACA RM L55H31

A THEORETICAL ANALYSIS OF A SIMPLE AERODYNAMIC DEVICE TO IMPROVE THE LONGITUDINAL DAMPING OF A CRUCIFORM MISSILE CONFIGURATION AT SUPERSONIC SPEEDS. James E. Clements. October 1955. 36p. diagrs., tab. (NACA RM L55H31)

A theoretical investigation is presented of the longitudinal dynamic characteristics of a supersonic missile configuration with additional pitch damping obtained from viscously restrained free-floating control surfaces. Variations in the floating-control hinge-moment characteristics with Mach number and altitude are considered. A substantial increase in airframe damping was obtained through a proper choice of the hinge-moment coefficients and viscous damping rate.

#NACA RM SA50D05, by Maki
#NACA RM SE53F09, by Esgar and Richards
#NACA RM SE54D29, by Richards
#NACA RM SL50E09a, by Cocke, Lipson, and Scallion

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1287

SPARK IGNITION OF FLOWING GASES. Clyde C. Swett, Jr. 1956. ii, 18p. diagrs., tabs. (NACA Rept. 1287)

Research conducted at the NACA Lewis laboratory on ignition of flowing gases by means of long-duration discharges is summarized and analyzed. Data showing the effect of a flowing combustible mixture on the physical and electrical characteristics of spark discharges and data showing the effects of variables on the spark energy required for ignition of the combustible mixture are presented. A theory of ignition that has been developed to predict the effect of many of the gas-stream and spark variables is described and applied to a limited amount of experimental data. The trends observed for ignition in flowing gases were similar to those observed in quiescent gases with the exception that increasing velocity and turbulence increased the ignition energy requirements. Lengthening of the discharge path by the flowing stream results in less energy being available to the important part of the discharge length. Flow also causes multiple discharges which should be avoided since they represent an energy loss. Less energy is required for ignition with an "arc" discharge than with a "glow" discharge. Effects of most of the variables on ignition energy requirements were predicted by theoretical equations; the effects of fuel-air ratio, however, required an empirical correction to the equations.

NACA Rept. 1289

CONTRIBUTIONS ON THE MECHANICS OF BOUNDARY-LAYER TRANSITION. G. B. Schubauer and P. S. Klebanoff, National Bureau of Standards. 1956. ii, 11p. diagrs. (NACA Rept. 1289. Supersedes TN 3489)

The manner in which flow in a boundary layer becomes turbulent was investigated on a flat plate at wind speeds generally below 100 feet per second. Hot-wire techniques were used, and many of the results are derived from oscillograms of velocity fluctuations in the transition region. The more familiar aspects of transition are discussed, and the facts discovered while studying the characteristics of artificially produced turbulent spots are presented.

CURRENT NACA RESEARCH REPORTS

NACA Rept. 1303

WIND-TUNNEL INVESTIGATION OF A NUMBER OF TOTAL-PRESSURE TUBES AT HIGH ANGLES OF ATTACK. SUBSONIC, TRANSONIC, AND SUPERSONIC SPEEDS. William Gracey. 1957. ii, 10p. diagrs., tab. (NACA Rept. 1303. Supersedes TN 3641)

The total-pressure errors of 54 total-pressure tubes at angles of attack up to 60° and Mach numbers from 0.26 to 1.62 are presented. The configurations of the various tubes differed as regards external shape, internal shape, and type of total-pressure entry. External shapes tested included cylindrical, conical, and ogival nose sections. Internal shapes and total-pressure entries were varied on the basis of such factors as size of impact openings, internal chamber shape, leading-edge slant profile, and shielding (combined with venting). The effect of these variables on the sensitivities of the tubes to angle of attack is presented.

NACA TM 1408

THE PRINCIPLES OF TURBULENT HEAT TRANSFER. (Die Grundlagen des Turbulenten Wärmeüberganges.) H. Reichardt. September 1957. 45p. diagrs., tabs. (NACA TM 1408. Translation from Archiv für die gesamte Wärmetechnik, no. 6/7, 1951, p. 129-142)

Relations are derived for calculating heat-transfer coefficients for turbulent and laminar fully developed flow and heat transfer in pipes and channels at constant wall temperature. Nusselt numbers for a round pipe are computed for Prandtl numbers from 0 to 1000 at a Reynolds number of 30,000. The eddy diffusivity of momentum is assumed to vary in a continuous manner from the wall to the center of the channel. For very high Prandtl numbers it is postulated that the eddy diffusivity of momentum varies with the fifth power of the distance from the wall when very close to the wall.

NACA TM 1411

STUDY OF THE MICRO-NONUNIFORMITY OF THE PLASTIC DEFORMATION OF STEEL. (Issledovanie mikroneodnorodnosti plasticheskoi deformatsii stali.) B. B. Chechulin. August 1957. 21p. diagrs., tab. (NACA TM 1411. Translation from Fizika Metallov i Metallovedenie, v. 1, no. 2, 1955, p. 251-260.)

In 1949 Pashkov showed experimentally the enormous variation in strain from point to point in a polycrystalline metal. These large deviations from the mean strain are believed to have important effects upon the strength and flow characteristics of a metal. This work is continued in the present paper, in which the author presents a new statistical method for the study of nonuniform strains. By means of frequency diagrams of the axial inequality of the grains of a polycrystalline metal before and after loading, the average deviation of the strain from the mean can be determined. By this method it is shown that steel with an austenitic structure undergoes strains which differ much less from the mean than steels with ferritic or pearlitic structure. In the latter case, the deviations from the mean increase continuously with the mean strain.

NACA TM 1412

AERODYNAMIC FORCES ON A VIBRATING UNSTAGGERED CASCADE. (Luftkräfte an einem schwingenden Gitter.) H. Söhngen. August 1957. 16p. diagrs. (NACA TM 1412. Translation from Zeitschrift für angewandte Mathematik und Mechanik, v. 35, no. 3, Mar. 1955, p. 81-88.)

The unsteady aerodynamic forces, based on two-dimensional incompressible flow considerations, are determined for an unstaggered cascade, the blades of which are assumed to vibrate in phase with one another in an approach flow parallel to the blades.

NACA TN 3585

DETERMINATION OF SURGE AND STALL LIMITS OF AN AXIAL-FLOW TURBOJET ENGINE FOR CONTROL APPLICATIONS. Ross D. Schmidt, George Vasu, and Edward W. McGraw. September 1957. 29p. diagrs., tab. (NACA TN 3585. Supersedes RM E53B10)

Limitations on the transient operation were determined in relation to altitude and exhaust-nozzle-area parameters. The data presented are the result of an analysis of oscillograph traces obtained when the engine was operated off steady state by introducing either a step increase or a ramp increase in fuel flow. For a given speed, a lower fuel flow was required for the engine to recover from surge or stall than was necessary for surge or stall to occur. Very little difference existed between the surge line (compressor pressure ratio against engine rotational speed) obtained under transient conditions and that obtained under steady-state conditions by decreasing the flow area with an adjustable first-stage turbine stator.

NACA TN 3989

STRENGTH AND DUCTILITY OF BAINITIC STEELS. Donald H. Desy, J. O. Brittain, and M. Gensamer, Columbia University. August 1957. 32p. diagrs., photos., tabs. (NACA TN 3989)

Some of the factors believed to affect the strength and ductile-to-brittle transition temperature of bainitic steels, including mean ferrite path and degree of internal strain, have been studied. Seven laboratory heats of carbon-molybdenum and two heats of carbon steel were transformed isothermally to bainite at various temperatures and tested. Mean-ferrite-path measurements were made on electron micrographs of three of these steels. The transition temperatures of the bainite fell between -80° and -160° C and did not vary regularly with hardness, carbon or alloy content, or mean ferrite path.

CURRENT NACA RESEARCH REPORTS

NACA TN 3990

EFFECT OF CRYSTAL ORIENTATION ON FATIGUE-CRACK INITIATION IN POLYCRYSTALLINE ALUMINUM ALLOYS. J. G. Weinberg and J. A. Bennett, National Bureau of Standards. August 1957. 22p. diagrs., photos., tabs. (NACA TN 3990)

Tests on large-grained specimens of 1100 and 5052 aluminum alloys indicate that fatigue cracks initiate in preexisting slipbands on planes that are parallel to (111) planes. Bending and torsional fatigue tests were conducted to determine which factors influence the initiation of cracks. In bending fatigue it appears that grain size and shape as well as resolved shear stress were influential, while in torsional fatigue the resolved shear stress appeared to be the only important factor.

NACA TN 3995

AN INVESTIGATION OF FLOW IN CIRCULAR AND ANNULAR 90° BENDS WITH A TRANSITION IN CROSS SECTION. Stafford W. Wilbur. August 1957. 32p. diagrs., photos., tabs. (NACA TN 3995)

An investigation at low speed was conducted to determine the relative performances of circular and annular 90° bends with various combinations of transition in cross section (circular to annular and annular to circular). Included are the exit velocity profiles, the relative total-pressure-loss coefficients measured at the exit station, and an index for the exit total-pressure distortion. Separation of the flow in the bend occurred for all configurations except those with a contracting area. With the transition in cross section downstream of the bend proper, the separated region was removed by natural mixing but was accompanied by high losses. Certain locations of the transition produced higher performances than others.

NACA TN 4013

LOW-SPEED EXPERIMENTAL INVESTIGATION OF THE MAGNUS EFFECT ON VARIOUS SECTIONS OF A BODY OF REVOLUTION WITH AND WITHOUT A PROPELLER. M. J. Queijo and Herman S. Fletcher. August 1957. 68p. diagrs., photos., tab. (NACA TN 4013)

An experimental investigation has been made at low speed to determine the Magnus effect on various sections of a body of revolution of which several sections could be rotated either as individual units or in combinations. The investigation included the measurement of the Magnus effect on the body alone and also on the body with a three-blade propeller. The tests were made over an angle-of-sideslip range from -5° to 30°, and at rotational speeds from 0 to 8,000 rpm with the propeller off and from 0 to 5,000 rpm with the propeller on.

NACA TN 4032

REDUCTION OF OXIDIZED NICHROME V POWDERS AND SINTERING OF NICHROME V BODIES. Paul Sikora and Philip Clarkin. September 1957. 18p. photos., tabs. (NACA TN 4032)

Methods of obtaining essentially oxide-free powders were evaluated by oxygen analyses, tensile tests, and microstructures of specimens made from reduced powders. The three techniques that effectively lowered the oxygen content of as-received powders at 1800° to 2150° F in a hydrogen atmosphere were (1) tumbling the powder in a rotary furnace, (2) heating with sodium hydride, and (3) heating with carbon. Microstructures and tensile properties of several specimens made from reduced powder by pressing, sintering, and hot-swaging were nearly equivalent to those of wrought material. No consistent correlation existed between tensile properties and residual-oxygen content.

NACA TN 4037

STABILITY OF LAMINAR BOUNDARY LAYER NEAR A STAGNATION POINT OVER AN IMPERMEABLE WALL AND A WALL COOLED BY NORMAL FLUID INJECTION. Morris Morduchow, Richard G. Grape, and Richard P. Shaw, Polytechnic Institute of Brooklyn. August 1957. 56p. diagrs., tabs. (NACA TN 4037)

Minimum critical Reynolds numbers for laminar instability of two-dimensional stagnation flows over a wall cooled by normal fluid injection are determined theoretically. The individual as well as the net effects of wall temperature and normal fluid injection are investigated including the special case of zero injection rate. Comparison is made with results for flow over a flat plate.

NACA TN 4039

INVESTIGATION OF THE EFFECTS OF PROFILE SHAPE ON THE AERODYNAMIC AND STRUCTURAL CHARACTERISTICS OF THIN, TWO-DIMENSIONAL AIRFOILS AT SUPERSONIC SPEEDS. Elliott D. Katzen, Donald M. Kuehn, and William A. Hill, Jr. September 1957. 59p. diagrs., tabs. (NACA TN 4039. Supersedes RM A54B08a)

The effects of thickness, trailing-edge bluntness, boattailing, and forward profile were determined. The results indicated that available theoretical methods were adequate for calculating the lift and pitching moment of the airfoils under all conditions of the test. The theoretical methods for calculating forebase drag and correlation curves for estimating base pressure were adequate for predicting the total drag when the position of transition was known.

CURRENT NACA RESEARCH REPORTS

NACA TN 4063

EQUATIONS, TABLES, AND FIGURES FOR USE IN THE ANALYSIS OF HELIUM FLOW AT SUPERSONIC AND HYPERSONIC SPEEDS. James N. Mueller. September 1957. 178p. diagrs., tab. (NACA TN 4063)

This report presents equations, tables, and figures for use in the analysis of helium (specific-heat ratio of 5/3) flow at supersonic and hypersonic speeds (Mach numbers 1 to 40). The equations provide the perfect-gas relations for continuous one-dimensional flow, normal- and oblique-shock waves, and Prandtl-Meyer expansions. The tables present useful dimensionless ratios for continuous one-dimensional flow and for normal-shock waves as functions of Mach number. Figures of the helium viscosity relation as a function of temperature, mass-flow rates as a function of Mach number and temperature, the Reynolds number as a function of Mach number and stagnation temperature, and the oblique-shock characteristics of wedges and cones at Mach numbers of 12, 16, 20, and 24 are shown.

NACA TN 4066

A METHOD UTILIZING DATA ON THE SPIRAL, ROLL-SUBSIDENCE, AND DUTCH ROLL MODES FOR DETERMINING LATERAL STABILITY DERIVATIVES FROM FLIGHT MEASUREMENTS. Bernard B. Klawans and Jack A. White. August 1957. 38p. diagrs., tabs. (NACA TN 4066)

A method for determining lateral stability derivatives from flight measurements is obtained by arranging the lateral equations of motion in such form that information from each of the three modes of lateral motion may be utilized.

NACA TN 4071

A CORRELATION OF RESULTS OF A FLIGHT INVESTIGATION WITH RESULTS OF AN ANALYTICAL STUDY OF EFFECTS OF WING FLEXIBILITY ON WING STRAINS DUE TO GUSTS. C. C. Shufflebarger, Chester B. Payne, and George L. Cahen. August 1957. 40p. diagrs., tab. (NACA TN 4071)

An analytical study of the effects of wing flexibility on wing strains due to gusts has been made for four spanwise stations of a four-engine bomber airplane, and the results have been correlated with results of a previous flight investigation. The measured bending-strain amplification factors due to wing flexibility (ratio of strain for the flexible airplane to strain for the "rigid" airplane) at a station near the wing root were 1.09 when based on the ratio of root-mean-square values and approximately 1.19 when based on the ratio of strains obtained from distributions of strain peaks. The amplification factors decreased with each successive outboard station and then increased slightly at the tip station. When the airplane was considered to have three degrees of freedom (vertical motion and wing bending in the first and second symmetric bending modes), calculated amplification factors were in reasonable agreement with the measured results.

NACA TN 4075

TENSILE STRESS-STRAIN PROPERTIES OF 17-7 PH AND AM 350 STAINLESS-STEEL SHEET AT ELEVATED TEMPERATURES. Ivo M. Kurg. September 1957. 16p. diagrs., tabs. (NACA TN 4075)

Tensile stress-strain test results for 17-7 PH and AM 350 stainless-steel sheet are presented for temperatures from room temperature to 1,300° F. Stress-strain curves and data for yield and ultimate stresses, Young's modulus, and elongation are given in tabular and graphical form. A comparison is made between the tensile and compressive properties.

NACA TN 4076

CALCULATED AND MEASURED STRESSES IN SIMPLE PANELS SUBJECT TO INTENSE RANDOM ACOUSTIC LOADING INCLUDING THE NEAR NOISE FIELD OF A TURBOJET ENGINE. Leslie W. Lassiter and Robert W. Hess. September 1957. 33p. diagrs. (NACA TN 4076)

Flat 2024-T3 aluminum panels measuring 11 inches by 13 inches were tested in the near noise fields of a 4-inch air jet and turbojet engine. The stresses which were developed in the panels are compared with those calculated by generalized harmonic analysis. The calculated and measured stresses were found to be in good agreement. In order to make the stress calculations, supplementary data relating to the transfer characteristics, damping, and static response of flat and curved panels under periodic loading are necessary and were determined experimentally. In addition, an appendix containing detailed data on the near pressure field of the turbojet engine is included.

NACA TN 4077

STATIC LONGITUDINAL AND LATERAL STABILITY CHARACTERISTICS AT LOW SPEED OF 45° SWEPTBACK-MIDWING MODELS HAVING WINGS WITH AN ASPECT RATIO OF 2, 4, OR 6. David F. Thomas, Jr., and Walter D. Wolhart. September 1957. 30p. diagrs., photos., tabs. (NACA TN 4077)

Results are presented of tests conducted in the Langley stability tunnel to determine the effects of various components and combinations of components on the static longitudinal and lateral stability characteristics at low speed of a series of 45° sweptback-midwing-airplane configurations having wings with an aspect ratio of 2, 4, or 6. The tests were made at a dynamic pressure of 24.9 pounds per square foot which corresponds to a Mach number of 0.13 and Reynolds numbers of 1.00×10^6, 0.71×10^6, and 0.58×10^6 based on the respective wing mean aerodynamic chords. The angle-of-attack range covered was from -4° to 32° and the sideslip angles used for the lateral-derivative tests were 5° and -5°. An increasing loss in tail contribution to directional stability both with increasing wing aspect ratio and increasing angle of attack was found to be a principal cause of all the complete models becoming directionally unstable in the high angle-of-attack range.

CURRENT NACA RESEARCH REPORTS

NACA TN 4079

WIND-TUNNEL INVESTIGATION OF EXTERNAL-FLOW JET-AUGMENTED DOUBLE SLOTTED FLAPS ON A RECTANGULAR WING AT AN ANGLE OF ATTACK OF 0° TO HIGH MOMENTUM COEFFICIENTS. Edwin E. Davenport. September 1957. 31p. diagrs., tabs. (NACA TN 4079)

A wind-tunnel investigation has been made to determine the characteristics of external-flow jet-augmented double slotted flaps which appear suitable for application to airplanes with pod-mounted engines. The investigation included tests of a rectangular wing with an aspect ratio of 6 over a momentum-coefficient range from 0 to 28. Lift coefficients larger than the jet reaction in the lift direction were obtained with the external-flow jet-augmented double slotted flaps.

NACA TN 4088

PRACTICAL SOLUTION OF PLASTIC DEFORMATION PROBLEMS IN ELASTIC-PLASTIC RANGE. A. Mendelson and S. S. Manson. September 1957. 52p. diagrs., tab. (NACA TN 4088)

A practical method for solving plastic deformation problems in the elastic-plastic range is presented. The method is one of successive approximations and is illustrated by four examples which include a flat plate with temperature distribution across the width, a thin shell with axial temperature distribution, a solid cylinder with radial temperature distribution, and a rotating disk with radial temperature distribution.

NACA TN 4089

THE MECHANISM OF THERMAL-GRADIENT MASS TRANSFER IN THE SODIUM HYDROXIDE - NICKEL SYSTEM. Charles E. May. September 1957. 54p. diagrs., tabs. (NACA TN 4089)

"Thermal-gradient mass transfer" was investigated in the molten sodium hydroxide - nickel system. Kinetic equations are theoretically derived. Possible mechanisms (physical, electrochemical, and chemical) are discussed. The following mechanism is found to be most probable:

$$Na_2NiO_2 + 2Na \underset{\text{Hot zone}}{\overset{\text{Cold zone}}{\rightleftharpoons}} 2Na_2O + Ni$$

This mechanism requires that the chemical reaction is the rate-determining step in dynamic systems and that the diffusion process is the rate-controlling step in static systems. Beneficial and detrimental effects of additives are interpreted in terms of the probable mechanism.

NACA TN 4090

ANALYSIS OF SHOCK MOTION IN DUCTS DURING DISTURBANCES IN DOWNSTREAM PRESSURE. Herbert G. Hurrell. September 1957. 11p. diagr. (NACA TN 4090)

A linearized analysis is made of the effect of small downstream pressure disturbances on the position of a normal shock in a duct with area variation. In the analysis, the gas flow is treated as quasi-one-dimensional and nonviscous. The analysis shows that, within a given frequency limit, shock position is related to small disturbances in downstream pressure by a first-order lag. The time constant and the gain of the lag are expressed in terms of a dimensionless time constant that depends only on the steady-state Mach number of the shock.

NACA TN 4103

IMPACT-LOADS INVESTIGATION OF CHINE-IMMERSED MODEL HAVING A CIRCULAR-ARC TRANSVERSE SHAPE. Philip M. Edge, Jr. September 1957. 35p. diagrs., photo., tab. (NACA TN 4103)

Hydrodynamic-impact-loads data were obtained at the Langley impact basin from tests of a narrow-beam model having a circular-arc transverse shape of 1-beam radius. Tests were run in smooth water at fixed trims over a range of landing conditions for a beam-loading coefficient of 18.59 with a few runs for beam-loading coefficients of 27.59 and 36.57. The data are compared with loads predicted by theory and with experimental loads obtained from similar tests with a concave-convex transversely curved shape.

NACA TN 4104

THE USE OF PURE TWIST FOR DRAG REDUCTION ON ARROW WINGS WITH SUBSONIC LEADING EDGES. Frederick C. Grant. August 1957. 28p. diagrs., tabs. (NACA TN 4104)

Linearized-theory calculations are presented for the drag reduction achieved by applying the first three terms of a power series for twist to flat delta wings and by applying linear twist to flat arrow wings with sonic trailing edges. Tip and root incidence angles for the optimum linearly twisted wings are shown. The calculations cover the speed range of subsonic leading edges.

CURRENT NACA RESEARCH REPORTS

NACA TN 4106

IMPACT-LOADS INVESTIGATION OF A CHINE-IMMERSED MODEL HAVING A LONGITUDINALLY CURVED BOW AND A V-BOTTOM WITH A DEAD-RISE ANGLE OF 30°. Philip M. Edge, Jr., and John S. Mixson. September 1957. 24p. diagrs., photo., tabs. (NACA TN 4106)

Hydrodynamic-impact-loads data were obtained at the Langley impact basin with a chine-immersed model having a dead-rise angle of 30° and the forward half longitudinally curved upward on a radius of 10 beams. Impacts were made at fixed trim in smooth water at a beam-loading coefficient of 18.8 and over a range of landing-approach conditions. The data are evaluated as to the extent of bow immersion, and the maximum loads obtained are compared with loads predicted by theory for a straight-keel model.

NACA TN 4107

EFFECTS OF AIRPLANE FLEXIBILITY ON WING STRAINS IN ROUGH AIR AT 5,000 FEET AS DETERMINED BY FLIGHT TESTS OF A LARGE SWEPT-WING AIRPLANE. Richard H. Rhyne and Harold N. Murrow. September 1957. 32p. diagrs., photo., tabs. (NACA TN 4107)

The results of a flight investigation on a large swept-wing bomber airplane to determine the overall magnitude of the aeroelastic effects on the bending and shear strains in rough air show that the amplification of strain per unit acceleration in gusts, as compared with strain per unit acceleration for a "rigid" and "quasi-rigid" reference, increases with outboard spanwise station to a maximum amplification factor of 2.72.

NACA TN 4108

A THERMAL SYSTEM FOR CONTINUOUS MONITORING OF LAMINAR AND TURBULENT BOUNDARY-LAYER FLOWS DURING ROUTINE FLIGHT. Norman R. Richardson and Elmer A. Horton. September 1957. 25p. diagrs., photos. (NACA TN 4108)

A thermal system has been developed which could be used to determine whether the boundary layer on a wing in flight is turbulent or laminar. Detectors cemented to the wing surface combine the functions of heating and temperature measurement. Detection is based on the difference in rate of heat transfer to a turbulent boundary layer as compared with that to a laminar boundary layer. Tests in the Langley low-turbulence pressure tunnel indicate that a usable signal is obtained when the Reynolds number per foot is about 0.15×10^6 or greater. This system, when used with a recording galvanometer and a motor-driven selector switch, would permit continuous and unattended monitoring of the boundary layer during routine flight.

NACA TN 4119

WIND-TUNNEL INVESTIGATION OF EFFECTS OF GROUND PROXIMITY AND OF SPLIT FLAPS ON THE LATERAL STABILITY DERIVATIVES OF A 60° DELTA-WING MODEL OSCILLATING IN YAW. Byron M. Jaquet. September 1957. 32p. diagrs. photos., tab. (NACA TN 4119)

An investigation was made in the Langley stability tunnel to determine the effects of the proximity of the ground and of split flaps on the lateral stability derivatives of a 60° delta-wing model oscillating continuously in yaw. The model was tested with and without the vertical tail and the split flaps, without ground, and at ground-to-model distances from 0.30 to 1.25 wing mean aerodynamic chord at angles of attack to 30°. The test Mach number was 0.13 and the Reynolds number based on the wing mean aerodynamic chord was 1.6×10^6.

MISCELLANEOUS

Errata No. 2 on NACA RM A50J26. By Murray Tobak, David E. Reese, Jr., and Benjamin H. Beam. December 1950.

Errata on NACA TN 4067, by Heldenfels and Vosteen, August 1957.

UNPUBLISHED PAPERS

N-54676*

EFFECT OF LATERAL WIND ON THE BOUNDARY LAYER OF A HIGH-SPEED COMPRESSIBLE FLOW ABOUT A CYLINDRICAL OBSTACLE (WING AT AN ANGLE OR WITH SWEEPBACK). (Influenza di un vento laterale sullo strato limite di corrente compressibile ad alta velocita che investe un ostacolo cilindrico)(ala in deriva o a freccia.) Aldo Castagno. 21p. diagrs. Translation from Aerotecnica, v. 36, no. 3, July 1956, p. 152-159. (Ask for N-54676*)

A study is made of the laminar boundary layer on a cylindrical obstacle in a compressible oblique flow under the assumptions of zero heat transfer at the wall and Prandtl number equal to unity. Formulas are given which permit the computation of the distributions of the velocities and forces in the cases of the flat plate and the general wing airfoil with possible point of separation.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification September 13, 1957.

NACA RM A9I27

AERODYNAMIC STUDY OF A WING-FUSELAGE COMBINATION EMPLOYING A WING SWEPT BACK 63°. - EFFECTS AT SUBSONIC SPEEDS OF A CONSTANT-CHORD ELEVON ON A WING CAMBERED AND TWISTED FOR A UNIFORM LOAD AT A LIFT COEFFICIENT OF 0.25. J. Lloyd Jones and Fred A. Demele. December 5, 1949. 44p. diagrs., photos., tab. (NACA RM A9I27)

Longitudinal aerodynamic characteristics and lateral control data are presented of a cambered and twisted wing having a leading edge swept back 63° in combination with a slender fuselage and equipped with constant-chord elevons. The tests were conducted at a Reynolds number of 2.0 million and at Mach numbers ranging from 0.20 to 0.93. Data from the tests have been applied to the calculation of the longitudinal stability and control characteristics and of the lateral control characteristics of an airplane geometrically similar to the model.

NACA RM A9I29

EXPERIMENTAL INVESTIGATION AT SUPERSONIC SPEEDS OF SIDE SCOOPS EMPLOYING BOUNDARY-LAYER SUCTION. Sherman S. Edwards. December 12, 1949. 37p. diagrs., photos. (NACA RM A9I29)

Pressure-recovery characteristics of side scoops employing boundary-layer control by means of suction scoops are described at Mach numbers between 1.36 and 2.01. It is shown that, neglecting the energy expended in boundary-layer removal, total-pressure recovery within 0.05 of that of nose inlets can be attained at free-stream Mach numbers less than 1.8. Reduced pressure recovery occurred with increasing positive angles of attack. Drooping the model forebody with respect to the inlets improved the pressure recovery at angle of attack.

NACA RM A52E06

THE EFFECT OF AN OPERATING PROPELLER ON THE AERODYNAMIC CHARACTERISTICS AT HIGH SUBSONIC SPEEDS OF A MODEL OF A VERTICAL-RISING AIRPLANE HAVING AN UNSWEPT WING OF ASPECT RATIO 3. Fred B. Sutton and Donald A. Buell. November 1954. 90p. diagrs., photos., tabs. (NACA RM A52E06)

Wind-tunnel tests were conducted in the Ames 12-foot pressure wind tunnel through a range of power coefficients at angles of attack up to 16° at Mach numbers from 0.50 to 0.92 at a Reynolds number of 1.7 million. Static aerodynamic characteristics are presented for the complete model and for combinations of model components. The characteristics of the propeller are also shown.

NACA RM A54I17

A FLIGHT INVESTIGATION AT TRANSONIC SPEEDS AND SMALL ANGLES OF ATTACK OF THE AERODYNAMIC CHARACTERISTICS OF A MODEL HAVING A 45° SWEPTBACK WING OF ASPECT RATIO 3 WITH AN NACA 64A006 AIRFOIL SECTION. George H. Holdaway. January 1955. 32p. diagrs., photo., tab. (NACA RM A54I17)

An investigation of the static and dynamic longitudinal aerodynamic characteristics of a model with the subject wing and a 45° sweptback cruciform tail was made at transonic speeds and small angles of attack by a free-fall recoverable-model technique. The load distributions on the fuselage in the vicinity of the wing and aerodynamic characteristics of the exposed wing panels were also determined.

NACA RM A54I22

EFFECTS OF RIGID SPOILERS ON THE TWO-DIMENSIONAL FLUTTER DERIVATIVES OF AIRFOILS OSCILLATING IN PITCH AT HIGH SUBSONIC SPEEDS. James C. Monfort and John A. Wyss. December 1954. 33p. diagrs., photos., tabs. (NACA RM A54I22)

A study was made of the effects of spoilers having fixed heights on the flutter derivatives of two-dimensional airfoils oscillated in pitch at Mach numbers from 0.5 to 0.9, at frequencies from 4 to 40 cycles per second. Airfoils with NACA 65A012, 65A008, 2-008, and 877A008 profiles were used with spoilers of fixed heights, equal to 2-1/2 and 4 percent of the wing chord, affixed at the 70-percent-chord station.

NACA RM A55I19

THE EFFECT OF FLUID INJECTION ON THE COMPRESSIBLE TURBULENT BOUNDARY LAYER - PRELIMINARY TESTS ON TRANSPIRATION COOLING OF A FLAT PLATE AT M = 2.7 WITH AIR AS THE INJECTED GAS. Morris W. Rubesin, Constantine C. Pappas, and Arthur F. Okuno. December 1955. 37p. diagrs. (NACA RM A55I19)

Local values of heat-transfer rate and recovery factor, obtained on a transpiration-cooled flat plate, are presented. Air was injected into a turbulent boundary layer at several rates of flow through a porous flat plate oriented parallel to an air stream. Surface temperatures were maintained near recovery temperature. The Mach number was 2.7 and the Reynolds number range was 1.5 million to 7.0 million.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM A55I29

THE EFFECT OF LEADING-EDGE EXTENSIONS OF THE LONGITUDINAL CHARACTERISTICS AT MACH NUMBERS UP TO 0.92 OF A WING-FUSELAGE-TAIL COMBINATION HAVING A 40° SWEPTBACK WING WITH NACA 64A THICKNESS DISTRIBUTION. Fred B. Sutton. January 1956. 52p. diagrs., photos., tabs. (NACA RM A55I29)

The investigation was conducted in the Ames 12-foot pressure wind tunnel. Leading-edge extensions extending from 0.45 semispan to the wing tip and from 0.60 semispan to the wing tip were investigated at a Mach number of 0.25 at a Reynolds number of 8 million and at Mach numbers from 0.25 to 0.92 at a Reynolds number of 2 million.

#NACA RM E52I16, by Calvert, Meyer, and Morse

NACA RM E54I13

EXPERIMENTAL INVESTIGATION OF DRAG OF AFTERBODIES WITH EXITING JET AT HIGH SUBSONIC MACH NUMBERS. Reino J. Salmi. November 1954. 28p. diagrs., photos. (NACA RM E54I13)

The boattail and base pressures of a series of blunt-based conical afterbodies including some ejector configurations were measured at Mach numbers of 0.6 to 0.9 with and without a jet exiting at the base. For both the jet-off and jet-on cases, boattailing was very effective in reducing the drag of the afterbodies. In particular, for simulated jet-engine afterburner-off conditions, the drag of the base that would be formed by iris-type flaps on the secondary shroud was greatly reduced by incorporating a boattail ahead of the base.

NACA RM E54I20

INVESTIGATION OF COMPRESSIBLE FLOW MIXING LOSSES OBTAINED DOWNSTREAM OF A BLADE ROW. Warner L. Stewart. December 1954. 21p. diagrs. (NACA RM E54I20)

The analytical phase of the investigation indicated that increasing the flow velocities into the high subsonic and supersonic levels resulted in an increased mixing loss, with this loss becoming a sizable percentage of the blade viscous loss. Comparison of these results with those obtained experimentally for a transonic turbine stator indicated good agreement at the mean section where nominal two-dimensional flow conditions existed.

NACA RM E55B04

PANEL-FLUTTER INVESTIGATION AT SUPERSONIC SPEEDS OF A PRESSURIZED STRUCTURE FABRICATED OF 0.020-INCH-THICK LAMINATED GLASS-PLASTIC. L. Abbott Leissler. June 1955. 13p. diagrs., photo. (NACA RM E55B04)

An internally pressurized, glass-reinforced plastic shell shaped to simulate a proposed missile fuel cell was investigated at free-stream Mach numbers of 1.5 and 2.0 to determine the minimum pressure differential required to avoid panel flutter. No structural failure occurred with a pressure differential as low as 50 pounds per square foot, the minimum investigated, nor was skin flutter visually observed with either an empty shell at zero angle of attack or a shell half-filled with water at an angle of attack of 10°.

NACA RM E55E06

PREPARATION AND PHYSICAL PROPERTIES OF SOME TRIALKYLBORANES. Louis Rosenblum and Harrison Allen, Jr. November 1955. 19p. diagrs., photos., tab. (NACA RM E55E06)

Triethylborane, tri-n-propylborane, and tri-n-butylborane were prepared by the Grignard method. The first two compounds were distilled to purities of 99.8 and 99.7 mole percent, respectively, but tri-n-butylborane decomposed during distillation. The following physical properties of triethylborane and tri-n-propylborane were determined: (1) freezing point, (2) heat of fusion, (3) boiling point, (4) heat of combustion, (5) refractive index, (6) density, (7) dielectric constant, and (8) infrared spectra.

NACA RM E55H12

INVESTIGATION OF A CERMET GAS-TURBINE-BLADE MATERIAL OF TITANIUM CARBIDE INFILTRATED WITH HASTALLOY C. Charles A. Hoffman. January 1956. 23p. diagrs., photos., tab. (NACA RM E55H12)

A cermet composition was investigated as a potential material for gas-turbine blades. Blades of HS-21 alloy were also operated in the engine simultaneously to provide a basis of comparison. The cermet blades survived as long as approximately 312-1/2 hours at about 1500° F with an average midspan centrifugal stress of approximately 11,500 psi. The alloy blade midspan stress was about 15,300 psi. Because of extensive damage to both types of blade due to external causes, a reliable comparison of operating lives could not be made. The cermet blades tended to fail in the airfoil rather than in the base, although the base was the usual location of failure in a prior study of cold-pressed and sintered cermets of other compositions with the same blade shape.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM E55I29a

PRELIMINARY ATTEMPTS AT ISOTHERMAL COMPRESSION OF A SUPERSONIC AIR STREAM. E. Perchonok and F. Wilcox. January 1956. 33p. diagrs., photos., tab. (NACA RM E55I29a)

Guided by analytical predictions, preliminary experments were undertaken in an attempt to achieve isothermal (constant static temperature) compression of a supersonic air stream. When applied to a supersonic inlet diffuser at both $M_0 = 1.9$ and 3.0, the process produced large total-pressure losses due to the momentum exchange between the inlet air stream and the coolant as expected, but the total-pressure increase associated with evaporative cooling was not observed. Tests at $M_0 = 3.0$ with a heated air stream and multipoint upstream injection suggest that some improvement in the process might be obtained with a full-scale inlet at the high stagnation temperature of supersonic flight.

NACA RM H54G20a

ROLLING PERFORMANCE OF THE REPUBLIC YF-84F AIRPLANE AS MEASURED IN FLIGHT. John B. McKay. January 1955. 24p. diagrs., photo., tab. (NACA RM H54G20a)

Flight measurements of the rolling performance of the Republic YF-84F airplane were made at altitudes of 10,000, 25,000, and 40,000 feet. The tests were conducted over a Mach number range from 0.35 to 0.95.

#NACA RM L50I08, by Grigsby

NACA RM L51I04

FLIGHT DETERMINATION OF THE DRAG AND LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A ROCKET-POWERED MODEL OF A 60° DELTA-WING AIRPLANE FROM MACH NUMBERS OF 0.75 TO 1.70. Grady L. Mitcham, Norman L. Crabill, and Joseph E. Stevens. November 1951. 44p. diagrs., photos., tab. (NACA RM L51I04)

A flight investigation of a rocket-powered model of a 60° delta-wing airplane has been conducted to determine the variation of drag with lift and the static and dynamic longitudinal stability parameters from a Mach number of 0.75 to 1.70 at Reynolds numbers of 10×10^6 to 26×10^6.

NACA RM L51I07

TWO-DIMENSIONAL CHORDWISE LOAD DISTRIBUTIONS AT TRANSONIC SPEEDS. Walter F. Lindsey and Richard S. Dick. February 1952. 41p. diagrs., photos. (NACA RM L51I07)

The two-dimensional loadings on nine airfoils are presented at Mach numbers between 0.8 and 1.0. The separate effects of thickness, thickness distribution, and camber are discussed. A method of estimating pressure distributions on symmetrical airfoils at sonic velocity is presented.

NACA RM L52I05

AN ANALYSIS OF THE EFFECT OF A CURVED RAMP ON THE TAKE-OFF PERFORMANCE OF CATAPULT-LAUNCHED AIRPLANES. Wilmer H. Reed, III. November 1952. 28p. diagrs., tab. (NACA RM L52I05)

The possibility of improving take-off performance of catapult-launched airplanes by means of a curved ramp installed forward of the catapult-release point and designed to give the catapulted airplane an initial upward vertical velocity and a nose-up pitching velocity has been analyzed.

NACA RM L52I05a

EXPLORATORY ROCKET FLIGHT TESTS TO INVESTIGATE THE USE OF A FREELY SPINNING MONOPLANE TAIL FOR STABILIZING A BODY. Paul E. Purser and Joseph E. Stevens. October 1952. 25p. diagrs., photos., tab. (NACA RM L52I05a)

Exploratory rocket flight tests have been made to determine the feasibility of stabilizing a body such as a missile, rocket, bomb, or jettisonable external store by the use of freely spinning monoplane fins instead of the usual cruciform or triform fin arrangements. An analysis of the effects of rolling on longitudinal and directional stability of aircraft (NACA TN 1627) which had indicated that such a device could provide stability was verified qualitatively by the flight tests.

NACA RM L52I29

TOTAL-PRESSURE AND SCHLIEREN STUDIES OF THE WAKES OF VARIOUS CANARD CONTROL SURFACES MOUNTED ON A MISSILE BODY AT A MACH NUMBER OF 1.93. William B. Boatright. November 1952. 47p. photos., diagrs. (NACA RM L52I29)

Studies of the wake behind various canard control surfaces of equal span mounted on a missile body have been made at a Mach number of 1.93. These studies were made for eight constant-span control surfaces of varying plan form, thickness, and section by means of total-pressure surveys at a location corresponding to a rearward ram-jet-engine inlet location and by means of plan-view schlieren photographs of the path of the core of the rolled-up vortex sheet from the canard control surfaces. The effect of body-mounted rocket boosters on the pressure field was determined for three control surfaces, as was the effect of end plates attached to the tips of one of the control surfaces.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM L52I30

AERODYNAMIC CHARACTERISTICS EXTENDED TO HIGH ANGLES OF ATTACK AT TRANSONIC SPEEDS OF A SMALL-SCALE 0° SWEEP WING, 45° SWEPT-BACK WING, AND 60° DELTA WING. Harleth G. Wiley. November 1952. 26p. diagrs. (NACA RM L52I30)

This paper presents the aerodynamic characteristics through high angles of attack and at transonic speeds of a 0° sweep wing, a 45° sweptback wing, and a 60° delta wing. Lift, drag, pitching moment, and bending moment were obtained over an angle-of-attack range of 0° to approximately 60° over a Mach number range of 0.6 to 1.1. The effects of leading-edge roughness on the 0° sweep wing, a constant-thickness flat-plate airfoil section on the 45° sweptback wing, and a fuselage on the 60° delta wing were briefly investigated.

NACA RM L53F01

A WIND-TUNNEL INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS OF A FULL-SCALE SUPERSONIC-TYPE THREE-BLADE PROPELLER AT MACH NUMBERS OF 0.96. Albert J. Evans and George Liner. July 1953. 61p. diagrs., photo. (NACA RM L53F01)

This paper contains the results of an investigation of a full-scale supersonic-type three-blade propeller in the Langley 16-foot transonic tunnel with a 6000-horsepower propeller dynamometer. The tests covered a range of blade angles from 20.2° to 60.2° at forward Mach numbers up to 0.96. The effects of compressibility on the aerodynamic characteristics of the propeller and comparisons of the experimental results with calculated results are presented.

NACA RM L53I01

SOME EXPERIMENTAL EFFECTS OF AFTERBODY SHAPE ON THE ZERO-LIFT DRAG OF BODIES FOR MACH NUMBERS BETWEEN 0.8 AND 1.3. William E. Stoney, Jr. October 1953. 24p. diagrs., photos. (NACA RM L53I01)

Zero-lift drag data were obtained on a series of fin-stabilized bodies differing only in afterbody shape. Three series of afterbodies (fineness ratios 1.78, 3.00, and 5) with varying ratios of base radius to maximum radius (0, 0.458, 0.700, and 1) were combined with a fineness-ratio-7.13 parabolic nose. Both conical and parabolic afterbodies were tested. The models were launched from the Langley helium gun, and data were obtained for Mach numbers from 0.8 to 1.3 and for Reynolds numbers (based on body length) of about 10×10^6. The results indicate that a conical angle of about 4.5° will give the minimum drag for any fineness ratio less than 6, and that the minimum-drag afterbody has a fineness ratio of 6, and that its drag is approximately 30 to 40 percent of that for a square-base body of fineness ratio 0.

NACA RM L53I02

THE INTERPRETATION OF NONLINEAR PITCHING MOMENTS IN RELATION TO THE PITCH-UP PROBLEM. George S. Campbell and Joseph Weil. October 1953. 32p. diagrs., tabs. (NACA RM L53I02)

Equations are presented for calculating the dynamic behavior of airplanes having arbitrarily nonlinear aerodynamic characteristics. Application of the methods derived is directed toward a study of some of the factors affecting the severity of pitch-up motions encountered by airplanes having regions of reduced stability: pitching-moment shape, control movement, dynamic pressure, airplane moment of inertia, and aerodynamic damping. Brief consideration is also given to the effectiveness of automatic stabilization devices in reducing pitch-up severity.

NACA RM L53I04

ROCKET-MODEL INVESTIGATION TO DETERMINE THE HINGE-MOMENT AND NORMAL-FORCE PROPERTIES OF A FULL-SPAN, CONSTANT-CHORD, PARTIALLY BALANCED TRAILING-EDGE CONTROL ON A 60° CLIPPED DELTA WING BETWEEN MACH NUMBERS OF 0.50 AND 1.26. C. William Martz and John W. Goslee. October 1953. 33p. diagrs., photos., tab. (NACA RM L53I04)

Control-force and hinge-moment characteristics were obtained from a free-flight investigation of a rocket-powered research model equipped with 60° sweptback clipped delta wings featuring full-span, constant-chord trailing-edge controls hinged at 40 percent control chord. Data were obtained for angles of attack from ±4° at a Mach number of 1.26 to ±16° at a Mach number of 0.5 and for control-surface deflections up to ±5° between Mach numbers of 0.5 and 1.26. Comparisons are made with linear theory and with other rocket-model data.

NACA RM L53I09

WAKE SURVEYS IN THE SLIPSTREAM OF A FULL-SCALE SUPERSONIC-TYPE THREE-BLADE PROPELLER AT MACH NUMBERS TO 0.96. John M. Swihart and Harry T. Norton, Jr. October 1953. 33p. diagrs., photo. (NACA RM L53I09)

This paper presents the results of an investigation to determine the thrust and thrust loading from wake-survey measurements of a full-scale supersonic-type three-blade propeller at Mach numbers to 0.96. The blade-angle range was from 45.4° to 60.2° measured at the 0.75 radial station over a Mach number range from 0.60 to 0.96. The results of the investigation indicate that operation at blade angles near the design condition produced no sharp compressibility losses at Mach numbers to 0.89. The losses in section thrust coefficient were more severe for the higher blade.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM L53I21

AN INVESTIGATION AT MACH NUMBER 2.40 OF FLAP-TYPE CONTROLS EQUIPPED WITH OVERHANG NOSE BALANCES. James N. Mueller. November 1953. 95p. diagrs., photos., tab. (NACA RM L53I21)

The results of a two-dimensional pressure distribution investigation at a Mach number of 2.40 of some of the factors affecting the balancing characteristics of flap-type controls equipped with overhang nose balances on a 6-percent-thick symmetrical wing of two afterbody shapes are presented in the form of pressure-distribution diagrams, schlieren photographs, and section aerodynamic coefficients. The factors included are percent overhang, wing-flap gap, fixed transition, flap nose shape, flap trailing-edge thickness, and wing afterbody shape. A method for estimating the loads on the controls is shown to give good results. The Reynolds number of the tests was 0.78×10^6.

NACA RM L53I23a

THE EFFECT OF NOSE RADIUS AND SHAPE ON THE AERODYNAMIC CHARACTERISTICS OF A FUSELAGE AND A WING-FUSELAGE COMBINATION AT ANGLES OF ATTACK. John P. Gapcynski and A. Warner Robins. October 1953. 23p. diagrs. (NACA RM L53I23a)

An investigation has been conducted in the Langley 4- by 4-foot supersonic pressure tunnel to determine the effect of nose blunting on the aerodynamic characteristics of a wing-body combination, and to determine the possible drag reduction of blunt-nosed bodies with the use of spikes and perforated cones. Tests were conducted at a Mach number of 1.61 and a Reynolds number per foot of 4.1×10^6. Limited tests were made at a Mach number of 2.01. The angle-of-attack range was approximately -2° to 10°.

NACA RM L53I28b

CONSIDERATIONS AFFECTING HYDRO-SKI AIRPLANE DESIGN. Kenneth L. Wadlin. November 1953. 14p. diagrs. (NACA RM L53I28b)

This paper discusses the basic concepts of hydro-ski aircraft and how the application of hydro-skis affects supersonic configurations. The interdependency of the fuselage, ski, and possible load-alleviating methods upon the design of hydro-ski airplanes is also considered. Data on fuselages, struts, and lifting surfaces in the planing and submerged condition are presented. Trends indicated by these data and some theoretical work are illustrated and discussed.

NACA RM L54I14

COMPARISON OF EFFECTS OF AILERONS AND COMBINATIONS OF SPOILER-SLOT-DEFLECTOR ARRANGEMENTS ON SPIN RECOVERY OF SWEPT-BACK-WING MODEL HAVING MASS DISTRIBUTED ALONG THE FUSELAGE. Frederick M. Healy and Walter J. Klinar. November 1954. 18p. diagrs., photo., tabs. (NACA RM L54I14)

An investigation has been made in the Langley 20-foot free-spinning tunnel to determine the effectiveness of a lateral-control system employing spoilers and deflectors as compared with ailerons in bringing about recoveries from spins of a model of a 35° swept-wing fighter loaded heavily along the fuselage.

NACA RM L54I15

DESIGN AND EVALUATION OF A TURBOJET EXHAUST SIMULATOR, UTILIZING A SOLID-PROPELLANT ROCKET MOTOR, FOR USE IN FREE-FLIGHT AERODYNAMIC RESEARCH MODELS. Carlos A. deMoraes, William K. Hagginbothom, Jr., and Ralph A. Falanga. December 1954. 25p. diagrs., photos. (NACA RM L54I15)

A method has been developed for modifying a rocket motor so that its exhaust characteristics simulate those of a turbojet engine. The analysis necessary to the design, a typical example, and the tests from which the designs were evaluated are presented. Although applied to solid propellant in the present case, the technique can be applied to any installation where the desired jet total pressure is appreciably less than that of the combustion or reaction camber.

NACA RM L54I19

FLUTTER INVESTIGATION OF A TRUE-SPEED DYNAMIC MODEL WITH VARIOUS TIP-TANK CONFIGURATIONS. John L. Sewall, Robert W. Herr, and William B. Igoe. March 1955. 80p. diagrs., photos., tabs. (NACA RM L54I19)

A 1/6-scale dynamic model, equipped with wing tip tanks and representative of current unswept-wing fighter-type airplanes of conventional plan form, was tested for flutter in the Langley 16-foot transonic tunnel. The wing was of spar-balsa segment-type construction and was dynamically scaled to flutter at the same speed as a typical full-scale configuration, thus avoiding the usual limitations imposed by compressibility. A device for arresting flutter by providing for a quick shift in the tip-tank center of gravity was located in each tip tank and proved to be very effective in stopping symmetric flutter for cases when the tip-tank center of gravity was shifted forward of the wing elastic axis. The flutter problem for which this model was designed was concerned with the effects of external stores, and, in general, the results obtained concur with the results of previous studies of the problem. A conventional Rayleigh-Ritz type of flutter analysis predicted flutter speeds that were excessively conservative with respect to experiment as the tip-tank center of gravity approached the elastic axis.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM L54I30

FLOW AND FORCE CHARACTERISTICS OF 2-PERCENT-THICK AIRFOILS AT TRANSONIC SPEEDS. Walter F. Lindsey and Emma Jean Landrum. January 1955. 74p. diagrs., photos. (NACA RM L54I30)

A two-dimensional investigation utilizing pressure-distribution measurements and schlieren photographs has been made of the flow and force characteristics of slab-sided airfoils of 2-percent thickness at transonic Mach numbers. The aerodynamic characteristics and an analysis of the flow past the models are presented. The results are compared with previous tests on airfoils of 4-percent thickness and greater, and show that at high subsonic Mach numbers additional improvements in aerodynamic characteristics were obtained with the 2-percent-thick airfoils.

NACA RM L54L16

STUDY OF SOME EFFECTS OF STRUCTURAL FLEXIBILITY ON THE LONGITUDINAL MOTIONS AND LOADS AS OBTAINED FROM FLIGHT MEASUREMENTS OF A SWEPT-WING BOMBER. James J. Donegan and Carl R. Huss. May 1955. 53p. diagrs., tabs. (NACA RM L54L16)

Some measurements obtained during elevator pulse maneuvers with a Boeing B-47A airplane in the Mach number range from 0.62 to 0.82 are analyzed to obtain frequency responses in pitching velocity and normal load factor up to frequencies of 43 radians per second. Transfer coefficients and longitudinal stability derivatives are obtained. Effects of structural flexibility were examined by considering the configuration with three different amounts of flexibility and comparing the maximum responses of each to the same inputs.

NACA RM L55B02

PRELIMINARY RESULTS FROM FLIGHT MEASUREMENTS IN GRADUAL-TURN MANEUVERS OF THE WING LOADS AND THE DISTRIBUTION OF LOAD AMONG THE COMPONENTS OF A BOEING B-47A AIRPLANE. T. V. Cooney, William H. Andrews, and William A. McGowan. June 1955. 20p. diagrs., photo., tab. (NACA RM L55B02)

Preliminary results are presented of strain-gage measurements of the wing loads and distribution of load among the components of the Boeing B-47A airplane in gradual-turn maneuvers at altitudes from 15,000 to 35,000 feet and covering a Mach number range from 0.44 to 0.80.

NACA RM L55I16

THE EFFECT OF LEADING-EDGE DROOP UPON THE PRESSURE DISTRIBUTION AND AERODYNAMIC LOADING CHARACTERISTICS OF A 45° SWEPTBACK WING AT TRANSONIC SPEEDS. James W. Schmeer. November 1955. 42p. diagrs., photos. (NACA RM L55I16)

An experimental investigation has been made in the Langley 16-foot transonic tunnel to determine the effects of 6° leading-edge droop on the presure distribution and aerodynamic loading characteristics of a 45° sweptback wing. Data were obtained through an angle-of-attack range at Mach numbers of 0.80 to 1.03 with average Reynolds numbers of 5.7×10^6 to 6.3×10^6, respectively. Basic pressure-coefficient distribution, center-of-pressure location, and integrated loading characteristics are compared with similar data for the basic or undrooped wing of a previous investigation. Ink-flow pictures for the wing with leading-edge droop are also presented. The results indicate that leading-edge droop delays the onset of separation on the outboard sections of the wing at high subsonic Mach numbers; the beneficial effects decrease with speed and become negligible above a Mach number of 0.94.

NACA RM L55L23b

HIGH-TEMPERATURE OXIDATION AND IGNITION OF METALS. Paul R. Hill, David Adamson, Douglas H. Foland, and Walter E. Bressette. March 1956. 12p. diagrs. (NACA RM L55L23b)

Spontaneous ignition tests were made of a number of metals used in aircraft construction. Rods and cones were tested in heated subsonic and supersonic air jets and wires were heated in static atmospheres of air and oxygen. Several steels, titanium, and magnesium ignited spontaneously, while stainless steels, Inconel, aluminum, and copper did not.

NACA RM L56C23a

FLIGHT INVESTIGATION AND ANALYSIS OF THE WING DEFORMATIONS ON A SWEPT-WING BOMBER DURING ROLLING MANEUVERS. Alton P. Mayo and John F. Ward. October 1956. 48p. diagrs., photo., tabs. (NACA RM L56C23a)

The results of deflection measurements made at six spanwise stations on the wing of a swept-wing jet bomber (Boeing B-47A) during rolling maneuvers are presented in the form of coefficients expressing the deflections due to the aileron loads, the sideslip loads, the wing-flapping inertia loads, and the rolling-velocity loads on the airplane. Comparisons of the experimental deflections and twists with those obtained from theoretical calculations are presented along with a detailed explanation of the procedures used in the analysis of the flight data and in the theoretical calculations.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM L56E21a

LIFT-CURVE SLOPES DETERMINED IN FLIGHT ON A FLEXIBLE SWEPT-WING JET BOMBER. William S. Aiken, Jr., and Raymond A. Fisher. December 1956. 49p. diagrs., photos., tabs. (NACA RM L56E21a)

An analysis is made of the effects of Mach number and dynamic pressure on the lift-curve slope of a large flexible swept-wing jet-propelled airplane by using flight measurements of normal acceleration and angle of attack with auxiliary instrumentation as needed. The methods and procedures used to correct the flight measurements (obtained in abrupt push-pull maneuvers) and to convert the flight test data to equivalent rigid conditions for comparison with rigid-model wind-tunnel tests are described in detail. The airplane angle of zero lift and the airplane-less-tail angle of zero lift for the Mach number range of the flight tests (0.42 to 0.81) are also presented.

NACA RM L56H29a

DYNAMIC MODEL INVESTIGATION OF TWO TAIL-SITTER VERTICALLY RISING AIRPLANES TO DETERMINE THE ALTITUDE REQUIRED TO APPROACH NORMAL-FLIGHT CONDITIONS AFTER POWER FAILURE IN HOVERING FLIGHT. Walter J. Klinar and L. Faye Wilkes. November 1956. 15p. diagrs., tabs. (NACA RM L56H29a)

An investigation has been conducted utilizing dynamic models to determine the altitude required for models of two designs that take off and land vertically to turn over and nose into the direction of flight after power failure during hovering flight. Brief computations were also made to attempt to project the flights to the point where normal gliding flight was obtained.

NACA RM L56J02

HORIZONTAL-TAIL PARAMETERS AS DETERMINED FROM FLIGHT-TEST TAIL LOADS ON A FLEXIBLE SWEPT-WING JET BOMBER. William S. Aiken, Jr., and Raymond A. Fisher. January 1957. 42p. diagrs., photos., tabs. (NACA RM L56J02)

An analysis is made of horizontal-tail loads measured by means of strain gages in flight on a flexible multiengined jet-propelled swept-wing medium bomber to determine the horizontal-tail angle of attack, and elevator deflection parameters and centers of pressure of loads on the tail due to angles of attack and elevator deflection. Comparison of flight-determined parameters with available low-speed wind-tunnel data indicated excellent agreement, and the locations of the centers of pressure of the loads were in reasonable agreement with predictions. Least-squares curve-fitting procedures are used, and a method is developed for determining zero shifts for the strain-gage-measured horizontal-tail loads.

NACA RM L56L05

FLIGHT INVESTIGATION AND THEORETICAL CALCULATIONS OF THE FUSELAGE DEFORMATIONS OF A SWEPT-WING BOMBER DURING PUSH-PULL MANEUVERS. Alton P. Mayo. March 1957. 51p. diagrs., photo., tabs. (NACA RM L56L05)

The results of fuselage-deflection measurements at three stations on the fuselage of a swept-wing bomber (Boeing B-47A) during 12 push-pull maneuvers are presented in the form of coefficients expressing the deflection due to the normal-acceleration loads, the pitching angular-acceleration loads, the pitching angular-velocity loads, and the combined effect of zero-lift loads, fuselage dead weight, and landing-gear reactions. Comparisons are made between the experimental deflection coefficients and those obtained from theoretical calculations. An outline of the procedures used to obtain the experimental and the theoretical coefficients is presented.

NACA RM L57B19

AN ANALYSIS OF VERTICAL-TAIL LOADS MEASURED IN FLIGHT ON A SWEPT-WING BOMBER AIRPLANE. William A. McGowan and T. V. Cooney. May 1957. 53p. diagrs., photo., tabs. (NACA RM L57B19)

An analysis is presented of vertical-tail loads measured on a swept-wing bomber airplane at altitudes to 35,000 feet and Mach numbers to 0.82. Flight data obtained from rudder-step, rudder-pulse, aileron-roll, and steady-sideslip maneuvers were used in the analysis to determine lift-curve slopes, centers of pressure, and wing-fuselage, tail, and airplane static-directional-stability parameters. Results are compared, where possible, with values used in design and with theoretical values. Theoretical values of lift-curve slopes were in agreement with flight values when fuselage flexibility was considered.

NACA RM L57E28

ANALYSIS OF WING LOADS MEASURED ON A FLEXIBLE SWEPT-WING JET BOMBER DURING PUSH-PULL MANEUVERS. Patrick A. Gainer and Paul W. Harper. July 1957. 37p. diagrs., photo., tabs. (NACA RM L57E28)

Some results of a flight-test program of wing-load measurements by strain-gage methods on a flexible, swept-wing medium bomber, the Boeing B-47A, are presented. The data were obtained from symmetrical maneuvers. Results are presented in graphical form and compared with those predicted by aeroelastic theory. Comparisons of results obtained by experimental and theoretical methods indicate that presently available methods are capable of predicting additional and basic wing loads accurately within the range of flight conditions covered.

DECLASSIFIED NACA RESEARCH REPORTS

#NACA RM SA52E06, by Sutton and Buell
#NACA RM SA52J15, by Kelly and Smaus; also Film Supplement
#NACA RM SE53I01, by Lucas and Hatch
#NACA RM SE54J19, by Lucas and Filippi
#NACA RM SE55D11, by Lucas and Filippi
#NACA RM SL51F07a, by McKann, Coffee, and Arabian
#NACA RM SL52G15, by Morrison and Kuhn
#NACA RM SL54J18, by Kirby; also Film Supplement L-45

National Advisory Committee for Aeronautics
Research Abstracts
and
Reclassification Notice

NO. 121 **NOVEMBER 4, 1957**

SPECIAL NOTICE

Recent investigations indicate that errors exist in the data presented in NACA Technical Note 1757 and in NACA Report 933, which superseded the TN. These documents, by Ralph E. Grey, Jr., and H. Dean Wilsted, are entitled "Performance of Conical Jet Nozzles in Terms of Flow and Velocity Coefficients."

Although the recent investigations show that the thrust-measurement system used in the earlier work was inherently inaccurate, available data are insufficient to permit effective revision of the documents. We therefore recommend that existing copies of Report 933 and Technical Note 1757 be discarded.

CURRENT NACA RESEARCH REPORTS

NACA Rept. 1288

COOPERATIVE INVESTIGATION OF RELATIONSHIP BETWEEN STATIC AND FATIGUE PROPERTIES OF WROUGHT N-155 ALLOY AT ELEVATED TEMPERATURES. NACA Subcommittee on Power Plant Materials. 1956. ii, 35p. diagrs., photos., tabs. (NACA Rept. 1288. Supersedes TN 3216)

Extensive data are given relating properties of N-155 alloy under static, combined static and dynamic, and completely reversed dynamic stress conditions. Time periods for fracture ranged from 50 to 500 hours at room temperature, 1,000°, 1,200°, 1,350°, and 1,500° F. The work was on a cooperative basis to help clarify the principles governing load-carrying ability of heat-resistant alloys at temperatures and conditions where both creep and fatigue can occur simultaneously. In view of the uncertainty in interpreting results of various types of fatigue tests, duplicate data were obtained from as many types of fatigue testing machines as could be arranged.

NACA Rept. 1296

A THEORETICAL STUDY OF THE AERODYNAMICS OF SLENDER CRUCIFORM-WING ARRANGEMENTS AND THEIR WAKES. John R. Spreiter and Alvin H. Sacks. 1957. ii, 31p. diagrs., photos., tabs. (NACA Rept. 1296. Supersedes TN 3528)

A theoretical study is made of the pressures, loadings, forces, and vortex wake associated with certain cruciform wing arrangements. For 45° bank, the wake of a cruciform wing is treated numerically with 40 vortices and analytically with 4 vortices. Comparisons are made with water-tank measurements, and the calculation of loads on cruciform tails by reverse flow is considered.

NACA Rept. 1306

BODIES OF REVOLUTION HAVING MINIMUM DRAG AT HIGH SUPERSONIC AIRSPEEDS. A. J. Eggers, Jr., Meyer M. Resnikoff, and David H. Dennis. 1957. ii, 12p. diagrs., photos. (NACA Rept. 1306. Supersedes TN 3666)

Newtonian impact theory is used to determine body shapes of minimum drag under various combinations of the conditions of given body length, base diameter, surface area, and volume. In addition an estimate is made of centrifugal forces, and their effect on the

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minimum-drag shapes is considered. An experimental investigation carried out in the Ames 10- by 14-inch supersonic wind tunnel on a family of bodies, including two of the minimum-drag shapes, is found to provide a substantiation of the analysis.

NACA RM E57G18

NONMETALLIC MATERIAL COMPATIBILITY WITH LIQUID FLUORINE. Harold G. Price, Jr., and Howard W. Douglass. October 1957. 7p. tab. (NACA RM E57G18)

Static tests were performed at -320° F and atmospheric pressure and at -320° F and 1500 pounds per square inch gage. These tests showed less reactivity than was observed in previous tests with gaseous fluorine. In general, it was found that reactivity decreased as temperature and pressure decreased.

NACA TN 3290

ON THE MINIMIZATION OF AIRPLANE RESPONSES TO RANDOM GUSTS. Murray Tobak. October 1957. 71p. diagrs. (NACA TN 3290)

Exact theoretical responses in normal acceleration and pitching velocity to step and harmonic gusts are calculated for the rectangular wing flying at Mach number 1.2. These are used to assess the validity of approximate solutions. Alleviation of the airplane's response to random gusts is studied by means of optimum filter theory. The transfer function is derived of a control system that minimizes a linear combination of the airplane's mean-square normal acceleration and mean-square pitching velocity. Results of computations indicate the system may cause significant reductions of both motions.

NACA TN 4018

INFLUENCE OF TURBULENCE ON TRANSFER OF HEAT FROM CYLINDERS. J. Kestin and P. F. Maeder, Brown University. October 1957. 78p. diagrs., tabs. (NACA TN 4018)

This report deals with the problem of the influence of free-stream turbulence on the transfer of heat from a cylinder in forced convection at very low Mach numbers but at large Reynolds numbers. An attempt is made to determine whether the sole influence of turbulence is to shift the point of laminar separation in subcritical flow, or the point of transition in supercritical flow, and thus effect a change in the rate of heat transfer. It is shown that this is not the case and that varying the free-stream turbulence affects local rates of heat transfer.

NACA TN 4027

APPLICATION OF OBLIQUELY MOUNTED STRAIN GAGE TO MEASUREMENT OF RESIDUAL STRESSES IN DISKS. M. H. Hirschberg, R. H. Kemp, and S. S. Manson. September 1957. 18p. diagrs., photo. (NACA TN 4027)

A simple method is presented whereby the residual stress distribution in a disk can be determined. The residual tangential stresses are measured with the aid of the obliquely mounted strain gage when the disk is cut in the recommended manner. This procedure consists of making several preliminary radial saw cuts to reduce the overall residual stress level and then one final diametral saw cut ajacent to the mounted strain gages through the plane where the residual tangential stress is desired. The residual radial stresses are then calculated from the measured residual tangential stresses. Results of measurements on overspeeded disks compare favorably with the calculated values.

NACA TN 4030

EXPERIMENTAL INVESTIGATION OF CERMET TURBINE BLADES IN AN AXIAL-FLOW TURBOJET ENGINE. William C. Morgan and George C. Deutsch. October 1957. 20p. photos., tab. (NACA TN 4030)

In 16 tests to evaluate cermet blades in an axial-flow engine, a maximum blade life of 150 hours at maximum conditions of operation was obtained. Chipping in the tip region was a common characteristic in blade failures. Analysis indicates two probable causes of failure, impact and fatigue. Elimination of excessive carbon in the combustion chambers and avoiding conditions of extreme vibration made an improvement in test blade life.

NACA TN 4034

EFFECT OF FLUID-SYSTEM PARAMETERS ON STARTING FLOW IN A LIQUID ROCKET. Richard P. Krebs. September 1957. 38p. diagrs., tab. (NACA TN 4034)

Analysis shows the time rate of change of the main-valve area to have a large effect on the response time of the main flow and on the maximum value of the drop in head between the propellant tank and the suction side of the pump. This suppression head is directly proportional to the length of the suction line, and inversely proportional to the area of the line and the total valve operating time. Friction, tank head, and length of line from pump to rocket chamber have little effect on flow response or maximum suppression head when the total valve operating time is about 0.1 second.

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NACA TN 4035

IMPINGEMENT OF CLOUD DROPLETS ON 36.5-PERCENT-THICK JOUKOWSKI AIRFOIL AT ZERO ANGLE OF ATTACK AND DISCUSSION OF USE AS CLOUD MEASURING INSTRUMENT IN DYE-TRACER TECHNIQUE. R. J. Brun and Dorothea E. Vogt. September 1957. 52p. diagrs., tabs. (NACA TN 4035)

The trajectories of droplets in the air flowing past a 36.5-percent-thick Joukowski airfoil at zero angle of attack were determined. The amount of water in droplet form impinging on the airfoil, the area of droplet impingement, and the rate of droplet impingement per unit area on the airfoil surface were calculated from the trajectories and cover a large range of flight and atmospheric conditions. With the detailed impingement information available, the 36.5-percent-thick Joukowski can serve the dual purpose of use as the principal element in instruments for making measurements in clouds and of a basic shape for estimating impingement on a thick streamlined body.

NACA TN 4045

ELLIPTIC CONES ALONE AND WITH WINGS AT SUPERSONIC SPEEDS. Leland H. Jorgensen. October 1957. 55p. diagrs., photos. (NACA TN 4045)

The results of an experimental investigation to determine the aerodynamic characteristics of elliptic cones alone and in combination with triangular wings are presented. Data for Mach numbers 1.97 and 2.94 and a Reynolds number of 8×10^6 (based on cone length) show that there are distinct aerodynamic advantages to the use of elliptic instead of circular cones. Comparisons of theory with experiment are made.

NACA TN 4073

TABLES FOR THE NUMERICAL DETERMINATION OF THE FOURIER TRANSFORM OF A FUNCTION OF TIME AND THE INVERSE FOURIER TRANSFORM OF A FUNCTION OF FREQUENCY, WITH SOME APPLICATIONS TO OPERATIONAL CALCULUS METHODS. Carl R. Huss and James J. Donegan. October 1957. 205p. tabs. (NACA TN 4073)

A set of tables is presented which provides a means for the numerical transfer of data between the time and frequency domain by use of the Fourier transform and inverse Fourier transform. Several applications to operational methods are discussed briefly.

NACA TN 4091

EXPERIMENTAL INVESTIGATION OF TRANSPIRATION COOLING FOR A TURBULENT BOUNDARY LAYER IN SUBSONIC FLOW USING AIR AS A COOLANT. William E. Brunk. October 1957. 35p. diagrs. (NACA TN 4091)

Tests were run for both constant coolant-flow rate and constant wall temperature along a flat porous plate. The results, which indicate a definite decrease in wall temperature along the plate with increase in coolant flow, are in qualitative agreement with a theory for transpiration cooling with a turbulent boundary layer.

NACA TN 4093

INVESTIGATION OF HEAT TRANSFER FROM A STATIONARY AND ROTATING CONICAL FOREBODY. Robert S. Ruggeri and James P. Lewis. October 1957. 30p. diagrs., photo., tab. (NACA TN 4093)

Experimental convective heat transfer was determined for a conical forebody (15° half-angle) for free-stream velocities up to 400 feet per second, rotational speeds up to 1200 rpm, angles of attack of 0° and 6°, and for heating conditions of uniform surface temperature and uniform heater input power density. For the turbulent region, the results were in closer agreement with values predicted for two-dimensional bodies than with those predicted for a cone. Effects of rotation were insignificant. For the stationary spinner at 6° angle of attack, the heat-transfer coefficients were 6 to 13 percent greater on the lower surface than on the upper surface. Early boundary-layer transition occurred for all conditions investigated.

NACA TN 4094

EFFECTS OF EXTREME SURFACE COOLING ON BOUNDARY-LAYER TRANSITION. John R. Jack, Richard J. Wisniewski, and N. S. Diaconis. (Presented at Symposium on High-Speed Aerodynamics and Structures, Gainesville, Florida, January 22-24, 1957.) October 1957. 19p. diagrs., photo. (NACA TN 4094)

Boundary-layer transition studies were made on various bodies of revolution at a Mach number of 3.12 and for Reynolds numbers per foot as large as 15×10^6. In general, the data show that extreme surface cooling promotes early transition even with favorable pressure gradients and blunt leading edges. The effects of surface finish were small with moderate cooling, but were quite large with extreme cooling.

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NACA TN 4095

AN ANALYSIS OF THE EFFECT OF SEVERAL PARAMETERS ON THE STABILITY OF AN AIR-LUBRICATED HYDROSTATIC THRUST BEARING. William H. Roudebush. October 1957. 34p. diagrs., tab. (NACA TN 4095)

Equations are developed for the motion of a gas-lubricated hydrostatic thrust bearing, and solutions are obtained on a digital computer for air as the gas. Systematic investigations are made of various parameters to determine their effect on bearing stability. Bearing pad volume and rigidity appear as prime controlling factors.

NACA TN 4096

FLOW-TURNING LOSSES ASSOCIATED WITH ZERO-DRAG EXTERNAL-COMPRESSION SUPERSONIC INLETS. Rudolph C. Meyer. October 1957. 18p. diagrs. (NACA TN 4096)

An analysis based on momentum and continuity considerations is used to evaluate the total-pressure recovery of zero-wave-drag external-compression inlets for the Mach number range from 1.0 to 4.0. The geometry of such inlets can cause a significant loss in inlet total-pressure recovery which arises in the process of turning the flow back to the axial direction after supersonic compression. Some consideration is given to wind-tunnel blockage calculations in which the model drag enters as a parameter, and a criterion is developed which supplements the usual Kantrowitz condition.

NACA TN 4098

PROPELLANT VAPORIZATION AS A CRITERION FOR ROCKET-ENGINE DESIGN; CALCULATIONS USING VARIOUS LOG-PROBABILITY DISTRIBUTIONS OF HEPTANE DROPS. Richard J. Priem. October 1957. 29p. diagrs., tab. (NACA TN 4098)

Vaporization rates of n-heptane sprays in a rocket combustion chamber were computed for various log-probability distributions and mass-median drop sizes of the spray and for an engine operating with various injection velocities, final gas velocities, initial fuel temperatures, and chamber pressures. Incomplete vaporization of a small number of large drops may be responsible for the loss in engine performance. Experimental engine performance agrees with the calculations for a spray having a geometric standard deviation of 2.5 and mass-median drop radii of 70 to 280 microns, depending on the type of injector. The calculations of the percent of fuel vaporized are correlated with an effective chamber length.

NACA TN 4099

HEAT TRANSFER AND BOUNDARY-LAYER TRANSITION ON TWO BLUNT BODIES AT MACH NUMBER 3.12. N. S. Diaconis, Richard J. Wisniewski, and John R. Jack. October 1957. 31p. diagrs., photo. (NACA TN 4099)

Local heat-transfer values were measured on a hemisphere-cone-cylinder and a 120°-included-angle cone-cylinder at a Mach number of 3.12. Experimental values of the Stanton number parameter on both bodies agreed well with theoretical predictions with a surface roughness <16 microinches. The heat-transfer parameters on the hemisphere increased with surface roughness; the increase correlated for the test data on the basis of roughness Reynolds number. Transition studies indicated that transition Reynolds number increased with wall temperature. This phenomenon was influenced by unit Reynolds number and surface roughness on the hemisphere-cone-cylinder.

NACA TN 4101

EFFECT OF LUBRICANT VISCOSITY ON ROLLING-CONTACT FATIGUE LIFE. Thomas L. Carter. October 1957. 25p. diagrs., photo., tabs. (NACA TN 4101)

The rolling-contact fatigue spin rig was used to obtain life data for groups of steel balls lubricated with a series of paraffin-base mineral oils of varying viscosity. AISI M-1 balls were tested at 100° F and a calculated maximum compressive Hertz stress of 725,000 psi. A continuous trend toward longer life with higher lubricant viscosity was observed. Life varied approximately as the 0.2 power of lubricant viscosity.

NACA TN 4105

A METHOD OF COMPUTING THE TRANSIENT TEMPERATURE OF THICK WALLS FROM ARBITRARY VARIATION OF ADIABATIC-WALL TEMPERATURE AND HEAT-TRANSFER COEFFICIENT. P. R. Hill. October 1957. 54p. diagrs., tabs. (NACA TN 4105)

Formulas to determine the transient temperature of thick walls with an arbitrary time variation of adiabatic-wall temperature and heat-transfer coefficient are presented. The special cases of the thin wall and the infinitely thick wall are also discussed. A simple formula for determining the heat flow from a known temperature history is also given. Heat transfer in a direction parallel to the surface is assumed to be negligible and constant wall properties are assumed.

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NACA TN 4112

GENERALIZED MASTER CURVES FOR CREEP AND RUPTURE. George J. Heimerl and Arthur J. McEvily, Jr. October 1957. 31p. diagrs., tab. (NACA TN 4112)

The similarity of Larson-Miller master curves for creep rate, rupture life, and creep strain is shown for a number of materials. By the use of the approximate invariance of the product of creep rate and rupture life, the individual master curves are generalized into a single curve which is the same as the master curve for rupture. From this master curve, the creep rate and various amounts of creep strain can be predicted.

NACA TN 4113

STUDY OF PRESSURE DISTRIBUTIONS ON SIMPLE SHARP-NOSED MODELS AT MACH NUMBERS FROM 16 TO 18 IN HELIUM FLOW. Wayne D. Erickson. October 1957. 42p. diagrs., photos. (NACA TN 4113)

Experimental pressure distributions have been obtained on some simple sharp-nosed aerodynamic shapes in helium flow at Mach numbers from 16 to 18. Temperature recovery factors are also presented. The results are compared with theory which accounts for the shock—boundary-layer interaction. Tunnel-calibration results are also shown.

NACA TN 4114

WEIGHT-STRENGTH STUDIES OF STRUCTURES REPRESENTATIVE OF FUSELAGE CONSTRUCTION. James P. Peterson. October 1957. 47p. diagrs., tab. (NACA TN 4114)

Weight-strength plots, suitable for use in strength and weight analyses in the preliminary design of aircraft construction, are presented for cylindrical shells in bending. Of the types of stiffening considered, sandwich-type stiffening is found to be the most effective, and no decided advantage is found between longitudinal and waffle-like stiffening for minimum-weight designs within the range of structural configurations considered. The ratio of compressive-yield stress to density of material is found to be the most important material parameter for sandwich-type shells, while the density of the material is found to be equally as important for shells with longitudinal or waffle-like stiffening.

NACA TN 4115

THEORY OF AIRCRAFT STRUCTURAL MODELS SUBJECT TO AERODYNAMIC HEATING AND EXTERNAL LOADS. William J. O'Sullivan, Jr. September 1957. 48p. (NACA TN 4115)

The adequacy of an aircraft structure to withstand simultaneously the external loads and aerodynamic heating encountered in supersonic flight is examined by means of a structural model. By dimensional analysis it is shown that a structural model can be built which has the required similitude with respect to flow of heat through it, thermal stresses and deformations, and stresses and deformations due to external loads. For the conditions of negligible angular velocity and angular acceleration, the requisite heating and cooling of the model in simulation of flight of the aircraft is shown to be producible automatically by aerodynamic means without knowledge of the heat transfer to each point on the surface. The simultaneously imposed aerodynamic forces are determined so that the model may be subjected to the requisite external loads for simulation of external load-produced stresses and deformations.

NACA TN 4116

WIND-TUNNEL INVESTIGATION AT LOW SPEEDS TO DETERMINE FLOW-FIELD CHARACTERISTICS AND GROUND INFLUENCE ON A MODEL WITH JET-AUGMENTED FLAPS. Raymond D. Vogler and Thomas R. Turner. September 1957. 48p. diagrs., photos. (NACA TN 4116)

Results are presented of a wind-tunnel investigation made at low speeds to determine the flow-field characteristics and ground influence on an airplane model having an untapered, unswept wing with an aspect ratio of 8.3 equipped with jet-augmented flaps deflected 55° and 85°. The jet-momentum coefficients covered a range representative of that of the output of current jet airplanes. The adverse effects of the ground increase rapidly as the wing approaches the ground, as the flap-deflection angle increases, or as the momentum coefficient increases.

NACA TN 4117

EXPERIMENTAL INVESTIGATION OF LIFT, DRAG, AND PITCHING MOMENT OF FIVE ANNULAR AIRFOILS. Herman S. Fletcher. October 1957. 25p. diagrs., photos. (NACA TN 4117)

Results are presented of tests made to determine the lift, drag, and pitching-moment characteristics of a family of annular airfoils. The five annular airfoils tested covered aspect ratios of 1/3, 2/3, 1.0, 1.5, and 3.0. Estimated lift-curve slopes and induced drag coefficients are presented and compared with experimental values.

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NACA TN 4121

THEORY AND APPARATUS FOR MEASUREMENT OF EMISSIVITY FOR RADIATIVE COOLING OF HYPERSONIC AIRCRAFT WITH DATA FOR INCONEL AND INCONEL X. William J. O'Sullivan, Jr., and William R. Wade. October 1957. ii, 48p. diagrs., photos. (NACA TN 4121)

The importance of radiation as a means of cooling high-supersonic- and hypersonic-speed aircraft is discussed to show the need for measurements of the total hemispherical emissivity of surfaces. The theory underlying the measurement of the total hemispherical emissivity of surfaces is presented, readily duplicable apparatus for performing the measurements is described, and measurements for stably oxidized Inconel and Inconel X are given for the temperature range from 600° F to 2,000° F.

NACA TN 4122

EXTERNAL INTERFERENCE EFFECTS OF FLOW THROUGH STATIC-PRESSURE ORIFICES OF AN NACA AIRSPEED HEAD AT A MACH NUMBER OF 3. Norman S. Silsby. October 1957. 12p. diagrs. (NACA TN 4122)

Wind-tunnel tests have been made to determine the static-pressure error resulting from external interference effects of flow through the static-pressure orifices of an NACA airspeed head at a Mach number of 3 at 0° angle of attack. Results were obtained for flow both into and out of the orifices for a range of mass flow from 0 to about 4.2×10^{-6} slugs per second.

NACA TN 4123

ROUGH-WATER IMPACT-LOAD INVESTIGATION OF A CHINE-IMMERSED V-BOTTOM MODEL HAVING A DEAD-RISE ANGLE OF 10°. Melvin F. Markey and Thomas D. Carpini. October 1957. 32p. diagrs., photos., tab. (NACA TN 4123)

A hydrodynamic rough-water impact-loads investigation of a fixed-trim V-bottom float with a beam-loading coefficient of 5.78 and dead-rise angle of 10° was made at the Langley impact basin. The size of the waves varied from approximately 10 to 60 feet in length and 1 to 2 feet in height. Time histories were obtained showing the position of the model relative to the wave throughout the impact and typical examples are presented. The load coefficient was found to vary primarily with the slope of the impacting wave.

NACA TN 4127

THE MEASUREMENT OF PRESSURE ALTITUDE ON AIRCRAFT. William Gracey. October 1957. 25p. diagrs., tabs. (NACA TN 4127)

The various errors which determine the accuracy of an altimeter system are discussed and numerical values are assigned to each error. A statistical method for combining the individual errors is described. The overall errors of altimeter installations are calculated for Mach numbers up to 1.0 and altitudes up to 40,000 feet. An indication of the means by which some of the errors can be reduced is given. Various systems of barometric reference are also discussed.

BRITISH REPORTS

N-50060*

Royal Aircraft Establishment (Gt. Brit.)
EFFECTS OF ELEVATOR CIRCUIT STIFFNESS ON THE LOADING CONDITIONS IN LONGITUDINAL MANOEUVRES. D. R. Puttock. Mar. 1957. 31p. diagrs., tab. RAE Structures 220.
(Ask for N-50060*)

An investigation of the effects of elevator circuit stiffness on the loading conditions of an aircraft in a rapid pilot-induced pull-out maneuver is presented with a particular reference to the airworthiness aspects. The solution to the problem is given in general terms; it includes expressions for the incremental elevator angle, stick force, normal acceleration at the center of gravity, and the tail-plane load in response to a chosen sequence of pilot-induced stick movements to initiate a rapid pull-out maneuver. The solution is a complex one and the influence of significant parameters such as the degree of mass balance of the elevator circuit, the forward speed of the aircraft, and the rate of application of the stick movement is discussed in relation to a numerical example. Brief mention is made of further implications of this investigation.

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Errata on NACA TN 4014, by Mathauser, Berkovits, and Stein. July 1957.

N-41203*

Advisory Group for Aeronautical Research and Development. EVALUATION AND CALIBRATION OF WIRE-STRAIN-GAGE WIND TUNNEL BALANCES UNDER LOAD. Raymond M. Hansen. (Presented at 8th meeting of AGARD Wind Tunnel and Model Testing Panel, February 20-25, 1956, Rome, Italy.) February 1956. v, 17p. diagrs., photos., tabs. AGARD Report 13. (Ask for N-41203*)

Discusses the manner in which loads are applied to strain-gage balances in the laboratory and the reduction of the resulting data to a convenient form.

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N-41204*

Advisory Group for Aeronautical Research and Development. MECHANICAL DESIGN AND FABRICATION OF STRAIN-GAGE BALANCES. Raymond M. Hansen. (Presented at 8th meeting of AGARD Wind Tunnel and Model Testing Panel, February 20-25, 1956, Rome, Italy.) February 1956. iv, 14p. diagrs. AGARD Report 9. (Ask for N-41204*)

Considers wire-strain-gage-balance design concepts from a practical standpoint. A typical balance illustrates how the concepts were applied in practice.

N-41610*

Advisory Group for Aeronautical Research and Development. PROBLEMS INVOLVED IN PRECISION MEASUREMENTS WITH RESISTANCE STRAIN GAGES. Keith H. McFarland and John Dimeff. (Presented at 8th meeting of AGARD Wind Tunnel and Model Testing Panel, February 20-25, 1956, Rome, Italy.) February 1956. v, 17p. diagrs. AGARD Report 12. (Ask for N-41610*)

This paper surveys the electrical, thermal, and mechanical errors which may affect the accuracy of resistance wire strain-gage measurements. It also gives a brief description of the methods currently used to correct for these errors, in order to increase the accuracy and reproducibility of measuring systems using these gages as sensing elements.

N-41829*

Advisory Group for Aeronautical Research and Development. TIRE-RUNWAY BRAKING FRICTION COEFFICIENTS. Melvin N. Gough, Richard H. Sawyer, and James P. Trant, Jr. (Presented at 8th joint session of AGARD Flight Test Techniques and Wind Tunnel and Model Testing Panels, February 20-25, 1956, Rome, Italy.) February 1956. iv, 20p. diagrs., photos. AGARD Report 51. (Ask for N-41829*)

A brief review is made of the problem of obtaining adequate tire-runway braking friction coefficients for use in determining the stopping distances of aircraft in landings. Methods and instrumentation used by the NACA for obtaining friction-coefficient data from full-scale airplane landings are described, and their limitations are discussed. Included also is a description of a friction-measuring cart to be towed over surfaces of interest. This device appears to offer an inexpensive method of obtaining data of the type desired by airport operators to provide information to pilots concerning surface conditions to be encountered in landings.

N-42553*

Advisory Group for Aeronautical Research and Development. A NOTE ON A HALF-MODEL STRAIN-GAUGE BALANCE. N. C. Lambourne. (Presented at 8th meeting of AGARD Wind Tunnel and Model Testing Panel, February 20-25, 1956, Rome, Italy.) February 1956. iv, 7p. diagrs., photos. AGARD Report 11. (Ask for N-42553*)

This note briefly describes a general purpose strain-gage wall-balance recently constructed at the National Physical Laboratory. The equipment is designed for the measurement of four components; namely, normal force, longitudinal force, pitching moment, and rolling moment on half models.

N-42554*

Advisory Group for Aeronautical Research and Development. INSPECTION TECHNIQUES APPLIED TO THE METROLOGY OF AERODYNAMIC MODELS. H. T. Hill. (Presented at 8th meeting of AGARD Wind Tunnel and Model Testing Panel, February 20-25, 1956, Rome, Italy.) February 1956. iv, 20p. diagrs., photos. AGARD Report 24. (Ask for N-42554*)

An appreciation of the problem confronting the metrologist in inspection techniques for wind-tunnel models. Details are given of the present inspection methods employed by the Royal Aircraft Establishment, and thoughts on further development to improve the accuracy and speed at which these three-dimensional models can be inspected.

N-42559*

Advisory Group for Aeronautical Research and Development. STRAIN GAUGE BALANCES FOR WIND TUNNELS: AN OUTLINE OF PRACTICE IN THE UNITED KINGDOM. J. R. Anderson. (Presented at 8th meeting of AGARD Wind Tunnel and Model Testing Panel, February 20-25, 1956, Rome, Italy.) February 1956. vii, 67p. diagrs., photos., tab. AGARD Report 5. (Ask for N-42559*)

A brief survey of developments in strain-gage balance practice in the United Kingdom is made, with notes on the various types of balance used, their design and fabrication. Descriptions of 12 particular strain-gage balances are included.

N-42674*

Advisory Group for Aeronautical Research and Development. SOME PROBLEMS ASSOCIATED WITH THE MEASUREMENT OF LANDING DISTANCE: D. A. Lang. (Presented at 8th meeting of AGARD Flight Test Panel, February 20-25, 1956, Rome, Italy.) February 1956. iv, 20p. diagrs., tab. AGARD Report 31. (Ask for N-42674*)

Proposes a standard method of measuring landing distance, so that the distances obtained may be logically related to the length of runway required for

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safe operation and to enable comparison of results for different aircraft. Discusses factors affecting the landing distance, including approach technique, runway friction coefficients, variations in breaking force with tire size and pressure, and automatic braking systems.

N-43152*

Advisory Group for Aeronautical Research and Development. MEASUREMENTS AND RECORDING OF MEASUREMENTS ON WIND-TUNNEL BALANCES WITH RESISTANCE-WIRE GAGES. (Mesure et enregistrement des mesures sur les balances áerodynamiques a jauges a fil résistant.) M. Bassiere. (Presented at 8th meeting of AGARD Wind Tunnel and Model Testing Panel, February 20-25, 1956, Rome, Italy.) February 1956. v, 19p. diagrs., tab. AGARD Report 14. (Ask for N-43152*)

By combining a recorder especially suitable for measurements with strain-gage bridges with a coding device enabling the measurements to be noted or recorded on punched cards (or teletype), ONERA have equipped themselves with a very efficient assembly permitting rapid exploitation of the experimental results obtained in wind tunnels.

N-43153*

Advisory Group for Aeronautical Research and Development. FABRICATION OF MODELS WITH THE AID OF PLASTIC MATERIALS. (Fabrication de maquettes a l'aide des matieres plastiques.) G. Dixmier. (Presented at 8th meeting of AGARD Wind Tunnel Panel, February 20-25, 1956, Rome, Italy.) February 1956. iv, 35p. photos. (French text.) AGARD Report 22. (Ask for N-43153*)

The purpose of this report is to show examples of the fabrication of models which illustrate the use that can be made of low-pressure polymerizable resins in conjunction with glass cloth in the testing technique of experimental aerodynamics.

N-43181*

Advisory Group for Aeronautical Research and Development. PRECISION MACHINING TECHNIQUES AS APPLIED TO THE MANUFACTURE OF SUPERSONIC WIND TUNNEL MODELS. G. W. Rawlings. (Presented at 8th meeting of AGARD Wind Tunnel and Model Testing Panel, February 20-25, 1956, Rome, Italy.) February 1956. iv, 21p. diagrs., photos. AGARD Report 23. (Ask for N-43181*)

This report deals with the problems associated with the manufacture of scale models for supersonic and transonic wind tunnels and outlines methods employed to deal with these problems.

N-43713*

Advisory Group for Aeronautical Research and Development. SPECIAL TYPES OF INTERNAL STRAIN GAGE BALANCES. T. L. Smith. (Presented at 8th meeting of AGARD Wind Tunnel & Model Testing Panel, February 20-25, 1956, Rome, Italy.) February 1956. iv, 11p. diagrs. AGARD Report 7. (Ask for N-43713*)

A description of four special-purpose strain-gage balances: a three-component balance with special design to give small interaction of normal forces on drag, a four-component balance for measuring of damping in pitch, and a balance for giving front and rear normal force designed for long slender bodies.

N-43744*

Advisory Group for Aeronautical Research and Development. SPECIAL APPLICATIONS OF STRAIN-GAGE BALANCES USED IN THE SUPERSONIC AND HYPERSONIC WIND TUNNELS AT THE U. S. NAVAL ORDNANCE LABORATORY. James R. Lightfoot and Charles E. White. (Presented at 8th meeting of AGARD Wind Tunnel and Model Testing Panel, February 20-25, 1956, Rome, Italy.) February 1956. iii, 13p. diagrs., tabs. AGARD Report 8. (Ask for N-43744*)

Describes the purpose, functional description, and operation of three types of strain-gage balances developed at the NOL; the balance for spinning models, the aerodynamic damping balance, and the temperature-controlled balance.

CN-44501*

Advisory Group for Aeronautical Research and Development. INCREASE OF PRECISION IN LANDING BY USE OF THE INCIDENCE INDICATOR. (L'accroissement de la precision a l'atterrissage par l'emploi d'indicateur d'incidence.) P. Lecomte. (Presented at 8th session of AGARD Flight Test Panel, Rome, Italy, February 20-25, 1956.) February 1956. v, 19p. diagr., photos. (French text.) AGARD Report 30. (Ask for CN-44501*)

Landing on relatively short runways raises various technical problems. The present report gives details in the use of the angle-of-attack indicator for approach and on the advantages from the point of view of a decrease in approach speeds and an increase in the accuracy of touchdown.

N-45062*

Advisory Group for Aeronautical Research and Development. DEVELOPMENT OF HALF-MODEL WIND TUNNEL BALANCES. (Presented at 8th meeting of AGARD Wind Tunnel and Model Testing Panel, February 20-25, 1956, Rome, Italy.) February 1956. v, 35p. diagrs., photos., tab. AGARD Report 10. (Ask for N-45062*)

Three designs of half-model, three-component balances (designated A, B, and C) are described and an account is given of the experience obtained with two

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of them. In all balances, strain-gage transducers, of the bonded or unbonded type, are used for measurement of forces and moments. The operational experience with balances A and B was obtained in the N.A.E. high-speed, vacuum-type intermittent wind tunnels. The d-c millivolt balance outputs were in all cases measured with Leeds and Northrup "SPEEDOMAX" self-balancing chart potentiometers (1-second models).

N-45138*

Advisory Group for Aeronautical Research and Development. A VARIATIONAL APPROACH TO PURE MODE EXCITATION BASED ON CHARACTERISTIC PHASE LAG THEORY. B. M. Fraejis de Veubeke. (Presented at 3rd meeting of AGARD Structures Panel, April 9-17, 1956, Washington, D. C.) April 1956. v, 35p. diagrs. AGARD Report 39. (Ask for N-45138*)

Characteristic phase lag theory is applied to the derivation of an energy principle for pure mode excitation at a resonant frequency. The principle is not restricted to small damping nor to a specific variation of damping coefficients with frequency. Preliminary remarks on structural damping are followed by a discussion of the simplifying assumption which makes the damping matrix proportional to the stiffness matrix. This procedure allows a gradual presentation of the general analysis based on the concept of characteristic phase lag. Both torsional and flexural response of a beam to single point excitation are presented as examples for the influence of internal damping on continuous structures.

N-45198*

Advisory Group for Aeronautical Research and Development. SOME ASPECTS OF GROUND AND FLIGHT VIBRATION TESTS. R. Mazet. (Presented at 3rd meeting of AGARD Structures and Materials Panel, April 10-17, 1956, Washington, D. C.) April 1956. vi, 14p. diagrs. AGARD Report 40-T. (Ask for N-45198*)

A description is given of two techniques used at ONERA for the calculation of critical flutter speeds from ground vibration tests, and for flight verification of the aeroelastic stability of the aircraft.

N-45472*

Advisory Group for Aeronautical Research and Development. THE MEASUREMENT AND ASSESSMENT OF REPEATED LOADS ON AIRPLANE COMPONENTS. Philip Donely. (Presented at 3rd meeting of AGARD Structures and Materials Panel, April 10-17, 1956, Washington, D. C.) April 1956. vii, 34p. diagrs., tabs. AGARD Report 45. (Ask for N-45472*)

The factors affecting the load statistics of modern airplanes are assessed on the basis of the NACA studies of the repeated load problem. The loads arising from various sources are discussed and their importance to aircraft with various missions are shown to vary. It is shown that much more data are desirable if coordinated load histories for particular aircraft are to be predictable.

N-45617*

Advisory Group for Aeronautical Research and Development. TECHNIQUES FOR TESTING MODELS OF VTOL AND STOL AIRPLANES. John P. Campbell. (Presented at 9th meeting of AGARD Wind Tunnel and Model Testing Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. vi, 31p. diagrs., photos. AGARD Report 61. (Ask for N-45617*)

Describes briefly some of the techniques used by NACA in research on VTOL and STOL airplanes ("vertical take-off and landing" and "short take-off and landing"). Deals mainly with free-flying model technique but a brief description is also given of some of the force-testing techniques.

N-45841*

Advisory Group for Aeronautical Research and Development. DESIGN AND DEVELOPMENT OF THE NORTH AMERICAN AVIATION TRISONIC WIND TUNNEL. W. Daniels, Jr. (Presented at 9th meeting of AGARD Wind Tunnel and Model Testing Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. vi, 47p. diagrs., photos. AGARD Report 67. (Ask for N-45841*)

This tunnel will be the largest blowdown wind tunnel in existence when completed. The large test section (7-ft by 7-ft) and test speed range (Mach 0.2 to 3.5) of the facility will satisfy the requirements for aerodynamic testing to develop modern aircraft and missiles. Models will be large enough to contain all necessary instrumentation and components and produce data which can readily be applied to full-scale conditions. A few major components which are of new or novel design in the wind-tunnel field are the tandem test sections, control valve, mechanism for nozzle control, and tin-can temperature stabilizing material.

N-46129*

Advisory Group for Aeronautical Research and Development. THE DETERMINATION OF AILERON EFFECTIVENESS. R. R. Duddy. (Presented at 9th meeting of AGARD Joint Session Wind Tunnel and Model Testing and Flight Test Techniques Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. v, 8p. diagrs., tab. AGARD Report 73. (Ask for N-46129*)

This note describes two alternative methods of measuring aileron effectiveness in flight for comparison with the results of estimates and wind-tunnel measurements. Results obtained on four aircraft show that the agreement obtained is not particularly good but the tunnel measurements do indicate the reduction in aileron effectiveness to be expected in flight at high lift coefficients on swept-wing aircraft.

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N-46250*

Advisory Group for Aeronautical Research and Development. SOME COMMENTS ON HIGH-LIFT TESTING IN WIND TUNNELS WITH PARTICULAR REFERENCE TO JET-BLOWING MODELS. A. Anscombe and J. Williams. (Presented at 9th meeting of AGARD Wind Tunnel and Model Testing Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. vi, 33p. diagrs. AGARD Report 63. (Ask for N-46250*)

This note considers some of the special problems of wind tunnel testing which arise in high-lift work. Discussion is confined to current experience in the R.A.E. and N.P.L. low-speed wind tunnels, and refers mainly to tests on blowing over flaps or jet flaps. Comments are made on suitable size of model, methods of feeding compressed air into models without affecting balance readings, and general test technique. Methods of model construction are not specifically discussed.

N-46303*

Advisory Group for Aeronautical Research and Development. THE FLIGHT SIMULATOR IN AIRCRAFT CONTROL AND DESIGN. W. J. G. Pinsker. (Presented at 9th meeting of the Joint Session Wind Tunnel and Model Testing and Flight Test Techniques Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. iv, 31p. diagrs., photos. AGARD Report 71. (Ask for N-46303*)

The possibilities of simulating manually controlled flight are discussed and the principal types of flight simulators are described. Particular attention is given to the importance of realistic visual and physical flight impressions.

CN-46307*

Advisory Group for Aeronautical Research and Development. UTILIZATION OF ONLY SLIGHTLY PREPARED TERRAIN. (Utilisation des terrains sommairement amenages.) S. Lefebvre. (Presented at 9th session of AGARD Flight Test Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. vi, 31p. photos. (French text.) AGARD Report 74. (Ask for CN-46307*)

Information abstracted from various tests regarding the investigation of the problems involved in employing aircraft on hastily improvised runways is condensed. Special difficulties encountered in the investigation of the taxiing properties of aircraft on nonhomogeneous surfaces, such as earth runways, are first discussed. Then the behavior of the aircraft, that is, maneuverability on the ground, stability, and performance when taxiing, is dealt with. The influence of utilization of hastily improvised runways on the mechanical behavior of the aircraft is then studied. A summary is given of information drawn from tests.

CN-46309*

Advisory Group for Aeronautical Research and Development. CALIBRATION OF ANGLES OF ATTACK AND SIDESLIP. (Etalonnage d'incidence et de derapage.) A. Boisson. (Presented at 9th session of AGARD Flight Test Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. vii, 35p. diagrs., photos., tabs. (French text.) AGARD Report 77. (Ask for CN-46309*)

Angle of attack is measured by a special pressure head, which detects a pressure difference, and the ratio of this pressure difference to the dynamic pressure is a function of angle of attack. This function is determined experimentally from "incidence calibration" tests. The method of calibration is to measure, during runs at stabilized speeds, the longitudinal trim and the inclination of the flight path. The incidence is the difference between these two parameters. Sideslip is measured in a similar way. These flight-test methods are described.

N-47793*

Advisory Group for Aeronautical Research and Development. NOTES ON THE GROUND-RUN OF JET-PROPELLED AIRCRAFT DURING LANDING AND TAKE-OFF. Guiscardo S. Alias. (Presented at 9th meeting of AGARD Flight Test Techniques Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. vi, 35p. diagrs., tabs. AGARD Report 82. (Ask for N-47793*)

Equations for ground-run distances on an inclined runway which take account of the use of rockets during take-off and reverse thrust and braking parachutes during landing are derived. By dividing the ground-run distance by a "basic" horizontal distance a ratio is obtained which may be used comparatively to analyze the separate effects of various factors. This method is applied to ground-run distances on an inclined runway to examine the possibility of using, under special operational conditions, sloping bare ground or a part of a main road suitably prepared as a "one-way" strip for landing or take-off.

N-48958*

Advisory Group for Aeronautical Research and Development. BRIEF DESCRIPTION OF THE R.A.E. INTERMITTENT SUPERSONIC WIND TUNNEL PLANT. K. G. Winter. (Presented at 9th meeting of AGARD Wind Tunnel and Model Testing Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. v, 14p. diagrs., photos. AGARD Report 66. (Ask for N-48958*)

The plant is vacuum-operated on a closed circuit with storage of the air in a flexible container. The useful Mach number range is up to about 4.5. For the largest of the tunnels (15 in. x 16 in.) the maximum running time is of the order of 20 seconds over the whole Mach number range. Runs of 10 to 15 seconds duration can be made every five minutes.

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N-51164*

Advisory Group for Aeronautical Research and Development. PHILOSOPHY OF SAFETY IN THE SUPERSONIC AGE. N. J. Hoff. (Presented at 6th General Assembly of AGARD, August 27-31, 1956, Brussels, Belgium.) August 1956. iv, 15p. diagrs. AGARD Report 87. (Ask for N-51164*)

Present and past principles governing the proof of the structural strength of aircraft are reviewed. It is suggested that the safety of the airplane in the presence of rarely occurring unusually large loads, of fatigue, and of creep can be judged on a common basis only if the probability of the failure of the structure is accepted as the safety criterion.

CN-51496*

Advisory Group for Aeronautical Research and Development. UNITED STATES ARMY EXPERIENCE IN OPERATIONS FROM UNPREPARED FIELDS. John F. Denhart. (Presented at 9th meeting of AGARD Flight Test Techniques Panel, August 27-31, 1956, Brussels, Belgium.) vi, 28p. diagrs., photos., tab. AGARD Report 80. (Ask for CN-51496*)

This nontechnical presentation is based on the use of light aircraft to support the Army aviation mission. Although it may not be related to the use of heavier and faster aircraft which normally support the Air Force mission, some of the requirements and methods considered by the Army for the accomplishment of its mission may be applicable to high-performance aircraft.

N-52341*

Advisory Group for Aeronautical Research and Development. DATA ON TEMPERATURE STABILIZATION AND DIFFUSER PERFORMANCE OF THE 5 x 5 IN. PILOT BLOW-DOWN WIND TUNNEL. N. B. Tucker. (Presented at 9th meeting of AGARD Wind Tunnel and Model Testing Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. iv, 8p. diagrs. AGARD Report 92. (Ask for N-52341*)

Describes briefly experiments on temperature control and diffuser performance made with a 5 x 5 in. pilot tunnel to provide data for a 5 x 5 ft blowdown tunnel to be constructed at the National Aeronautical Establishment of Canada. Temperature control is achieved by a closely packed random arrangement of tin cans filling the reservoir volume. Performance results for the variable throat diffuser are at Mach numbers from 2 to 4.

N-53001*

Advisory Group for Aeronautical Research and Development. THE TEST FACILITIES USED FOR THE FLYING ATAR. (Les Installations d'essais Mises en Oeuvre pour l'ATAR volant.) G. Eggers and J. Jardinier. (Presented at 9th session of AGARD Flight Test Panel, Brussels, Belgium, August 27-31, 1956.) August 1956. v, 15p. diagrs., photos. (French text) AGARD Report 59. (Ask for N-53001*)

Special test beds have been set up at S.N.E.C.M.A. to investigate the new problems of vertical take-off and landing (V.T.O.L.). This paper describes briefly preliminary work which enabled each problem to be dealt with separately, leading up to tests on a complete machine - called the "Atar Volant" - capable of vertical flight. The tests include: operation of the turbo jet in any position and especially in the vertical one; ground effect on the spreading of the exhaust stream along the ground; measurement of efficiency of control by means of exhaust stream; tests of an artificial stabilization device; verification of control by means of exhaust stream and of artificial stabilization; tests on the "Atar Volant" by free evolutions about the center of gravity; free-flight tests under a frame; and tests on a training unit with a free-flight simulator.

N-54068*

Advisory Group for Aeronautical Research and Development. SOME STRAIN GAGE BALANCES USED IN FRENCH WIND TUNNELS. P. Rebuffet. (Presented at 8th meeting of AGARD Wind Tunnel Panel, February 20-25, 1956, Rome, Italy.) February 1956. viii, 64p. diagrs., photos., tab. AGARD Report 6-T. (Ask for N-54068*)

After examining some of the principal types of analyzing load-measuring devices using strain gages and reviewing the general principles of application, the author considers some of the strain-gage balances of sting and wall type used in French wind tunnels.

N-54069*

Advisory Group for Aeronautical Research and Development. ELEVATED STAGNATION TEMPERATURE AND STRAIN GAUGE BALANCES IN THE INSTRUMENTATION OF A SUPERSONIC WIND TUNNEL. G. P. Tonkin. (Presented at 8th meeting of AGARD Wind Tunnel Panel, February 20-25, 1956, Rome, Italy.) February 1956. vii, 52p. diagrs., photos., tabs. AGARD Report 15. (Ask for N-54069*)

An account is given of the work leading up to, and the method of production of, a strain gage for use in a supersonic tunnel of stagnation temperature greater than 200° C. It is a wire and ceramic gage which can be stored in plain grid form, and its use has afforded successful force and moment measurements. The balances and their design are also described, with references to other auxiliary services necessary in such a tunnel.

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CN-55068*

Advisory Group for Aeronautical Research and Development. A REPORT ON THE ARADO AR 232 TRANSPORT AIRCRAFT. W. Van Nes. (Presented at 9th meeting of AGARD Flight Test Techniques Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. vi, 27p. diagrs., photos., tab. AGARD Report 78. (Ask for CN-55068*)

An account is given of the Arado Ar 232 transport aircraft. The special ailerons and the unusual cross-country undercarriage are described and detailed performance figures are given. A description is given of the Göttingen test airplane fitted with suction over the inner wings and blowing over the outer wings and ailerons. The application of this system to the Arado Ar 232 is also described and the possibility of using hydrogen-peroxide-driven pumps to provide the mass flow is discussed. A comparison of the suction, suction-blowing, and direct thrust methods of decreasing the take-off run is made.

N-55069*

Advisory Group for Aeronautical Research and Development. THE VARIABLE DENSITY HIGH SPEED CASCADE WIND TUNNEL OF THE DEUTSCHE FORSCHUNGSANSTALT FUR LUFTFAHRT, BRAUNSCHWEIG. H. Schlichting. (Presented at 8th meeting of AGARD Wind Tunnel and Model Testing Panel, February 20-25, 1956, Rome, Italy.) February 1956. iv, 5p. diagrs., tab. AGARD Report 91. (Ask for N-55069*)

Describes briefly the new variable-density high-speed cascade wind tunnel of the Deutsche Forschungsanstalt für Luftfahrt at Braunschweig. The tunnel is open-jet, with Mach number range 0.2 to 1.1, and a special feature is that Mach number and Reynolds number can be varied independently.

CN-55070*

Advisory Group for Aeronautical Research and Development. SOURCES OF TRANSLATIONS OF AERONAUTICAL INTEREST IN NATO COUNTRIES. L. J. H. Haylor and R. A. Kennedy. (Presented at 7th meeting of AGARD Documentation Committee, August 1956, Brussels, Belgium.) August 1956. iii, 60p. AGARD Report 56. (Ask for CN-55070*)

Government departments, industrial research organizations, universities, professional institutions, and private organizations making and/or indexing translations of aeronautical interest in the NATO countries are included. The main indexing centers are: N.R.C. (Canada); C.N.R.S. and S.D.I.T. (France); Aslib (U.K.); S.L.A. - John Crerar Library and S.T.C. (U.S.A.).

N-55071*

Advisory Group for Aeronautical Research and Development. ENGLISH ELECTRIC PROPOSED BLOW-DOWN WIND TUNNEL. F. E. Roe. (Presented at 9th meeting of AGARD Wind Tunnel and Model Testing Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. iv, 21p. diagrs. AGARD Report 68. (Ask for N-55071*)

The need for wind-tunnel facilities to fulfill the requirements of both Aircraft and Guided Weapons Divisions of the English Electric Company is discussed. The basic design data for the two tunnels are outlined, and an estimate of the optimum characteristics obtained showing the economic and technical advantage of utilizing a single power source for both tunnels. The performance of such a joint facility is indicated.

N-55072*

Advisory Group for Aeronautical Research and Development. SOME CORRELATIONS OF FLIGHT-MEASURED AND WIND-TUNNEL MEASURED STABILITY AND CONTROL CHARACTERISTICS OF HIGH-SPEED AIRPLANES. Walter C. Williams, Hubert M. Drake, and Jack Fischel, HSFS. (Presented at 9th meeting of AGARD Wind Tunnel and Model Testing Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. vi, 11p. diagrs. AGARD Report 62. (Ask for N-55072*)

Comparisons are made of some of the more important stability and control characteristics of three swept-wing airplanes as measured in flight and in wind tunnels. Wind-tunnel data are used from high-speed closed-throat tunnels, a slotted-throat transonic tunnel, and a supersonic tunnel. It is shown that wind tunnels generally predict all trends of characteristics reasonably well but that there are differences in the actual values of parameters, which could be attributed to differences in the model caused by the method of support. The problem of nonlinearities in derivatives obtained in wind-tunnel tests, of aeroelastic effects, and of inlet effects, is discussed.

CN-55366*

Advisory Group for Aeronautical Research and Development. DISCUSSIONS FOLLOWING THE PRESENTATION OF PAPERS ON STRAIN GAUGES. (AGARD REPORTS 5-15.) (Reports 5-15 were presented at 8th meeting of AGARD Wind Tunnel and Model Testing Panel, February 20-25, 1956, Rome, Italy.) February 1956. 9p. AGARD. (Ask for CN-55366*)

UNPUBLISHED PAPERS

N-55351*

Case Institute of Technology. THE APPLICATION OF DISCRETE POTENTIAL THEORY TO TWO DIMENSIONAL INCOMPRESSIBLE FLOW. Charles Saltzer. May 1957. 30p. diagrs., tabs. Case Inst. of Tech. (Ask for N-55351*)

The determination of the stream-function of the flow about an airfoil is expressed as a Dirichlet problem with irregular boundaries for the Laplace difference equation. The method of discrete potential is extended to apply to irregular boundaries and is used to solve this problem. As an example the Joukowski airfoil is treated by this method and the results are evaluated by comparison with the exact results.

CN-55352*

Case Institute of Technology. THE REDUCTION OF THE DIRICHLET AND NEUMANN PROBLEMS FOR THE THREE DIMENSIONAL LAPLACE DIFFERENCE EQUATION TO FINITE-DIFFERENCE ANALOGUES OF THE INTEGRAL EQUATIONS OF POTENTIAL THEORY. Charles Saltzer. May 1957. 11p. Case Inst. of Tech. (Ask for CN-55352*)

The Dirichlet and Neumann problems for the three-dimensional Laplace and Poisson equations are reduced to finite-difference analogs of the integral equations of potential theory and the solution is discussed.

CN-55353*

Case Institute of Technology. THE GREEN'S FUNCTION FOR THE TWO-DIMENSIONAL LAPLACE PARTIAL DIFFERENCE EQUATION. Charles Saltzer. May 1957. 16p. tabs. Case Inst. of Tech. (Ask for CN-55353*)

A table of the Green's function, $\emptyset(p, q)$, for the Laplace partial difference equation in two dimensions is given correct to six decimal places for values of the argument: $p, q = 0, 1, 2, \ldots 50$. It is also shown that the first three terms of the asymptotic expansion differ from the Green's function by an amount not exceeding $6 \cdot 10^{-7}$ for $p^2 + q^2 \geq 121$.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification October 14, 1957.

NACA RM A9J06

THE EFFECTS OF SCALE AND TEST TECHNIQUE ON THE VALIDITY OF SMALL-SCALE MEASUREMENTS OF THE AERODYNAMIC CHARACTERISTICS OF A WING WITH THE LEADING EDGE SWEPT BACK 63°. L. Stewart Rolls. December 9, 1949. 20p. diagrs., photos. (NACA RM A9J06)

This report presents the results of tests by the NACA wing-flow method of two wings of the same plan form, aspect ratio 3.5, taper ratio 0.25, and leading-edge sweep angle 63°. The lift and pitching-moment characteristics are presented for the Mach number range 0.52 to 1.11 at a corresponding Reynolds number range of 0.39 million to 0.81 million. A comparison with the results of larger scale tests indicated considerable differences in the location of the aerodynamic center. The results of several modifications to the model configuration and test technique made in an attempt to explain the discrepancy are presented.

NACA RM A51F18

A COMPARISON OF THE CALCULATED MAXIMUM MANEUVER-RESPONSE CHARACTERISTICS OF THREE AIR-TO-AIR, BEAM-RIDER, GUIDED MISSILES HAVING DIFFERENT LIFT RATIOS. Howard F. Matthews and Elwood C. Stewart. September 1951. 57p. diagrs., tabs. (NACA RM A51F18)

A comparison was made of the calculated response characteristics to a maximum maneuver of a variable incidence, a canard, and a conventional tail-aft-control missile, which are indicative, respectively, of a high positive, a low positive, and a negative lift ratio. The results showed that the performance for the variable-incidence missile is equal to or slightly better than that of the canard, and the performance of both is better than that of the tail-aft-control missile. Consideration of additional factors such as servo energy, control-deflection interference limit, etc., may, in an overall evaluation, outweigh the small decrease in normal-displacement response time associated with the higher positive lift ratios.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM A52H28

INVESTIGATION OF THE DRAG OF VARIOUS AXIALLY SYMMETRIC NOSE SHAPES OF FINENESS RATIO 3 FOR MACH NUMBERS FROM 1.24 TO 3.67. Edward W. Perkins and Leland H. Jorgensen. November 1952. 50p. diagrs., photos. (NACA RM A52H28)

Experimental foredrag measurements at zero angle of attack for various theoretical minimum drag nose shapes, hemispherically blunted cones, and other more common profiles of fineness ratios of about 3 are compared with theoretical results for a Mach number and a Reynolds number range of 1.24 to 3.67 and 2×10^6 to 4×10^6 (based on body length), respectively. The results of experimental pressure distribution measurements are used for the development of an empirical expression for predicting the pressure drag of hemispherically blunted cones.

NACA RM A52J22

THEORETICAL INVESTIGATION OF THE PERFORMANCE OF PROPORTIONAL NAVIGATION GUIDANCE SYSTEMS - EFFECT OF MISSILE CONFIGURATION ON THE SPEED OF RESPONSE. Marvin Abramovitz. January 1953. 20p. diagrs., tabs. (NACA RM A52J22)

The speeds of response attainable with three missile configurations, a variable-incidence-wing, a canard, and a tail-control, in combination with a proportional navigation system are compared. With only rate-of-pitch feedback in the control system, the system speed of response with all three configurations is very nearly the same as that of the missiles alone. However, with normal acceleration feedback also included, the system speed of response with all three configurations is more rapid than that of the missiles alone.

NACA RM A53H17

COMPARISON OF THEORETICAL AND EXPERIMENTAL ZERO-LIFT DRAG-RISE CHARACTERISTICS OF WING-BODY-TAIL COMBINATIONS NEAR THE SPEED OF SOUND. George H. Holdaway. October 1953. 27p. diagrs., tab. (NACA RM A53H17)

Comparison with experiments on a variety of wing-body-tail combinations showed that linear theory predicted the zero-lift drag rise at low supersonic speeds within an accuracy of about 20 percent. Theoretical computations indicate that fuselage alterations to reduce the drag should be examined over the operating range of Mach numbers, also that the drag might be reduced by adding volume to the fuselage before and behind the wing.

NACA RM A53J14a

EFFECTS OF LEADING-EDGE CHORD EXTENSIONS AND AN ALL-MOVABLE HORIZONTAL TAIL ON THE AERODYNAMIC CHARACTERISTICS OF A WING-BODY COMBINATION EMPLOYING A TRIANGULAR WING OF ASPECT RATIO 3 MOUNTED IN A HIGH POSITION AT SUBSONIC AND SUPERSONIC SPEEDS. Benton E. Wetzel and Frank A. Pfyl. January 1954. 35p. diagrs., photo., tabs. (NACA RM A53J14a)

The effect of leading-edge chord extensions on the lift, drag, and pitching moment of a wing-body-tail combination having a 3-percent-thick triangular wing of aspect ratio 3 mounted in a high position, and the control characteristics of an unswept, all-movable horizontal tail were investigated. Results are presented for horizontal-tail deflections varying from $+4^\circ$ to -24°, at Mach numbers of 0.6 through 0.9 and 1.2 through 1.9, and at a Reynolds number of 3.8 million.

NACA RM A54F22

AN EXPERIMENTAL INVESTIGATION OF REDUCTION IN TRANSONIC DRAG RISE AT ZERO LIFT BY THE ADDITION OF VOLUME TO THE FUSELAGE OF A WING-BODY-TAIL CONFIGURATION AND A COMPARISON WITH THEORY. George H. Holdaway. August 1954. 35p. diagrs., photos., tabs. (NACA RM A54F22)

An experimental investigation was made at transonic speeds by the free-fall recoverable-model technique to assess at zero lift the possibilities of reducing the drag-rise coefficients of an unswept wing-body-cruciform-tail combination by adding volume to the fuselage.

NACA RM A55B21

AN EXPERIMENTAL INVESTIGATION OF TWO METHODS FOR REDUCING TRANSONIC DRAG OF SWEPT-WING AND BODY COMBINATIONS. John B. McDevitt. April 1955. 27p. diagrs., photos. (NACA RM A55B21)

An experimental investigation of several wing-body combinations was conducted at transonic speeds. The wing had an aspect ratio of 6 and NACA 64_2A015 sections normal to the 50-percent-chord line which was swept back 35°. One basic (Sears-Haack) body and three modified bodies were tested. Two of the modified bodies were designed to alleviate the adverse interference at the root of the sweptback wing. The third modified body was indented according to Whitcomb's area rule. Both methods resulted in considerable reductions of wave drag at transonic speeds.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM A55E11

APPLICATION OF STATISTICAL THEORY TO BEAM-RIDER GUIDANCE IN THE PRESENCE OF NOISE. I - WIENER FILTER THEORY. Elwood C. Stewart. August 1955. 40p. diagrs., tabs. (NACA RM A55E11)

A study has been made of the application of Wiener filter theory to the design of a beam-rider guidance system operating in the presence of glint noise. This theory is used to establish theoretical lower limits of root-mean-square error and desired transfer-function characteristics. Certain modifications necessary in practice are applied to the design of several systems. Consideration is also given to servo energy requirements.

NACA RM A55E11a

APPLICATION OF STATISTICAL THEORY TO BEAM-RIDER GUIDANCE IN THE PRESENCE OF NOISE. II - MODIFIED WIENER FILTER THEORY. Elwood C. Stewart. August 1955. 48p. diagrs., tabs. (NACA RM A55E11a)

An application has been made of Newton's modification of Wiener filter theory to optimize a beam-rider guidance system operating in the presence of glint noise. Results indicate that when the operation of the system is restricted to practical linear ranges, the minimum error attained from this theory closely approaches that for the Wiener theory. The system transfer functions and error performance against noise are given. Requirements on control deflection rates, circuit voltages, and servo energy are discussed.

NACA RM A55J11

A STUDY OF LOCAL-PRESSURE FLUCTUATIONS RELATIVE TO STATIC-PRESSURE DISTRIBUTIONS OF TWO-DIMENSIONAL AIRFOILS AT HIGH SUBSONIC MACH NUMBERS. Charles F. Coe. December 1955. 66p. diagrs., photos. (NACA RM A55J11)

The relationship of local-pressure fluctuations to the time-average static-pressure distribution has been investigated for six symmetrical two-dimensional airfoils. The thickness ratios of the airfoils varied from 12 percent to 4 percent. In addition, the relationship of the total-pressure fluctuations to the time-average total-pressure loss in the wake of an NACA 65A008 airfoil was studied. Results were obtained between Mach numbers of about 0.59 and 0.90 with corresponding Reynolds numbers varying from about 6.3 million to 8.0 million.

NACA RM A55J12

THE EFFECT OF TRAILING-EDGE BLUNTNESS ON THE PERFORMANCE OF A SMALL-SCALE SUPERSONIC PROPELLER AT FORWARD MACH NUMBERS TO 0.92. Fred A. Demele and Carl D. Kolbe. January 1956. 66p. diagrs., photo., tabs. (NACA RM A55J12)

The report presents the aerodynamic characteristics of two 1/12-scale, supersonic-type, three-blade propellers, one having sharp trailing edges and the other having blunt trailing edges. The blunt-trailing-edge propeller had slightly thinner blade sections and the same power absorption capabilities and essentially the same torsional stiffness as the sharp-trailing-edge propeller. The tests covered blade angles from -19° to 56° at forward Mach numbers up to 0.92. In general, slightly higher efficiency was achieved with the blunt-trailing-edge propeller.

NACA RM A55K10

INFLUENCE OF THE BODY FLOW FIELD ON THE ZERO-LIFT WAVE DRAG OF WING-BODY COMBINATIONS MODIFIED IN ACCORDANCE WITH THE TRANSONIC AREA RULE. William A. Page. February 1956. 26p. diagrs. (NACA RM A55K10)

An analysis based upon an approximation to the transonic small-disturbance theory indicates that for a restricted class of indented wing-body combinations the zero-lift wave drag approximates that of the corresponding equivalent body when a Mach number of 1 occurs locally at the wing instead of in the free stream. Comparisons made between the analysis and available experimental data suggest an explanation for some of the anomalous results obtained from tests of indented wing-body combinations.

#NACA RM E51J02, by McAulay

NACA RM E52A24

EXPERIMENTAL INVESTIGATION OF AN AXIAL-FLOW COMPRESSOR INLET STAGE OPERATING AT TRANSONIC RELATIVE INLET MACH NUMBERS. I - OVER-ALL PERFORMANCE OF STAGE WITH TRANSONIC ROTOR AND SUBSONIC STATORS UP TO ROTOR RELATIVE INLET MACH NUMBER OF 1.1. Seymour Lieblein, George W. Lewis, Jr., and Donald M. Sandercock. March 1952. 21p. diagrs., photos. (NACA RM E52A24)

An experimental investigation was conducted on an axial-flow compressor inlet stage consisting of a transonic rotor and subsonic stators. The rotor was designed for a tip speed of 1000 feet per second and an inlet hub-tip radius ratio of 0.525 and had a maximum relative inlet Mach number at the tip of 1.1 at design speed. At design speed of 1000 feet per second, a peak stage adiabatic efficiency of 0.90 was obtained at a corrected weight flow of 44.5 pounds

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per second and a pressure ratio of 1.47. Maximum pressure ratio was 1.48 and maximum weight flow was 48.0 pounds per second or 29.2 pounds per second per square foot frontal area. Weight-flow range was generally equivalent to the range of current inlet stages. Stator outlet conditions and general stage performance appeared satisfactory for multi-staging with current stage designs.

NACA RM E52C25

INVESTIGATION OF TURBINES FOR DRIVING SUPERSONIC COMPRESSORS. I - DESIGN AND PERFORMANCE OF FIRST CONFIGURATION. Warner L. Stewart, Harold J. Schum, and Warren J. Whitney. June 1952. 27p. diagrs., photo. (NACA RM E52C25)

A turbine to drive a supersonic compressor was designed and a cold-air model of this configuration operated to determine its performance. At equivalent design operating speed, the cold-air turbine passed 95 percent of design weight flow, and the turbine limiting-loading point was reached at a work slightly less than design. The performance of the turbine is presented in this report together with the design and aerodynamic problems encountered.

NACA RM E52C27

EXPERIMENTAL INVESTIGATION OF AXIAL-FLOW COMPRESSOR INLET STAGE OPERATING AT TRANSONIC RELATIVE INLET MACH NUMBERS. II - BLADE-COORDINATE DATA. George W. Lewis, Jr. June 1952. 9p. diagrs. (NACA RM E52C27)

Supplementary blade-design data including rotor- and stator-blade coordinates and mean-line angles at the leading and the trailing edges are presented for a transonic axial-flow compressor inlet stage.

NACA RM E52E26

INVESTIGATION OF TURBINES FOR DRIVING SUPERSONIC COMPRESSORS. II - PERFORMANCE OF FIRST CONFIGURATION WITH 2.2-PERCENT REDUCTION IN NOZZLE FLOW AREA. Warner L. Stewart, Harold J. Schum, and Robert Y. Wong. July 1952. 14p. diagrs., tab. (NACA RM E52E26)

The experimental performance of a modified turbine for driving a supersonic compressor is presented and compared with the performance of the original configuration to illustrate the effect of small changes in the ratio of nozzle-throat area to rotor-throat area on the performance of turbines designed to operate with both blade rows close to choking. On the basis of the results of this investigation, the ratio of areas is concluded to become especially critical in the design of turbines such as those designed to drive high-speed, high specific-weight-flow compressors where the turbine nozzles and rotor are both very close to choking.

NACA RM E52J08

PERFORMANCE CHARACTERISTICS OF CANARD-TYPE MISSILE WITH WING-MOUNTED NACELLE ENGINES AT MACH NUMBERS 1.5 TO 2.0. Emil J. Kremzier and Joseph Davids. November 1952. 30p. diagrs., tab. (NACA RM E52J08)

Performance characteristics of a complete canard-type missile configuration with two wing-mounted nacelle engines were determined for Mach numbers from 1.5 to 2.0, angles of attack from 0° to 10°, control-surface-deflection angles from -6° to 10°, and a range of engine mass-flow ratios. Overall force and moment characteristics together with engine diffuser performance as affected by the missile components are presented. Addition of the engines increased the configuration lift and drag but decreased the maximum lift-drag ratio to 5.2 at Mach number 2.0 and zero control-surface deflection, and produced a stabilizing effect on the pitching moment about the reference moment center.

NACA RM E53A20

INVESTIGATION OF TURBINES FOR DRIVING SUPERSONIC COMPRESSORS. III - FIRST CONFIGURATION WITH FOUR NOZZLE SETTINGS AND ONE NOZZLE MODIFICATION. Warner L. Stewart, Warren J. Whitney, and Daniel E. Monroe. March 1953. 28p. diagrs., photo., tab. (NACA RM E53A20)

A turbine designed to power a supersonic compressor was investigated with four nozzle settings and one nozzle modification to determine the effect on turbine performance. With the correct ratio of nozzle throat area to rotor effective throat area, the design specific work was obtained near the peak efficiency. From the results of the investigation it was concluded that the convex insweep of the rotor inner wall and high degree of blade taper caused the turbine configuration to have two aerodynamic disadvantages in comparison with a turbine configuration with an axial inner wall at the rotor outlet and little axial taper.

NACA RM E53C02

INVESTIGATION OF TURBINES FOR DRIVING SUPERSONIC COMPRESSORS. IV - DESIGN AND PERFORMANCE OF SECOND CONFIGURATION INCLUDING STUDY OF THREE-DIMENSIONAL FLOW EFFECTS. Warren J. Whitney, Warner L. Stewart, and Harold J. Schum. May 1953. 20p. diagrs., photo., tab. (NACA RM E53C02)

The design and performance of a turbine configuration designed to drive a supersonic compressor are presented herein. The performance results of this turbine, the design of which included the three-dimensional flow effects, are compared with the results obtained from a turbine configuration designed for this application by a conventional technique in which three-dimensional effects were not considered. The comparison demonstrated that proper consideration of the three-dimensional character of the flow can result in satisfactory performance. The performance results of both configurations

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are also compared with the results of a three-dimensional analysis made on the two configurations to illustrate the validity of the analysis in predicting three-dimensional flow problems.

NACA RM E53D01

DIFFUSION FACTOR FOR ESTIMATING LOSSES AND LIMITING BLADE LOADINGS IN AXIAL-FLOW-COMPRESSOR BLADE ELEMENTS. Seymour Lieblein, Francis C. Schwenk, and Robert L. Broderick. June 1953. 43p. diagrs., tabs. (NACA RM E53D01)

A simplified limiting-blade-loading parameter for axial-flow-compressor blade elements was derived from application of boundary-layer-theory separation criterion to typical suction-surface velocity distribution of blade element at design angle of attack. Comparison was made between derived diffusion factor and other blade-loading parameters by correlation of loss coefficients against loading parameter for cascade data of NACA 65-series compressor blade sections. Further loss-diffusion factor correlations were made for hub-, tip-, and mean-radius regions of several axial-flow-compressor inlet-stage rotors and stators. Loss-diffusion variation in rotor hub and mean and stator hub, tip, and mean regions compared favorably with cascade results, but rotor tip-region variation was markedly different.

NACA RM E53D24

INVESTIGATION OF AN AXIAL-FLOW-COMPRESSOR ROTOR WITH CIRCULAR-ARC BLADES OPERATING UP TO A ROTOR-INLET RELATIVE MACH NUMBER OF 1.22. William H. Robbins and Frederick W. Glaser. July 1953. 63p. diagrs., photos., tabs. (NACA RM E53D24)

A 14-inch-diameter axial-flow-compressor rotor with a hub-tip diameter ratio of 0.50 was designed and operated to investigate the blade-element characteristics as well as the overall performance of a set of circular-arc rotor blades operating over a range of inlet relative Mach numbers from 0.40 to 0.82 with the inlet guide vanes installed and from 0.44 to 1.22 with the guide vanes removed. The optimum incidence angle appeared to increase as Mach number increased. At the design angle of incidence, the design turning-angle rule predicts accurately the turning at all radial positions except the hub section, where slight underturning resulted. In the rotor without guide vanes, at a tip speed of 1120 feet per second there were indications that the limiting relative Mach number, which was determined to be between 1.10 and 1.20, had been exceeded. Therefore, the overall peak efficiency was reduced approximately 7 percent in this range of Mach number.

NACA RM E53G17

EXPERIMENTAL INVESTIGATION OF AN AXIAL-FLOW COMPRESSOR INLET STAGE OPERATING AT TRANSONIC RELATIVE INLET MACH NUMBERS. III - BLADE-ROW PERFORMANCE OF STAGE WITH TRANSONIC ROTOR AND SUBSONIC STATOR AT CORRECTED TIP SPEEDS OF 800 AND 1000 FEET PER SECOND. Francis C. Schwenk, Seymour Lieblein, and George W. Lewis, Jr. September 1953. 69p. diagrs., photos., tabs. (NACA RM E53G17)

A series of survey tests at two rotor speeds was conducted on an axial-flow compressor inlet stage consisting of a transonic rotor and subsonic stators to permit a detailed analysis of the flow across each of the blade rows. The extensive blade-element data which are presented for the purpose of providing basic design information for this type of stage include the variations with incidence angle of such factors as losses, turning angle, axial velocity ratio, work coefficient, and efficiency for rotor-inlet relative Mach numbers up to 1.1.

NACA RM E53G27

INVESTIGATION OF TURBINES FOR DRIVING SUPERSONIC COMPRESSORS. V - DESIGN AND PERFORMANCE OF THIRD CONFIGURATION WITH NONTWISTED ROTOR BLADES. Warren J. Whitney, Warner L. Stewart, and Daniel E. Monroe. September 1953. 23p. diagrs., photos., tab. (NACA RM E53G27)

The design and the performance of a turbine rotor with nontwisted blades designed to drive a supersonic compressor are presented herein. The performance results obtained with this turbine are compared with the results of a free-vortex turbine which was designed for this application, and both the design and off-design performance of the two turbines were very nearly the same. From the comparison of the performance results, it was demonstarted that employing a nontwisted rotor blade velocity distribution for this application enabled the use of a high degree of blade-chord taper as a stress-reduction device without any apparent deterioration of overall turbine performance.

NACA RM E53J13

PUMPING AND THRUST CHARACTERISTICS OF SEVERAL DIVERGENT COOLING-AIR EJECTORS AND COMPARISON OF PERFORMANCE WITH CONICAL AND CYLINDRICAL EJECTORS. S. C. Huntley and Herbert Yanowitz. January 1954. 42p. diagrs. (NACA RM E53J13)

An investigation was made of the performance of four divergent ejectors having shroud-exit to primary-nozzle-exit diameter ratios of 1.2 and 1.3 with minimum-shroud to primary-nozzle-exit diameter

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ratios of 1.1 and 1.2, respectively, and spacing ratios of 0.87 and 1.6. A comparison of the performance of conical, cylindrical, and divergent ejectors showed that on the basis of similar design variables (exit-diameter ratio and spacing ratio) each configuration has merit. At an exit-diameter ratio of 1.2 and spacing ratios of 0.9 and 1.6, the divergent ejector had the highest thrust at zero secondary flow. With corrected weight-flow ratios of 0.03 and 0.07, the divergent ejector had the highest thrust at low primary pressure ratios, while the cylindrical ejector had the highest thrust at high primary pressure ratios. The range of primary pressure ratio over which the cylindrical ejector was advantageous in thrust increased for both the higher corrected weight-flow ratio and the larger spacing ratio. The conical ejector, however, can pump a given corrected weight flow over a wider range of primary pressure ratio but at the expense of a relatively low ejector thrust. The divergent ejector had the smallest range of primary pressure ratio for a given corrected weight-flow ratio. The possibility of obtaining ejector thrust performance from a simple one-dimensional equation by using a measurement of wall pressure distribution was illustrated.

NACA RM E53J28

PRELIMINARY INVESTIGATION OF PERFORMANCE OF VARIABLE-THROAT EXTENDED-PLUG-TYPE NOZZLES OVER WIDE RANGE OF NOZZLE PRESSURE RATIOS. Carl C. Ciepluch, H. George Krull, and Fred W. Steffen. February 1954. 35p. diagrs., photos., tab. (NACA RM E53J28)

As part of an overall program for the experimental investigation of large-scale jet nozzles, a preliminary evaluation of the internal performance characteristics of several variable-throat extended-plug-type nozzles was obtained over a range of nozzle pressure ratios from 2 to 15 with nozzle throat-area variations as great as 2:1. The extended-plug nozzle attained peak thrust coefficients as high as those which have been attained with fixed-geometry convergent-divergent nozzles. The thrust coefficients of the extended-plug nozzles were relatively insensitive to both nozzle pressure ratio and throat area over the range investigated. The lack of sensitivity of thrust coefficient to nozzle pressure ratio and throat area was due primarily to the absence of severe decreases in thrust coefficient, which are normally observed at low nozzle pressure ratios for convergent-divergent nozzles because of overexpansion. For choked flow, the flow coefficients of the extended-plug nozzles varied from 0.95 to 0.997. A ratio of the outer-shell exit area to nozzle throat area was found to be an important variable affecting nozzle performance. Most of the configurations reported herein showed a small decrease in thrust coefficient at low nozzle pressure ratios; however, it is believed that this characteristic can be nearly eliminated by proper nozzle design.

NACA RM E53L23a

GENERAL CONSIDERATIONS OF MACH NUMBER EFFECTS ON COMPRESSOR-BLADE DESIGN. John F. Klapproth. April 1954. 24p. diagrs., photos. (NACA RM E53L23a)

A very approximate design method was used to obtain a qualitative effect of Mach number on blade shape for a prescribed velocity distribution. Experimental performance of ratios having blades similar to those obtained using the approximate design procedure shows rotor efficiencies above 70 percent for rotor tip Mach numbers up to 1.4. A critical factor influencing the performance appeared to be the rotor tip diffusion.

NACA RM E55I20

DESIGN CONSIDERATIONS OF A CONDENSING SYSTEM FOR VAPORIZED MAGNESIUM. Walter R. Witzke, George M. Prok, and Thomas A. Keller. November 1955. 19p. diagrs., photos., tabs. (NACA RM E55I20)

The effect of the design characteristics of various condensing chambers on magnesium buildup at the chamber inlet was investigated. The condensing chambers are used in the vapor-condensation process for making magnesium slurries. A complete description of the various chamber designs and the procedure used in testing the chambers is given. The results are evaluated on the basis of clogging and total magnesium distilled per run. Orifice design was also considered.

NACA RM E56D10a

ESTIMATION OF SPECIFIC SURFACE OF FINELY DIVIDED MAGNESIUM. Murray L. Pinns. August 1956. 28p. diagrs., tabs. (NACA RM E56D10a)

A preliminary investigation into the estimation of the specific surface of finely divided magnesium from the adsorption of cetyl alcohol from hydrocarbon solution indicated that the method may be satisfactory. Average particle diameters calculated from estimates made on atomized and vapor-process magnesium agreed within a factor of 2 with electron-microscope observations. A correlation was found between adsorption and the minimums in plots of Brookfield viscosity and yield value against cetyl-alcohol concentration. Magnesium slurries containing up to 5 percent cetyl alcohol were centrifuged, and the quantities of cetyl alcohol adsorbed were determined from the interfacial tensions between the supernatant liquids and water. Suggestions were made for improving the procedure.

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NACA RM L50J03

AN INVESTIGATION OF THE LONGITUDINAL CHARACTERISTICS OF THE X-3 CONFIGURATION USING ROCKET-PROPELLED MODELS. PRELIMINARY RESULTS AT MACH NUMBERS FROM 0.65 TO 1.25. Jesse L. Mitchell and Robert F. Peck. December 1, 1950. 30p. diagrs., photos. (NACA RM L50J03)

A rocket-propelled model of the X-3 has been flown using the disturbance technique to obtain longitudinal stability, control, trim, and drag data in the Mach number range from 0.65 to 1.25. The model is statically and dynamically stable but had slightly nonlinear lift and pitching-moment characteristics at subsonic speeds. The drag rise begins at about 0.9 Mach number and amounts to 0.042 increase in drag coefficient at zero lift. The transonic trim change is of small magnitude at the test center of gravity (-15 percent of the mean aerodynamic chord).

NACA RM L51J15

TESTS AT MACH NUMBER 1.62 OF A SERIES OF MISSILE CONFIGURATIONS HAVING TANDEM CRUCIFORM LIFTING SURFACES. Carl E. Grigsby. January 1952. 106p. diagrs., tabs. (NACA RM L51J15)

An investigation was made in the Langley 9-inch supersonic tunnel of a series of missile configurations having low-aspect-ratio tandem lifting surfaces of nearly equal span. Breakdown tests were made on a total of 10 configurations comprising combinations of five wings and six tails. For each configuration these tests included: two longitudinal wing locations relative to the tail, two roll angles for both the wing and the tail (0° and 45°), and the in-line and interdigitated cases for each roll angle. All tests were made at a Mach number of 1.62 and a Reynolds number of 0.348×10^6 per inch. The angle-of-attack range was from -5° to 15°. The lift, drag, and pitching-moment data, center-of-pressure locations, and tail-lift efficiency factors are presented without analyses.

NACA RM L52D18a

LARGE-SCALE FLIGHT MEASUREMENTS OF ZERO-LIFT DRAG OF 10 WING-BODY CONFIGURATIONS AT MACH NUMBERS FROM 0.8 TO 1.6. John D. Morrow and Robert L. Nelson. January 1953. 53p. diagrs., photo., tabs. (NACA RM L52D18a)

Measurements of zero-lift drag were made at high Reynolds numbers and at Mach numbers from 0.8 to 1.6 of 10 wing-body configurations having straight, swept, and triangular wing plan forms and thickness ratios from 3 to 12 percent. The wings were mounted on bodies of fineness ratio 10. Of several wing-body configurations having straight, swept, and delta wings of equal area, a 3-percent-thick, 60° delta wing had the least zero-lift drag at supersonic speeds. At transonic speeds, however, a 5.6-percent-thick swept wing had the least drag. At low supersonic speeds the maximum lift-drag ratios for all models were between 7 and 9.5. Changing the section of a straight wing from a hexagonal section to an NACA 65A004.5 section resulted in a 23-percent reduction in zero-lift drag coefficient at transonic speeds. At higher speeds the drag difference decreased, and it was zero at $M = 1.4$. Doubling the thickness of the 3-percent-thick, 60° delta wing added roughly 40 percent to the configuration drag and 60 percent to the wing drag at zero lift. Differences in body profile shape had a large effect on the interference drag of a wing-body combination at transonic speeds, but were of little significance at subsonic and supersonic speeds for the specific bodies studied in this investigation. The base pressures on the bodies of the present configurations indicate base drags of very small magnitude. The pressures were affected by the size and shape of the wings mounted on the body.

NACA RM L52F23

PRELIMINARY FREE-FLIGHT INVESTIGATION OF THE ZERO-LIFT DRAG PENALTIES OF SEVERAL MISSILE NOSE SHAPES FOR INFRARED SEEKING DEVICES. Robert O. Piland. December 1952. 22p. diagrs., photos. (NACA RM L52F23)

The results of a preliminary investigation to develop a nose shape suitable for housing an infrared seeker are presented. The zero-lift drag characteristics of a missile-like body with various unconventional nose shapes were obtained through a range of Mach numbers from 0.8 to 1.8 and Reynolds numbers, based on body length, from 20×10^6 to 70×10^6, respectively, by using rocket-propelled free-flight models. Results of the test indicate that at supersonic speeds about 70 percent of the drag penalty incurred by using spherical-tip nose shapes may be eliminated by using nose shapes which will still allow the seeker to function.

NACA RM L52J08

INVESTIGATION AT HIGH SUBSONIC SPEEDS OF BODIES MOUNTED FROM THE WING OF AN UNSWEPT-WING-FUSELAGE MODEL, INCLUDING MEASUREMENTS OF BODY LOADS. H. Norman Silvers and Thomas J. King, Jr. November 1952. 37p. diagrs., photos., tabs. (NACA RM L52J08)

Ogive-cylinder bodies of fineness ratio 9.34 were tested in the Langley high-speed 7- by 10-foot tunnel with two lengths of pylon support at 0.33 semispan, one length of pylon support at 0.96 semispan, and mounted directly to the wing tips of a wing-fuselage model which had an unswept wing of aspect ratio 4, taper ratio 0.6, and NACA 65A006 airfoil sections. The pylon support members were unswept and had NACA 64A010 airfoil sections. Forces and moments in pitch of the combined model and bodies were measured in addition to six-component force and moment measurements of the bodies in the presence of the model over a Mach number range extending from 0.50 to 0.91.

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NACA RM L52J20

PRELIMINARY INVESTIGATION OF THE EFFECTS OF INLET ASYMMETRY ON THE PERFORMANCE OF CONVERGING-DIVERGING DIFFUSERS AT TRANSONIC SPEEDS. John S. Dennard and William J. Nelson. November 1952. 30p. diagrs., photos., tab. (NACA RM L52J20)

The effects of inclining the plane of the inlet on the performance of several converging-diverging diffusers at zero angle of attack have been investigated at Mach numbers from 0.30 to 1.15 and at 1.41. It was found that converging-diverging diffusers designed for $M = 1.41$ with appreciable constant-area throat lengths operated without abrupt changes in performance over the entire speed and mass-flow ranges. It was also shown that spillage at slightly subcritical flow rates may be localized by inclining the plane of the inlet. At slightly subcritical flow rates a small reduction in pressure loss was obtained at the highest test speed, $M = 1.41$, by inclining the inlet plane 45°. At speeds up to $M = 1.15$ the inclined inlets had about the same pressure recovery as the unskewed inlets.

NACA RM L52J24a

FLIGHT INVESTIGATION OF THE ZERO-LIFT DRAG OF TWO RAM-JET MISSILE CONFIGURATIONS AT MACH NUMBERS FROM 1.00 TO 1.89. Clarence A. Brown, Jr., and Walter E. Bressette. March 1953. 24p. diagrs., photos. (NACA RM L52J24a)

Flight tests were conducted to determine the zero-lift external drag of an underslung single-inlet ram-jet missile configuration and a two-dimensional twin-inlet missile configuration. The external-drag coefficient for the underslung single-inlet ram jet varied smoothly with Mach number whereas the external-drag coefficient of the two-dimensional twin-inlet ram jet had a gradual rise to a peak value at a Mach number of 1.37 and then varied smoothly with increased Mach number.

NACA RM L52J27

EFFECTS OF THE SPANWISE, CHORDWISE, AND VERTICAL LOCATION OF AN EXTERNAL STORE ON THE AERODYNAMIC CHARACTERISTICS OF A 45° SWEPTBACK TAPERED WING OF ASPECT RATIO 4 AT MACH NUMBERS OF 1.41, 1.62, AND 1.96. Carl R. Jacobsen. January 1953. 31p. diagrs., photo. (NACA RM L52J27)

An investigation has been made in the Langley 9- by 12-inch supersonic blowdown tunnel to determine the effects of external-store location on the lift, drag, and pitching-moment characteristics of a tapered 45° sweptback wing of aspect ratio 4 at Mach numbers of 1.41, 1.62, and 1.96. The chordwise and vertical location of a store having a Douglas Aircraft Company, Inc., store shape of fineness ratio 8.58 was systematically varied over the outer 60 percent of the wing semispan. For a wing area of 600 square feet, the store would have sufficient volume to contain about 400 gallons of fuel.

NACA RM L52L12

A TRANSONIC WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF BODY INDENTATION, AS SPECIFIED BY THE TRANSONIC DRAG-RISE RULE, ON THE AERODYNAMIC CHARACTERISTICS AND FLOW PHENOMENA OF A 45° SWEPTBACK-WING-BODY COMBINATION. Harold L. Robinson. February 1953. 33p. diagrs., photos., tab. (NACA RM L52L12)

The aerodynamic characteristics of a sweptback-wing-body configuration having the body indented according to the transonic drag-rise rule as given in NACA RM L52H08 have been compared with those for a configuration with the body cylindrical at the wing-body juncture. This investigation indicated that body indentation reduced the drag coefficient at transonic speeds up to a lift coefficient of 0.4 by the same amount as at zero lift.

NACA RM L52L23

A TRANSONIC WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF BODY INDENTATION, AS SPECIFIED BY THE TRANSONIC DRAG-RISE RULE, ON THE AERODYNAMIC CHARACTERISTICS AND FLOW PHENOMENA OF AN UNSWEPT-WING-BODY COMBINATION. Claude V. Williams. January 1953. 38p. diagrs., photos., tabs. (NACA RM L52L23)

The aerodynamic characteristics and flow phenomena of an unswept-wing-body configuration, having the body indented in the region of the wing-body juncture according to the transonic drag-rise rule, have been compared in a transonic wind-tunnel investigation with the characteristics of a similar configuration that was cylindrical in the region of the wing-body juncture. This investigation indicated that body indentation significantly reduced the transonic drag at lift coefficients up to 0.4.

NACA RM L52L26b

TRANSONIC WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF ASPECT RATIO, SPANWISE VARIATIONS IN SECTION THICKNESS RATIO, AND A BODY INDENTATION ON THE AERODYNAMIC CHARACTERISTICS OF A 45° SWEPTBACK WING-BODY COMBINATION. Melvin M. Carmel. January 1953. 44p. diagrs., tab. (NACA RM L52L26b)

Results are presented which show that the favorable effects of increasing the aspect ratio from 4 to 6 at subsonic speeds more than offset the adverse effects of moderately increasing the thickness ratio of the inboard sections of a wing. At the supersonic test Mach numbers, the effects were approximately equal. Large favorable effects at Mach numbers above approximately 0.90 can be obtained by indenting the body of a wing-body combination with thickened inboard wing sections. The favorable effect becomes increasingly greater with increases in Mach number and lift coefficient.

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NACA RM L53D14a

INVESTIGATION OF THE DRAG OF BLUNT-NOSED BODIES OF REVOLUTION IN FREE FLIGHT AT MACH NUMBERS FROM 0.6 TO 2.3. Harvey A. Wallskog and Roger G. Hart. June 1953. 28p. diagrs., photos., tab. (NACA RM L53D14a)

The effects on total drag coefficient of some nose-shape modifications which could provide suitable housings for guidance systems are presented. Data from rocket-propelled, fin-stabilized bodies of revolution were measured in free flight up to a Mach number of 2.3 and Reynolds numbers, based on body length, as high as 80×10^6. Small degrees of spherical bluntness on parabolic noses produced a small decrease in drag at low supersonic Mach numbers. It was shown that some modifications to a blunt-nosed shape may produce appreciable reductions in total drag. The increase in drag coefficient for a spherical nose of given size is shown to be greater when the round nose replaces the tip of a higher fineness-ratio parabolic nose. Estimated drag-coefficient increments due to spherical bluntness are compared with experimental results.

NACA RM L53E25

THE EFFECT OF NACELLE COMBINATIONS AND SIZE ON THE ZERO-LIFT DRAG OF A 45° SWEPTBACK WING AND BODY CONFIGURATION AS DETERMINED BY FREE-FLIGHT TESTS AT MACH NUMBERS BETWEEN 0.8 AND 1.3. Sherwood Hoffman and William B. Pepper, Jr. June 1953. 22p. diagrs., photos., tabs. (NACA RM L53E25)

The effect on zero-lift drag of increasing the size and number of nacelles on a 45° sweptback wing and body combination has been determined by free-flight tests of rocket-propelled models through a range of Mach numbers varying from 0.8 to 1.3 and Reynolds numbers from 4×10^6 to 7×10^6 based on the wing mean aerodynamic chord. The drag rises of the models were found to be in general agreement with the concepts of the transonic drag-rise rule.

NACA RM L53F05a

A TRANSONIC WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF BODY INDENTATION ON THE AERODYNAMIC CHARACTERISTICS OF AN APPROXIMATE-DELTA-WING-BODY CONFIGURATION, AND A COMPARISON WITH A WING OF REVERSED PLAN FORM. Claude V. Williams. August 1953. 36p. diagrs., photos., tabs. (NACA RM L53F05a)

The aerodynamic characteristics and flow phenomena of an approximate-delta-wing–body configuration, having the body indented according to the transonic drag-rise rule, have been compared in a transonic wind-tunnel investigation with the characteristics of a similar configuration that was cylindrical in the region of the wing-body juncture. This investigation indicated that body indentation significantly reduced the transonic drag rise at lift coefficients up to 0.4, and increased the maximum lift-drag ratio. A comparison with the results of a previous investigation indicated that reversal of wing plan form had little effect on the drag characteristics at Mach numbers near 1.0.

NACA RM L53G02

INVESTIGATION OF AN AXIAL-FLOW COMPRESSOR ROTOR HAVING NACA HIGH-SPEED BLADE SECTIONS (A_2I_{8b} SERIES) AT MEAN RADIUS RELATIVE INLET MACH NUMBERS UP TO 1.13. Melvyn Savage, John R. Erwin, and Robert P. Whitley. November 1953. 43p. diagrs., photos., tab. (NACA RM L53G02)

A high-pressure-ratio, axial-flow-compressor rotor, bladed with NACA A_2I_{8b}-series blade sections, was tested over a range of rotor inlet Mach numbers at the mean radius from 0.63 to 1.13. The general results indicate that efficient high-pressure-ratio transonic rotors can be designed for operation at mean radius inlet Mach numbers up to approximately 0.87 using low-speed cascade data; for operation at higher inlet Mach numbers, low-speed cascade data must be supplemented with a more detailed examination of the transonic flow field. The use of low-speed cascade data for determining design angles of attack was quite effective in that peak efficiency and design angle-of-attack efficiency were coincident at 0.96 for inlet Mach numbers up to 0.87. Above 0.87 while design angle-of-attack efficiency decreased rapidly, peak efficiency gradually decreased to 0.90 at a Mach number of 0.96 where total pressure ratio was 1.555. The shift in peak efficiency to higher than design angles of attack is explained by examination of the effects of angle-of-attack variation on the severity of the pressure gradients of blade upper and lower surfaces.

NACA RM L53I25b

SOME CONSIDERATIONS CONCERNING INLETS AND DUCTED BODIES AT MACH NUMBERS FROM 0.8 TO 2.0. Richard I. Sears. November 1953. 17p. diagrs. (NACA RM L53I25b)

Recently obtained data for the drag and pressure recovery of various nose, scoop, and wing root inlets at Mach numbers 0.8 to 2.0 are presented. The discussion points out some of the large differences that can exist in the drag and pressure recovery of good and not-so-good configuration.

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NACA RM L53J08a

CONTROL HINGE-MOMENT AND EFFECTIVENESS CHARACTERISTICS OF SEVERAL INTERCHANGEABLE TIP CONTROLS ON A 60° DELTA WING AT MACH NUMBERS OF 1.41, 1.62, AND 1.96. Odell A. Morris. November 1953. 33p. diagrs., photo., tab. (NACA RM L53J08a)

An experimental investigation has been made to supplement information obtained previously with tip controls on a 60° delta wing. Control hinge moments and effectiveness characteristics were determined with and without fences at the wing-control juncture for several tip controls having different amounts of leading- or trailing-edge sweep. The effects of wing skew were also examined. Tests were made over an angle-of-attack range of ±12° and for control deflections up to 20° at Mach numbers 1.41, 1.62, and 1.96 and Reynolds numbers of 2.4×10^6, 2.25×10^6, and 2.0×10^6, respectively.

NACA RM L53J20a

AN INVESTIGATION OF THE TRANSONIC AREA RULE BY FLIGHT TESTS OF A SWEPTBACK WING ON A CYLINDRICAL BODY WITH AND WITHOUT BODY INDENTATION BETWEEN MACH NUMBERS 0.9 AND 1.8. Sherwood Hoffman. December 1953. 24p. diagrs., photos., tabs. (NACA RM L53J20a)

The results of an investigation of the transonic area rule by flight tests of a sweptback-wing—cylindrical-body configuration with and without a fuselage indentation and of their equivalent bodies of revolution are presented over a continuous Mach number range from 0.9 to 1.8. The drag rise of the flight models was found to be in general agreement with the concepts of the transonic area rule and with the results of tests of similar models in the Langley 8-foot transonic tunnel. The fuselage indentation produced an undesirable increase in the drag of the configuration above Mach number 1.18.

NACA RM L53J22a

INVESTIGATION AT TRANSONIC SPEEDS OF AERODYNAMIC CHARACTERISTICS OF A SEMIELLIPTICAL AIR INLET IN THE ROOT OF A 45° SWEPTBACK WING. Robert R. Howell and Charles D. Trescot, Jr. December 1953. 39p. diagrs., photos., tabs. (NACA RM L53J22a)

An investigation has been made in the Langley transonic blowdown tunnel to determine the changes in lift, drag, and pitching-moment characteristics due to a semielliptical-shaped air inlet installed in the root of a 45° sweptback wing and to study the internal-flow characteristics of the inlet. The tests were conducted for a Mach number range from 0.63 to 1.41 at a Reynolds number of approximately 6.5×10^6. The measurements included pressures at the inlet and at an assumed compressor face station, and the lift, drag, and pitching moments for ranges of angle of attack and inlet mass-flow ratio from 0° to 9.6° and 0.3 to 0.86, respectively. A maximum total pressure recovery of 97 percent free-stream total pressure was obtained. The external drag increment due to the inlet installation was generally small for the test Mach number range.

NACA RM L53J27a

A STUDY OF THE USE OF LEADING-EDGE NOTCHES AS A MEANS FOR IMPROVING THE LOW-SPEED PITCHING-MOMENT CHARACTERISTICS OF A THIN 45° SWEPT WING OF ASPECT RATIO 4. Joseph Weil and William D. Morrison, Jr. December 1953. 17p. diagrs. (NACA RM L53J27a)

In an effort to develop a simple but effective means of controlling the stall progression of swept wings, a low-speed investigation has been undertaken primarily to determine the effectiveness of leading-edge notches. The investigation included considerations of notch size, location, and shape, as well as combined effects of notch—chord-extension and notch-fence arrangements. The wing used for the study had 45° quarter-chord sweep, aspect ratio 4, taper ratio 0.3, and 65A006 airfoil sections streamwise.

NACA RM L53J30

PRELIMINARY INVESTIGATION OF THE TOTAL-PRESSURE-RECOVERY CHARACTERISTICS OF A SYMMETRIC AND AN ASYMMETRIC NOSE INLET OVER A WIDE RANGE OF ANGLE OF ATTACK AT SUPERSONIC MACH NUMBERS. Howard S. Carter and Charles F. Merlet. December 1953. 27p. diagrs., photo. (NACA RM L53J30)

A preliminary investigation was made of the total-pressure-recovery characteristics of a symmetric nose inlet at a Mach number M of 1.42 and of an asymmetric nose inlet at M = 1.42 and 1.84. The symmetric inlet maintained a maximum recovery of 0.95 for all mass-flow ratios tested between angles of attack of -6° and 6°. At M = 1.42 and 1.84, the asymmetric inlet was relatively insensitive to positive angle of attack through 30°, but encountered severe separation losses at negative angles of attack. The maximum recoveries attained were 0.97 at M = 1.42 and 0.80 at M = 1.84.

NACA RM L53K17

TRANSONIC DRAG MEASUREMENTS OF EIGHT BODY-NOSE SHAPES. William E. Stoney, Jr. February 1954. 14p. diagrs., photos. (NACA RM L53K17)

Zero-lift drag data were obtained on a series of eight fin-stabilized bodies having fineness-ratio-3 noses and differing only in nose shape. The models were launched from the Langley helium gun (at the testing station at Wallops Island, Va.) and data were obtained for Mach numbers from 0.8 to 1.25 with corresponding Reynolds numbers (based on body length) of 8×10^6 to 15×10^6. The results were compared with theoretical calculations and with wind-tunnel measurements. Lowest transonic drag values were obtained with nose shapes defined by the Von Kármán optimum and by a parabola with its vertex at the nose tip.

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NACA RM L53L07

LOW-SPEED CASCADE TESTS OF TWO 45° SWEPT COMPRESSOR BLADES WITH CONSTANT SPANWISE LOADING. Loren A. Beatty, Melvyn Savage, and James C. Emery. March 1954. 65p. diagrs., photos., tab. (NACA RM L53L07)

A cascade investigation of two 45° swept blades was conducted in the low-speed cascade tunnels at the Langley Laboratory. In this investigation, a series of tests was conducted in the 5-inch cascade tunnel at a solidity of 1.00 and an inlet-air angle of 60° on a 2.5-inch chord blade whose camber shape and twist distribution were calculated by the method of NACA TN 1350 to obtain a uniform spanwise loading. In addition, a blade of 5-inch chord, linear twist distribution, and NACA 65-(10A2I8b)10 blade section was tested in the 10-inch cascade tunnel at inlet-air angles of 30°, 45°, and 60° at a solidity of 1.00 and at an inlet-air angle of 45° at solidities of 1.25 and 1.50.

NACA RM L53L21

FLIGHT INVESTIGATION OF ENGINE NACELLES AND WING VERTICAL POSITION ON THE DRAG OF A DELTA-WING AIRPLANE CONFIGURATION FROM MACH NUMBER 0.8 TO 2.0. Joseph H. Judd. March 1954. 39p. diagrs., photos., tabs. (NACA RM L53L21)

Flight tests from Mach numbers 0.8 to 2.0 and Reynolds numbers, based on the wing mean aerodynamic chord, from 5.8×10^6 to 22.8×10^6 were made for a 60° delta wing (NACA 65A003 airfoil section) mounted in midwing and high-wing positions on a modified transonic body with ducted ram-jet type nacelles at 66 percent of the wing semispan. The high-wing configurations, with and without nacelles, had greater drag coefficients than corresponding midwing configurations.

NACA RM L54A08

TRANSONIC WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF BODY INDENTATION FOR BOATTAIL AND CYLINDRICAL AFTERBODY SHAPES ON THE AERODYNAMIC CHARACTERISTICS OF AN UNSWEPT-WING—BODY COMBINATION. Thomas C. Kelly. March 1954. 22p. diagrs., tab. (NACA RM L54A08)

An investigation has been conducted in the Langley 8-foot transonic tunnel to study the effects of body indentation, as specified by the area rule, and afterbody shape on the aerodynamic characteristics of an unswept-wing—body combination. Results indicate that the transonic drag rise for a wing-body combination may be markedly reduced by indentation. Also, the transonic drag rise for a cylindrical afterbody configuration was less severe than that for a boattail configuration, while the use of body indentation with both configurations resulted in nearly the same proportional reductions of the transonic drag rise at a Mach number of 1.0. Data are presented at angles of attack from 0° to 8° and at Mach numbers from 0.80 to 1.15.

NACA RM L54A15

TRANSONIC WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF TAPER RATIO, BODY INDENTATION, FIXED TRANSITION, AND AFTERBODY SHAPE ON THE AERODYNAMIC CHARACTERISTICS OF A 45° SWEPTBACK WING-BODY COMBINATION. Francis G. Morgan, Jr., and Melvin M. Carmel. March 1954. 37p. diagrs., tab. (NACA RM L54A15)

This paper presents the aerodynamic characteristics of wing-body combinations having wings of aspect ratio 4 and 45° sweepback. Comparisons are made to determine the effects of taper ratio, body indentation, fixed transition, and afterbody shape. The tests covered a Mach number range from 0.80 to 1.15, angles of attack from 0° to 12°, and Reynolds numbers varying from 1.80×10^6 to 2.00×10^6 based on the mean aerodynamic chord of the wings.

NACA RM L54A27

ZERO-LIFT DRAG OF SEVERAL CONICAL AND BLUNT NOSE SHAPES OBTAINED IN FREE FLIGHT AT MACH NUMBERS OF 0.7 TO 1.3. Robert O. Piland and Leonard W. Putland. March 1954. 14p. diagrs., photos., tab. (NACA RM L54A27)

The zero-lift drag characteristics of seven nose shapes on a slender body of revolution have been determined in free flight between Mach numbers of 0.7 and 1.3 corresponding to Reynolds numbers, based on body length, of 6×10^6 and 11×10^6, respectively. The nose shapes tested consisted of a spherical segment, a flat face with a sharp shoulder, a flat face with a rounded shoulder, 30° and 40° total-angle cones, and a spherical segment with each of two different-length spikes projecting upstream from the center of the nose.

NACA RM L54A29

TRANSONIC WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF BODY INDENTATION ON THE AERODYNAMIC CHARACTERISTICS OF A SEMI-ELLIPTICAL SWEPTBACK WING-ROOT INLET CONFIGURATION. Arvid L. Keith, Jr. March 1954. 22p. diagrs., photos., tabs. (NACA RM L54A29)

The drag characteristics of a semielliptical shaped sweptback wing-root inlet configuration with fuselage indented to eliminate the effective area added by the inlet installation have been compared with those of a basic wing-body combination and a sweptback wing-root inlet configuration without indentation at Mach numbers from 0.65 to 1.4. The comparisons show that indentation eliminated the small increment in transonic drag coefficient caused by installation of the inlet in the root of the basic wing-body combination. For the major part of the supersonic Mach

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number range investigated, the indented inlet configuration had lower drag than either the basic configurations or the plain inlet configuration and indications were that indentation would be effective to Mach numbers somewhat higher than the test limit. Discussion of some aspects of the application of the transonic area rule to air inlet configurations in general is included.

NACA RM L54B02

THE EFFECT OF NACELLE LOCATION ON THE ZERO-LIFT DRAGS OF 45° SWEPTBACK WING-BODY CONFIGURATIONS HAVING BOATTAIL AND CYLINDRICAL AFTERBODIES AS DETERMINED BY FLIGHT TESTS AT TRANSONIC SPEEDS. Sherwood Hoffman and Austin L. Wolff. March 1954. 29p. diagrs., photos., tabs. (NACA RM L54B02)

The effects of nacelle location on the zero-lift drags of 45° sweptback wing-body combinations having boattail and cylindrical afterbodies have been determined by flight tests of rocket-propelled models through a range of Mach number from 0.8 to 1.25 and Reynolds number from 4×10^6 to 7×10^6 based on the wing mean aerodynamic chord. The drag rises of the models were found to be in qualitative agreement with the concepts of the transonic area rule near Mach number 1.0.

NACA RM L54B10

AN ANALYSIS OF PRESSURE STUDIES AND EXPERIMENTAL AND THEORETICAL DOWNWASH AND SIDEWASH BEHIND FIVE POINTED-TIP WINGS AT SUPERSONIC SPEEDS. William B. Boatright. April 1954. ii, 119p. diagrs., photos. (NACA RM L54B10)

The results of flow angle and pressure surveys throughout cross-flow planes at 1.5, 3, and 4 chords behind pointed-tip wings are presented. Three triangular wings of 50°, 63°, and 72° leading-edge sweep angle were surveyed at free-stream Mach numbers of 1.62 and 2.41. Also flow surveys were conducted behind the 50° triangular wing reversed and behind a pointed-tip wing having a sweptback leading edge and a sweptforward trailing edge (both 50°) at Mach number 1.62. In the analysis of the data, especial attention is focused on the assessment of the various theoretical methods for predicting the flow angle at wing angles of attack where the deflection and distortion of the vortex sheet become important.

NACA RM L54E11

THE EFFECT OF CANOPY LOCATION ON THE AERODYNAMIC CHARACTERISTICS OF A SWEPTBACK WING-BODY CONFIGURATION AT TRANSONIC SPEEDS. Harold L. Robinson. June 1954. 14p. diagrs., photo. (NACA RM L54E11)

Transonic wind-tunnel tests of three configurations - basic wing-body combination, a canopy placed on the body so as to fill the concave portion of the wing-body area distribution curve (design location), and a configuration having the canopy placed 0.0614 of the body length forward of this design location - indicated that significant drag reductions can be achieved by proper canopy location.

NACA RM L54H13a

A FLIGHT INVESTIGATION OF THE TRANSONIC AREA RULE FOR A 52.5° SWEPTBACK WING-BODY CONFIGURATION AT MACH NUMBERS BETWEEN 0.8 AND 1.6. Sherwood Hoffman. November 1954. 25p. diagrs., photos., tab. (NACA RM L54H13a)

The results of an investigation of the transonic area rule by zero-lift rocket-model tests of models of a 52.5° sweptback wing-body configuration with and without a fuselage indentation and of equivalent bodies of revolution are presented through a range of Mach number from 0.8 to 1.6 and Reynolds number from 4×10^6 to 12×10^6, based on wing mean aerodynamic chord. The wing had a taper ratio of 0.2, aspect ratio 3.0, and an NACA 65A004 airfoil section in the free-stream direction. The drag rises of the configurations are studied according to the concepts of the area rule at transonic and supersonic speeds. The Mach number 1.0 indentation lowered the drag rise between Mach numbers 0.9 and 1.35, and increased the pressure drag above Mach number 1.35.

NACA RM L54H30

EFFECT ON TRANSONIC AND SUPERSONIC DRAG OF FUSELAGE GLOVES DESIGNED TO GIVE A SMOOTH OVERALL AREA DISTRIBUTION TO A SWEPT-WING—BODY COMBINATION. James Rudyard Hall. November 1954. 10p. diagrs., photos. (NACA RM L54H30)

A free-flight investigation into the effect of fuselage gloves, or local increases in volume, designed to improve the overall longitudinal area distribution of a swept-wing—body combination revealed that a reduction of about 20 percent in maximum pressure drag was obtained. The drag reduction effected by the use of gloves decreased with increasing Mach number, becoming zero at a Mach number of about 1.35, the limit of the experiments.

NACA RM L54I01a

A METHOD FOR DESIGNING LOW-DRAG NOSE-INLET—BODY COMBINATIONS FOR OPERATION AT MODERATE SUPERSONIC SPEEDS. Robert R. Howell. November 1954. 29p. diagrs., photos., tab. (NACA RM L54I01a)

The results of an experimental investigation in the Mach number range between 0.8 and 1.4 and a related analytical study indicate that pressure-drag equivalence can be obtained between an axially symmetric nose-inlet—body combination and its equivalent body according to the transonic area rule at inlet mass-flow ratios at least as low as 0.7. It was also demonstrated that the equivalent-body concept is an effective method for obtaining low-drag nose-inlet—body combinations for operation at moderate supersonic speeds.

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NACA RM L54I21

THE EFFECT OF SOME SURFACE ROUGHNESS ELEMENTS ON THE DRAG OF A BODY OF REVOLUTION AT SUPERSONIC SPEEDS. Russell N. Hopko. November 1954. 14p. diagrs., photos., tab. (NACA RM L54I21)

The effects of some rivets, butt joints, and lap joints on the drag of a body of revolution at zero lift at supersonic Mach numbers to 2.1 have been obtained in free flight with rocket-propelled models. The butt joints tested showed no significant effects on the drag. Rivets and lap joints increased the drag of the smooth-body configuration, the forward-facing lap joints contributing the greatest increases.

NACA RM L54J20

PRELIMINARY LOW-SPEED WIND-TUNNEL INVESTIGATION OF SOME ASPECTS OF THE AERODYNAMIC PROBLEMS ASSOCIATED WITH MISSILES CARRIED EXTERNALLY IN POSITIONS NEAR AIRPLANE WINGS. William J. Alford, Jr., H. Norman Silvers, and Thomas J. King, Jr. December 1954. 30p. diagrs., photos., tab. (NACA RM L54J20)

A low-speed wind-tunnel investigation was made of some aspects of the aerodynamic problems associated with the use of missiles carried externally near airplane wings. Flow-field surveys were made at the one-half semispan station of a 45° sweptback-wing-fuselage combination. Force and moment measurements were obtained on a model of a typical air-to-air guided missile when traversing the measured flow fields. A comparison of estimated and experimental missile aerodynamic characteristics as affected by the flow fields is presented.

NACA RM L54J29a

JET EFFECTS ON LONGITUDINAL TRIM OF AN AIRPLANE CONFIGURATION MEASURED AT MACH NUMBERS BETWEEN 1.2 AND 1.8. Robert F. Peck. January 1955. 17p. diagrs., photos. (NACA RM L54J29a)

During free-flight tests of a model with a horizontal tail mounted just behind and above a propulsive-jet exit but outside the blast cone, strong jet-induced effects on longitudinal trim were measured. Positive tail loads are believed to have resulted from the formation of a shock wave near or impinging on the tail and originating near the intersection of the external flow and the jet boundary.

NACA RM L54K12a

EFFECTS OF BODY INDENTATION ON THE DRAG CHARACTERISTICS OF A DELTA-WING–BODY COMBINATION AT TRANSONIC SPEEDS. Dewey E. Wornom and Robert S. Osborne. January 1955. 32p. diagrs., photos., tabs. (NACA RM L54K12a)

Wing-body combinations employing a 60° delta wing and three bodies of revolution were tested at Mach numbers from 0.60 to 1.14. Force and moment characteristics of configurations employing the basic body and bodies with indentation based on the transonic and supersonic area-rule concept are presented. Body indentations designed for Mach numbers of 1.0 and 1.4 were both effective in reducing the transonic zero-lift drag rise.

NACA RM L54K16

EXPERIMENTAL INVESTIGATION OF AN AXIAL-FLOW SUPERSONIC COMPRESSOR HAVING SHARP LEADING-EDGE BLADES WITH AN 8-PERCENT MEAN THICKNESS-CHORD RATIO AND OF THE EFFECT OF A LEADING-EDGE RADIUS. Theodore J. Goldberg. February 1955. 33p. diagrs., photo. (NACA RM L54K16)

Details are presented of the results of tests in Freon-12 gas of an axial-flow supersonic compressor having sharp leading-edge blades with an 8-percent mean thickness-chord ratio. Tests were made for a range of tip speed from 485 to 815 fps in Freon-12 which corresponds to a range from 1,050 to 1,760 fps in air. At the design speed of 730 fps (1,600 fps in air) with guide vanes, the rotor produced a total-pressure ratio of 2.06 with an efficiency of 78.6 percent at an equivalent weight flow of 51.2 lb/sec of Freon-12. Without guide vanes, the values were 1.96, 74.5, and 52, respectively. Effects of rounding the leading edge on rotor performance are also presented.

NACA RM L54L02a

ANALYSIS OF AERODYNAMIC BLADE-LOADING-LIMIT PARAMETERS FOR NACA 65-$(C_{l_0}A_{10})10$ COMPRESSOR-BLADE SECTIONS AT LOW SPEEDS. Melvyn Savage. April 1955. 32p. diagrs. (NACA RM L54L02a)

A simple cascade loading-limit parameter for incompressible axial-flow compressor-blade elements was developed from an analysis of previously published incompressible cascade and rotor data on NACA 65-$(C_{l_0}A_{10})10$ compressor-blade sections. Analysis of the data indicated that there was good correlation between loss coefficient and loading-limit parameter with very little effect of inlet angle and solidity over a wide range of inlet-angle, angle-of-attack, and solidity conditions. The loading parameter appeared to be effective in predicting the onset of rotor stall for the rotor conditions investigated.

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A comparison between the loading-limit parameter presented herein with the diffusion factor of NACA RM E53D01 was made by utilizing the incompressible rotor data over the wide range of inlet-angle and solidity conditions for which data were available.

#NACA RM L54L07, by Stevens and Purser

NACA RM L54L28

TRANSONIC WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF TAPER RATIO AND BODY INDENTATION ON THE AERODYNAMIC LOADING CHARACTERISTICS OF A 45° SWEPTBACK WING IN THE PRESENCE OF A BODY. James B. Delano and John P. Mugler, Jr. April 1955. 53p. diagrs., photos., tab. (NACA RM L54L28)

This paper presents the aerodynamic loading characteristics of wings having an aspect ratio of 4, 45° sweepback of the 0.25-chord line, and taper ratios of 0.3 and 0.6 in the presence of unindented and indented bodies. Comparisons are made to show the effect of taper ratio and body indentation on the aerodynamic loading characteristics. The tests covered a Mach number range from 0.6 to 1.2 and an angle-of-attack range from 0° to 20° at a Reynolds number of approximately 2.0×10^6 based on the average chord for the wings.

NACA RM L54L31

SOME STUDIES OF AXISYMMETRIC FREE JETS EXHAUSTING FROM SONIC AND SUPERSONIC NOZZLES INTO STILL AIR AND INTO SUPERSONIC STREAMS. Eugene S. Love and Carl E. Grigsby. May 1955. ii, 178p. diagrs., photos., tabs. (NACA RM L54L31)

Results are presented of some experimental and theoretical studies made of axisymmetric jets exhausting from sonic and supersonic nozzles into still air and into supersonic streams with a view toward current problems associated with propulsive jets and the investigation of these problems.

NACA RM L55F03

EFFECT OF WING SIZE AND AMOUNT OF INDENTATION ON APPLICABILITY OF TRANSONIC AREA RULE TO SWEPT-WING CONFIGURATIONS. James Rudyard Hall. July 1956. 33p. diagrs., photos., tabs. (NACA RM L55F03)

A systematic free-flight investigation was made to help define the range of applicability of the transonic area rule to swept-wing configurations. The reduction of pressure drag obtainable from partial indentation is approximately proportional to the amount of indentation employed up to a Mach number of 1.3. Generally, for unindented swept-wing configurations it is possible to obtain the pressure drag within 10 percent by applying a ratio of pressure drag measured for the present configurations to the measured pressure drag of the equivalent body of the configuration. In two cases it was possible to approximate the drag of a swept-wing configuration with an equivalent body incorporating a more severe wing projection than a normal projection. Wing-fuselage interference drag did not vary appreciably for the three wing sizes tested for unindented bodies.

NACA RM L55G11

TRANSONIC WIND-TUNNEL INVESTIGATION OF THE AERODYNAMIC LOADING CHARACTERISTICS OF A 60° DELTA WING IN THE PRESENCE OF A BODY WITH AND WITHOUT INDENTATION. John P. Mugler, Jr. September 1955. 30p. diagrs., photos., tab. (NACA RM L55G11)

This paper presents force and moment test results showing the aerodynamic loading characteristics of a 60° delta wing in the presence of a basic (unindented) body and the same body when indented in accordance with the transonic-area-rule concept. The wing had 60° sweepback of the leading edge, an aspect ratio of 2.31, a taper ratio of 0, and NACA 65A003 airfoil sections parallel to the model plane of symmetry. Comparisons are made to show the effect of body indentation on the loading characteristics. The tests covered a Mach number range from 0.6 to 1.2 and an angle-of-attack range from 0° to 20° at a Reynolds number of about 3.6×10^6 based on the wing mean aerodynamic chord.

NACA RM L55J12

SOME EFFECTS OF SWEEP AND THICKNESS ON THE EXPERIMENTAL DOWNWASH CHARACTERISTICS AT TRANSONIC SPEEDS OF A SERIES OF HIGHLY TAPERED WINGS WITH AN ASPECT RATIO OF 3. TRANSONIC-BUMP METHOD. Albert G. Few, Jr. February 1956. 65p. diagrs., photo. (NACA RM L55J12)

The present paper presents experimental results of some effects of sweep and thickness on the transonic downwash and wake characteristics of a series of highly tapered wings with an aspect ratio of 3. The tests covered a Mach number range from 0.60 to 1.18 and employed the transonic-bump-test technique. Reynolds numbers ranged from about 0.78×10^6 to 0.93×10^6 and angles of attack from -2° to about 24°. The downwash and dynamic pressure were measured for a range of vertical heights at one spanwise station, and for a given wing plan form, at only one longitudinal station.

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NACA RM L55J13

PRELIMINARY FREE-FLIGHT STUDY OF THE DRAG AND STABILITY OF A SERIES OF SHORT-SPAN MISSILES AT MACH NUMBERS FROM 0.9 TO 1.3. James Rudyard Hall. February 1956. 14p. diagrs., photo. (NACA RM L55J13)

A preliminary free-flight study has been made of the drag and stability of a series of missile configurations employing 80°, 85°, and 90° of fin leading-edge sweep. Increasing the fin sweep reduced the drag markedly. The configurations employing 80° and 85° of fin sweep were stable with the center of gravity as far rearward as at least 54 and 52 percent of the body length, respectively. The configuration employing 90° of fin sweep was marginally stable with the center of gravity at 43 percent of the body length. The Reynolds number of the tests varied from 4×10^6 at a Mach number of 0.9 to 9×10^6 at a Mach number of 1.3.

NACA RM L55J14

INITIAL INCLINATION OF THE MIXING BOUNDARY SEPARATING AN EXHAUSTING SUPERSONIC JET FROM A SUPERSONIC AMBIENT STREAM. Eugene S. Love. January 1956. 30p. diagrs. (NACA RM L55J14)

Calculations have been made of the initial inclination of the mixing boundary separating an exhausting supersonic jet from an external supersonic stream as a function of jet static-pressure ratio. The calculations are based on a ratio of specific heats of 7/5 for the external stream and 9/7 for the jet. The results are presented in curve form and cover, in terms of the conditions immediately ahead of the jet exit, the following range of variables: boattail and nozzle divergence angles from 0° to 20°, external-stream Mach numbers from 1.2 to 3.0, jet Mach numbers from 1.0 to 3.0, and jet static-pressure ratios within the approximate inviscid limits for supersonic flow, except at the higher jet and stream Mach numbers where the calculations were terminated somewhat short of these limits.

NACA RM L55J20

TRANSONIC WIND-TUNNEL INVESTIGATION OF THE AERODYNAMIC LOADING CHARACTERISTICS OF A HIGHLY TAPERED UNSWEPT WING IN THE PRESENCE OF A BODY WITH AND WITHOUT INDENTATION. Joseph D. Brooks. February 1956. 30p. diagrs., photos., tab. (NACA RM L55J20)

An investigation of the aerodynamic loading characteristics and the effects of body indentation on the wing loads of an unswept wing with an aspect ratio of 2.67, a taper ratio of 0.2, and 4-percent-thick circular-arc airfoil sections measured parallel to the plane of symmetry was conducted in the Langley 8-foot transonic pressure tunnel. An internal strain-gage balance was used to measure wing loads independently of the body load. The tests covered a Mach number range from 0.6 to 1.2 and an angle-of-attack range from 0° to 20° at a Reynolds number of about 2.7×10^6.

NACA RM L55J25

WIND-TUNNEL INVESTIGATION AT HIGH SUBSONIC SPEEDS OF SOME EFFECTS OF FUSELAGE CROSS-SECTION SHAPE AND WING HEIGHT ON THE STATIC LONGITUDINAL AND LATERAL STABILITY CHARACTERISTICS OF A MODEL HAVING A 45° SWEPT WING. Thomas J. King, Jr. February 1956. 61p. diagrs., photo. (NACA RM L55J25)

This paper presents results of an investigation to determine the effects of fuselage cross-section shape on the high subsonic speed longitudinal and lateral stability characteristics of low- and high-wing—fuselage combinations. The wing had an aspect ratio of 4, taper ratio of 0.3, sweep of 45° of the quarter-chord line, and an NACA 65A006 airfoil section. The tests covered a Reynolds number range from 2.5×10^6 to 3.0×10^6, a Mach number range from 0.8 to 0.92, and an angle-of-attack range from -3° to 24°.

#NACA RM L55J28, by Gardiner, Gillis, and Graves

NACA RM L56A05

USE OF SHADOWGRAPH TECHNIQUE IN THE ANALYSIS OF THE PERFORMANCE OF TWO SUPERSONIC AXIAL-FLOW COMPRESSOR ROTORS OPERATING OVER A MEAN RADIUS RELATIVE INLET MACH NUMBER RANGE OF 0.85 TO 1.7. Theodore J. Goldberg and James R. Sterrett. April 1956. 48p. diagrs., photos. (NACA RM L56A05)

Shadowgraphs of the flow patterns through the blade passage and ahead of a compressor rotor were obtained by shining parallel light rays approximately radially onto the rotor hub and upstream inner ring which were painted white to serve as a screen. The visible flow patterns were used in conjunction with measured data to analyze the performance of two axial-flow supersonic compressors operating over a mean radius relative inlet Mach number range of 0.85 to 1.7 in Freon-12. This simple shadowgraph technique allowed a qualitative study of the starting mechanism, shock position and movement, and separation associated with shock boundary-layer interaction. A comparison with previous results of these two rotors obtained in another test stand indicates the possibility of test-stand and tip-clearance effects on rotor performance.

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NACA RM L56I07

EXPERIMENTAL INVESTIGATION OF THE AERODYNAMIC LOADING ON A HELICOPTER ROTOR BLADE IN FORWARD FLIGHT. John P. Rabbott, Jr., and Gary B. Churchill. October 1956. 65p. diagrs., photos., tabs. (NACA RM L56I07)

Chordwise and spanwise aerodynamic loading distributions have been measured on one blade of a two-blade teetering rotor for a tip-speed-ratio range of 0.08 to 0.29. These data and the variation of section and total blade loading with azimuth are presented. Also determined are the harmonic content and phase angles of loading for six harmonics of rotor speed. The harmonic content of the measured data is much greater than a uniform-inflow theory would predict. The nondimensional spanwise loading is indicated to be relatively constant with disk loading and tip-speed ratio.

NACA RM L57A03

INVESTIGATION OF THE EFFECT OF VELOCITY DIAGRAM ON INLET TOTAL-PRESSURE DISTORTIONS THROUGH SINGLE-STAGE SUBSONIC AXIAL-FLOW COMPRESSORS. George C. Ashby, Jr. April 1957. 21p. diagrs., photo. (NACA RM L57A03)

A preliminary theoretical and experimental investigation of the effect of velocity diagram on inlet total-pressure distortions through single-stage subsonic axial-flow compressors has been conducted. The wake of a 1/4-inch-diameter rod was measured upstream of a rotor. By using the measured upstream wake and a derived equation for incompressible flow, the wake downstream of the rotor was estimated and compared with the measured downstream wake for several velocity diagrams. From the results of the investigation, optimum velocity diagrams for eliminating total-pressure distortions across single-stage axial-flow compressors were determined. It was determined that the derived equation will estimate the distortion downstream of the rotor with reasonable accuracy for distortions which are large enough circumferentially to alter the static-pressure field in the blade passage.

NACA RM L57E03

LOW-SPEED CASCADE INVESTIGATION OF THIN LOW-CAMBER NACA 65-SERIES BLADE SECTIONS AT HIGH INLET ANGLES. James C. Emery. June 1957. 93p. diagrs., tab. (NACA RM L57E03)

An investigation of 6-percent-thick NACA 65-series compressor blade sections has been conducted in a two-dimensional porous-wall cascade tunnel. Blades cambered to have isolated airfoil lift coefficients of 0, 0.4, 0.8, and 1.2 were tested over the usable angle-of-attack range at inlet-air angles of 60°, 70°, and 75° and solidities of 0.75, 1.00, and 1.50. A few tests were made at a solidity of 2.00. The results of this investigation indicate a continuous variation of blade-section performance as the major cascade parameters (camber, solidity, and inlet angle) change and provide design information for a range of compressor operation that heretofore has been supplied by extrapolation.

#NACA RM SE50J11, by Ketchum, Blivas, and Pack
#NACA RM SL9D28, by Wiley
#NACA RM SL50J03, by Mitchell and Peck

This is authority for those possessing copies of the following research report to declassify it from Secret. Effective date of declassification October 14, 1957.

NACA RM E54K03

TRANSPORT OF RADIOACTIVITY BY LIQUID SODIUM IN A STAINLESS STEEL CIRCULATION SYSTEM. D. Fieno and D. Bogart. March 2, 1955. 17p. diagrs., photos., tab. (NACA RM E54K03)

Radioactivity transport experiments were conducted in a stainless-steel system in which liquid sodium was circulated over an activated stainless-steel insert section. The system consisted of a sealed toroid loop partly filled with sodium. Circulation of the sodium was induced by an oscillatory motion of the toroid in an apparatus developed at the NACA Lewis Laboratory. Periodic measurements of radioactivity at sections of the toroid loop established the growth of transported activity in the loop.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

National Advisory Committee for Aeronautics

Research Abstracts and Reclassification Notice

DEC - 6 1957
BATTELLE MEMORIAL INSTITUTE

NO. 122 DECEMBER 3, 1957

SPECIAL NOTICE

All NACA publications that were issued under the following series designations are now declassified:

NACA ACR (Advance Confidential Report)
NACA ARR (Advance Restricted Report)
NACA CB (Confidential Bulletin)
NACA RB (Restricted Bulletin)
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All NACA Research Memorandums with 1946 code numbers (such as E6B12) are now declassified.

The declassification of each publication in these groups has been previously announced. The present announcement is made for the benefit of those who may not have access to all of the individual announcements.

CURRENT NACA RESEARCH REPORTS

NACA Rept. 1309

AERODYNAMIC CHARACTERISTICS AT HIGH SPEEDS OF RELATED FULL-SCALE PROPELLERS HAVING DIFFERENT BLADE-SECTION CAMBERS. Julian D. Maynard and Leland B. Salters, Jr. 1957. ii, 24p. diagrs., photos., tab. (NACA Rept. 1309. Supersedes RM L8E06)

Comparisons are made of results obtained in wind-tunnel tests of related full-scale propellers over a range of blade angles from 20° to 55° at airspeeds up to 500 miles per hour to evaluate the combined effects of blade-section camber and compressibility on propeller aerodynamic characteristics.

NACA RM E57G11

ACCELERATION IN FIGHTER-AIRPLANE CRASHES. Loren W. Acker, Dugald O. Black, and Jacob C. Moser. November 1957. 78p. diagrs., photos. (NACA RM E57G11)

Full-scale crashes were conducted with FH-1 jet fighter airplanes under circumstances approximating those observed in the military service. These crashes simulated unflared landings at impact angles of 18°, 22°, and 27°, a ground cart wheel, and a ground loop. The magnitude, duration, and direction of the crash accelerations were measured on the airplane structure and on an anthropomorphic dummy installed in the cockpit. The accelerations measured are compared with existing data on human tolerance to the sudden loads that occur in crashes to see whether the human tolerance had been exceeded.

NACA RM E57G16a

THEORETICAL ROCKET PERFORMANCE OF JP-4 FUEL WITH SEVERAL FLUORINE-OXYGEN MIXTURES ASSUMING FROZEN COMPOSITION. Sanford Gordon and Kenneth S. Drellishak. November 1957. 62p. diagrs., tabs. (NACA RM E57G16a)

Data were calculated for a chamber pressure of 600 pounds per square inch absolute, fluorine in oxidant from 0 to 100 percent, pressure ratios of 1 to 1500, and a range of equivalence ratios. Parameters included are specific impulse, combustion and exit temperatures, molecular weight, characteristic velocity, coefficient of thrust, area ratio, specific heat, isentropic exponent, viscosity, thermal conductivity, and combustion composition.

NACA TN 4046

A COMPARATIVE ANALYSIS OF THE PERFORMANCE OF LONG-RANGE HYPERVELOCITY VEHICLES. Alfred J. Eggers, Jr., H. Julian Allen, and Stanford E. Neice. October 1957. (i), 66p. diagrs. (NACA TN 4046. Supersedes RM A54L10)

A simplified analysis is made of the motion and aerodynamic heating of long-range ballistic-, skip-, and glide-type vehicles. The ballistic vehicle appears relatively attractive because convective heat transfer can be reduced by using blunt shapes. The glide vehicle appears attractive because it has a relatively efficient trajectory, and the possibility of substantial radiative cooling. These vehicles compare favorably, in the sense of the Brequet range equation, to the supersonic airplane for very long-range flight.

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CURRENT NACA RESEARCH REPORTS

NACA TN 4047

A STUDY OF THE MOTION AND AERODYNAMIC HEATING OF MISSILES ENTERING THE EARTH'S ATMOSPHERE AT HIGH SUPERSONIC SPEEDS. H. Julian Allen and A. J. Eggers, Jr. October 1957. 61p. diagrs. (NACA TN 4047. Supersedes RM A53D28)

A simplified analysis of the velocity and deceleration history of missiles entering the earth's atmosphere at high supersonic speeds is presented. The results of this motion analysis are employed to indicate means available to the designer for minimizing aerodynamic heating. The heating problem considered involves not only the total heat transferred to a missile by convection, but also the maximum average and local time rates of convective heat transfer.

NACA TN 4048

MOTION OF A BALLISTIC MISSILE ANGULARLY MISALINED WITH THE FLIGHT PATH UPON ENTERING THE ATMOSPHERE AND ITS EFFECT UPON AERODYNAMIC HEATING, AERODYNAMIC LOADS, AND MISS DISTANCE. H. Julian Allen. October 1957. 66p. diagrs., tabs. (NACA TN 4048. Supersedes RM A56F15)

An analysis is given of the oscillating motion of a ballistic missile which upon entering the atmosphere is angularly misalined with respect to the flight path. The history of the motion for some example missiles is discussed from the point of the effect of the motion on the aerodynamic heating and loading. The miss distance at the target due to misalinement and to small accidental trim angles is treated. The stability problem is also discussed for the case where the missile is tumbling prior to atmospheric entry.

NACA TN 4087

DROP-SIZE DISTRIBUTION FOR CROSSCURRENT BREAKUP OF LIQUID JETS IN AIRSTREAMS. Robert D. Ingebo and Hampton H. Foster. October 1957. 36p. diagrs., photos. tabs. (NACA TN 4087)

Photographic and sampling techniques were combined to obtain drop-size data for ranges of injector, liquid, and airstream variables. The following empirical expression correlated the ratio of volume-median diameter D_{30} to orifice diameter D_O with Weber-Reynolds number ratio $D_{30}/D_O = 3.9(We/Re)^{0.25}$ where $We = \sigma/\rho_S D_O V_S^2$, $Re = D_O V_S/\nu$, σ and ν are surface tension and kinematic viscosity, respectively, of the liquid; and V_S and ρ_S are free-stream velocity and density, respectively, of the air. A drop-size-distribution equation based on maximum observed drop diameter and Weber-Reynolds number ratio was also derived.

$$\frac{dR}{dD} = 10^6\left(\frac{We}{Re}\right)^{0.24} \frac{D^5}{D_{max}^6} e^{-22.3(We/Re)^{0.04}D/D_{max}}$$

NACA TN 4097

INVESTIGATION OF SOME MECHANICAL PROPERTIES OF THERMENOL COMPRESSOR BLADES. Donald F. Johnson. October 1957. 14p. diagrs., photo. (NACA TN 4097)

A series of tests were made comparing the mechanical properties of similar compressor blades of AISI type 403 stainless steel and thermenol. Eighth-stage J47 and J65 compressor blades of each material were tested. Modulus of elasticity, modulus of rigidity, and damping were slightly lower for thermenol. However, thermenol showed better resistance to corrosion by sea water, and the thermenol blades proved equal or superior to the stainless-steel blades in fatigue strength.

NACA TN 4124

EFFECT OF GROUND PROXIMITY ON THE AERODYNAMIC CHARACTERISTICS OF A FOUR-ENGINE VERTICAL-TAKE-OFF-AND-LANDING TRANSPORT-AIRPLANE MODEL WITH TILTING WING AND PROPELLERS. William A. Newsom, Jr. October 1957. 15p. diagrs., photo., tab. (NACA TN 4124)

An investigation was conducted on an airplane model with the wing at an angle of incidence of 90° for a range of heights of the model above the ground and included force tests and tuft studies of the flow field caused by the propeller slipstream. The results indicate that, when the model was hovering near the ground, there was a strong upwash in the plane of symmetry which caused both an increase in lift because of the up load on the fuselage and an increase in the nose-down pitching moment because the rear part of the fuselage was longer than the front part.

NACA TN 4129

ANALYSIS OF OPERATIONAL AIRLINE DATA TO SHOW THE EFFECTS OF AIRBORNE WEATHER RADAR ON THE GUST LOADS AND OPERATING PRACTICES OF TWIN-ENGINE SHORT-HAUL TRANSPORT AIRPLANES. Martin R. Copp and Walter G. Walker. November 1957. 18p. diagrs., tabs. (NACA TN 4129)

Airspeed, altitude, and acceleration data were obtained from transports flown by one airline before and subsequent to the installation of airborne weather radar. A comparison of the results indicated that the magnitudes of the largest gust velocities and gust accelerations experienced for a given number of flight miles during radar operations were approximately 25 percent less than those experienced before the radar equipment was installed.

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CURRENT NACA RESEARCH REPORTS

NACA TN 4130

NACA 65-SERIES COMPRESSOR ROTOR PERFORMANCE WITH VARYING ANNULUS-AREA RATIO, SOLIDITY, BLADE ANGLE, AND REYNOLDS NUMBER AND COMPARISON WITH CASCADE RESULTS. Wallace M. Schulze, John R. Erwin, and George C. Ashby, Jr. October 1957. 62p. diagrs., photos., tab. (NACA TN 4130. Supersedes RM L52L17)

An axial-flow compressor rotor was tested at low speed and without guide vanes or stators in a 28-inch test compressor. The rotor was designed for a free-vortex type blade loading using NACA 65-series 10-percent-thick airfoil sections. In these tests, the effects of changes of blade-setting angle, annulus-area ratio, solidity, and Reynolds number on rotor performance were determined for a range of quantity flows. Rotor data are compared with estimations based on uncorrected and corrected cascade data.

NACA TN 4132

FATIGUE INVESTIGATION OF FULL-SCALE TRANSPORT-AIRPLANE WINGS. VARIABLE-AMPLITUDE TESTS WITH A GUST-LOADS SPECTRUM. Richard E. Whaley. November 1957. 43p. diagrs., photos., tabs. (NACA TN 4132)

Crack-initiation areas, frequency of occurrence of cracks, crack propagation, lifetime to crack initiation of all cracks, lifetime to final failure, and spread in lifetime are investigated and compared with results from constant-amplitude tests on similar wings. Information on X-ray techniques to determine the presence of cracks in hidden elements is also included.

NACA TN 4143

DEVELOPMENT OF A PISTON-COMPRESSOR TYPE LIGHT-GAS GUN FOR THE LAUNCHING OF FREE-FLIGHT MODELS AT HIGH VELOCITY. A. C. Charters, B. Pat Denardo, and Vernon J. Rossow. November 1957. (i), 95p. diagrs., photos., tabs. (NACA TN 4143. Supersedes RM A55G11)

A light-gas gun has been developed at the Ames Aeronautical Laboratory to launch small models for aerodynamic tests. The design of the gun and the analysis of its performance are presented. The results of the initial firing trials are discussed. The firing trials showed good agreement between measured and predicted velocities and pressures and a velocity of 15,400 ft/sec was reached. It is concluded that the gun is a satisfactory launcher for high-velocity free-flight tests.

NACA TN 4156

EFFECT OF INITIAL MIXTURE-TEMPERATURE ON BURNING VELOCITY OF HYDROGEN-AIR MIXTURES WITH PREHEATING AND SIMULATED PREBURNING. Sheldon Heimel. October 1957. 23p. diagrs., tabs. (NACA TN 4156)

Laminar burning velocities were determined in the temperature range 300° to 700° K from schlieren photographs of open flames. The temperature was raised in two ways: (1) by preheating of the hydrogen-air mixtures and (2) by simulated adiabatic preburning of part of the hydrogen in air at 300° K so that initial temperatures of 600° and 700° K would be attained for the resulting mixtures of hydrogen, air, water vapor, and nitrogen. The temperature dependence of burning velocity was determined for both preheated and preburned mixtures. With 29.6 and 45.0 percent hydrogen (original mixture), mole-for-mole substitution of nitrogen for water vapor in the preburning experiments caused no discernible change in burning velocity.

NACA TN 4162

STUDY OF SOME BURNER CROSS-SECTION CHANGES THAT INCREASE SPACE-HEATING RATES. Donald R. Boldman and Perry L. Blackshear, Jr. November 1957. 38p. diagrs., photos., tab. (NACA TN 4162)

A two-dimensional glass-walled combustor fed with a homogeneous combustible mixture was used to study the effect of area blockage on heat release. The blockage at a single V-gutter flame holder was varied from 12.5 to 75 percent with negligible effect on combustion efficiency. When a small flame holder was used and a 62.5-percent restriction introduced downstream, the heat-release rate underwent a three- to fourfold increase. Some effects of downstream blockage shapes are given.

NACA TN 4167

A RAPID METHOD FOR PREDICTING ATTACHED-SHOCK SHAPE. Eugene S. Love and Ronald H. Long. October 1957. 34p. diagrs., tab. (NACA TN 4167)

A method is presented for the rapid prediction of the shape of attached shocks emanating from smoothly contoured axisymmetric and two-dimensional nose shapes. From a practical viewpoint the accuracy of the method is comparable to that of the method of characteristics.

CURRENT NACA RESEARCH REPORTS

NACA TN 4169

ATMOSPHERIC TEMPERATURE OBSERVATIONS TO 100,000 FEET FOR SEVERAL CLIMATOLOGICAL REGIONS OF THE NORTHERN HEMISPHERE. H. B. Tolefson. November 1957. 26p. diagr., tab. (NACA TN 4169)

Radiosonde measurements of upper-air temperatures taken over a 5-year period at nine stations in the northern hemisphere are summarized in tabular form in order to provide information on the temperatures likely to be encountered during airplane and missile operations up to 100,000 feet. The results indicate that the scatter in the temperatures about the mean generally decreased with increasing altitude from the tropopause to 100,000 feet. Little, if any, effect of location upon the temperature was apparent for altitudes above about 90,000 feet.

NACA TN 4171

SOME GROUND MEASUREMENTS OF THE FORCES APPLIED BY PILOTS TO A SIDE-LOCATED AIRCRAFT CONTROLLER. Roy F. Brissenden. November 1957. 17p. diagrs., photos., tab. (NACA TN 4171)

Ground tests have been made to determine pilots' force capabilities on a proposed side-located aircraft controller. In addition to maximum force capabilities, pilots participating in the tests indicated forces that they considered desirable for operation of the controller. A neutral position and a range of deflections and forces are suggested.

NACA TN 4174

WIND-TUNNEL INVESTIGATION OF THE STATIC LATERAL STABILITY CHARACTERISTICS OF WING-FUSELAGE COMBINATIONS AT HIGH SUBSONIC SPEEDS. TAPER-RATIO SERIES. James W. Wiggins and Paul G. Fournier. October 1957. 25p. diagrs., photos. (NACA TN 4174. Supersedes RM L53B25a)

This paper presents the aerodynamic characteristics in sideslip of wing-fuselage combinations. The wings have a sweep angle of 45° at the quarter-chord line, aspect ratio of 4, taper ratios of 0.3, 0.6, and 1.0, and an NACA 65A006 airfoil section. The tests covered a Mach number range from 0.4 to 0.95, a Reynolds number range from 1.7×10^6 to 3.2×10^6, and an angle-of-attack range from -3° to 24°.

NACA TN 4175

INVESTIGATION OF DEFLECTORS AS GUST ALLEVIATORS ON A 0.09-SCALE MODEL OF THE BELL X-5 AIRPLANE WITH VARIOUS WING SWEEP ANGLES FROM 20° TO 60° AT MACH NUMBERS FROM 0.40 TO 0.90. Delwin R. Croom and Jarrett K. Huffman. November 1957. 28p. diagrs. (NACA TN 4175)

An investigation has been made in the Langley high-speed 7- by 10-foot tunnel to determine the effectiveness of deflectors as gust alleviators on a 0.09-scale model of the Bell X-5 research airplane with wing sweep angles from 20° to 60°. Results of this study have indicated that a deflector arrangement can be used as a gust-alleviation device on swept wings.

BRITISH REPORTS

N-50049*

Royal Aircraft Establishment (Gt. Brit.)
SOME METHODS OF EVALUATING IMPERFECT GAS EFFECTS IN AERODYNAMIC PROBLEMS. G. A. Bird. January 1957. 31p. diagrs. RAE Tech. Note Aero 2488. (Ask for N-50049*)

Simple numerical and graphical procedures are described for the calculation of the imperfect gas effects on the properties of steady and unsteady one-dimensional isentropic flows, the Prandtl-Meyer expansion round a corner and normal and oblique shock waves. The fundamental equations of each type of flow have been put into a form in which they may be solved using the published tables of the equilibrium properties of gases. Both thermal and caloric imperfections have been taken into account but relaxation time effects have been neglected. Numerical examples are given for each type of flow although the main emphasis has been placed on the methods rather than on the results. These basic methods have been used to calculate the magnitude of the imperfect gas effects on a number of specific aerodynamic problems which have been considered in detail.

N-50128*

Royal Aircraft Establishment (Gt. Brit.)
METHODS FOR DETERMINING THE WAVE DRAG OF NON-LIFTING WING-BODY COMBINATIONS. L. M. Sheppard. April 1957. 39p. diagrs. RAE Aero 2590. (Ask for N-50128*)

The area rule, moment of area rule, and transfer rule methods for estimating the wave drag of wing-body combinations are discussed. It is pointed out that the moment of area rule and the transfer rule are different forms of the area rule, and that the transfer rule expresses the interference wave drag in a simple form. The existing methods of wave drag estimation are restricted to combinations with bodies having continuous surface slope and here an extension to combinations with bodies having discontinuous surface slope is given. This paper is concerned with the theoretical methods and their associated numerical techniques and no numerical results or particular applications are presented.

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BRITISH REPORTS

N-50129*

Ministry of Supply (Gt. Brit.)
THE SULFINUZ TREATMENT OF S.80 AND S.99 STEELS, EFFECT ON FATIGUE STRENGTH AND OTHER PROPERTIES. July 1957. 15p. diagrs., photos., tabs. MOS S & T Memo. 9/57.
(Ask for N-50129*)

Tensile, Izod impact, fatigue and corrosion tests have been carried out on two steels treated by the "SULFINUZ" process. A significant improvement in fatigue strength is noted when compared with steels treated in a neutral salt bath. Under severe corrosive conditions the "SULFINUZ" treated specimens show greater attack with marked local action. A preliminary metallographic examination is described.

N-50131*

Royal Aircraft Establishment (Gt. Brit.)
THE SHRINKAGE AND EXTENSIBILITY OF HEATED YARNS. PART I. J. E. Swallow. March 1957. 22p. diagrs. RAE Tech. Note Chem. 1302.
(Ask for N-50131*)

The changes in length which occur when nylon, Terylene and Fortisan yarns are heated, and the reversibility of these changes, are described. The effects of stress on yarns which have been heated are considered. It is shown that stressing may reduce the dimensional stability conferred by heat-setting.

N-50132*

Royal Aircraft Establishment (Gt. Brit.)
FACTORS AFFECTING THE THERMAL STABILITY OF POLYESTER GLASS-FIBRE LAMINATES. B. A. Blythe and W. W. Wright. April 1957. 20p. diagrs., tabs. RAE Tech. Note Chem. 1306.
(Ask for N-50132*)

The effects of variation of glass cloth, glass-cloth treatment, and initiator for the polymerization reaction on the flexural strength at elevated temperatures of polyester glass-fiber laminates have been studied. The strengths of high- and low-alkali glass-cloth laminates were comparable. The use of treated glass cloths resulted in improved initial strength and strength retention with time; this was especially true of the Garan finish. Variation of the initiator used for the curing reaction, although resulting in a wide variation of the flexural strength values after particular times at temperature, appeared to have little effect on the characteristics of the thermal breakdown. The variations in flexural strength of laminates made using 10 heat-resistant laminating resins were determined with time at elevated temperature. Very good results were obtained with a phenolic resin.

N-50134*

Royal Aircraft Establishment (Gt. Brit.)
THE GEOMETRY OF WING SURFACES GENERATED BY STRAIGHT LINES AND WITH A HIGH RATE OF THICKNESS TAPER AT THE ROOT. D. Peckham. May 1957. 17p. diagrs. RAE Tech. Note Aero 2451. (Ask for N-50134*)

This note describes a way in which wings can be designed to have a high rate of thickness taper at the root, while still maintaining a surface shape generated by straight lines. The method can be most successfully applied to wings of parabolic arc section straight-tapered plan form, in which case there is no change in airfoil section shape across the span. Other plan-form shapes, and wing root airfoil section shapes, result in a variation of airfoil section shape across the span.

N-50143*

Royal Aircraft Establishment (Gt. Brit.)
HOUSINGS FOR STANDARD AIRBORNE ELECTRIC MOTORS. Z. R. S. Ratajski. March 1957. 25p. diagrs. RAE Tech. Note EL. 135.
(Ask for N-50143*)

This Technical Note discusses the present position on the standardization of housings for small d-c and a-c airborne motors and gives details of the modern, clamp-mounted cylindrical housings already used for a number of servo-components and motors. Reference is made to American Standards and proposals, including those of the Society of Automotive Engineers, Inc. (U.S.A.), for commercial airborne motors. It is recommended that the clamp-mounted cylindrical housing should be adopted as standard for the whole range of small airborne d-c and a-c motors.

N-50144*

Royal Aircraft Establishment (Gt. Brit.)
BRIEF LANDING TRIALS USING THE FLUSH LIGHTING PATTERN IN THE RUNWAY AT THE ROYAL NETHERLANDS AIR FORCE STATION AT SOESTERBERG. E. N. Hooton. March 1957. 20p. diagrs. RAE Tech. Note. BL. 45.
(Ask for N-50144*)

At the Royal Netherlands Air Force airfield at Soesterberg a center line and cross bar approach lighting pattern is installed within the runway flush with the runway surface. Brief flight tests have been made using Varsity and Devon aircraft to examine the visual guidance provided by this approach pattern during final flare and landing. Although, in detail, far from ideal for such a purpose, the provision of a pattern within the runway was considered to be a great improvement on runway edge lighting by three of the four pilots who took part in the tests. The results in general confirm ground simulator tests and indicate certain elements essential to any visual guidance system for landing.

BRITISH REPORTS

N-50145*

Royal Aircraft Establishment (Gt. Brit.) FATIGUE LOADINGS IN FLIGHT-LOADS IN THE TAILPLANE OF A COMET I. Anne Burns. March 1957. 19p. diagrs., photo., tabs. RAE Tech.Note Structures 222. (Ask for N-50145*)

Data are presented on the number of load cycles of various magnitudes occurring in the tailplane of a Comet IA during normal ground and flight conditions. The conditions include flight in turbulence, take-off, landing, taxiing, and ground running of the engine. The relative importance of the loads in the different conditions is illustrated by reference to the loads in a typical flight.

MISCELLANEOUS

Errata on NACA Rept. 1295, by Rogallo, Yaggy, and McCloud, III. 1956.

Errata on NACA RM L55L23b, by Hill, Adamson, Foland, and Bressette. March 26, 1957.

Errata on NACA TN 3176, by Baldwin, Jr., Turner, and Knechtel. May 1954.

Errata on NACA TN 3433, by Cunningham. May 1955.

UNPUBLISHED PAPERS

N-55837*

Battelle Memorial Institute. THE EFFECT OF VARIATIONS IN MELTING AND CASTING PROCEDURE ON THE STRUCTURE AND HIGH-TEMPERATURE PROPERTIES OF CAST X-40 ALLOY. E. E. Fletcher, H. J. Hucek, A. R. Elsea, and G. K. Manning. January 16, 1957. (iii), 59p. diagrs., photos., tabs. Battelle Memorial Inst. (Ask for N-55837*)

Melting and pouring atmospheres, such as vacuum, which lowered the nitrogen content of X-40 alloy below some minimum value (approximately 0.05 to 0.07 percent) markedly reduced the high-temperature strength of the alloy. The loss of other elements during melting had a relatively minor effect on the properties. Variations in pouring temperature over the range of 2650° to 2850° F had little effect on the properties. Of the three mold preheat temperatures studied (300°, 1600°, and 1900° F), castings made in 1900° F molds yielded the best and most consistent high-temperature properties. No consistent relationship between microstructure and high-temperature properties was observed; however, there were indications that castings with an intermediate grain size were stronger than those with either extremely coarse or fine grain sizes. The high-temperature bend test was found to be unsuitable as a screening test for stress-rupture properties, but it appeared to be useful for evaluating deformation or creep characteristics.

N-55838*

Battelle Memorial Institute. THE EFFECTS OF VARIATIONS IN NITROGEN AND MANGANESE CONTENT ON THE STRUCTURE AND HIGH-TEMPERATURE PROPERTIES OF CAST X-40 ALLOY. E. E. Fletcher, H. J. Hucek, A. R. Elsea, and G. K. Manning. June 14, 1957. 32p. diagrs., photos., tabs. Battelle Memorial Inst. (Ask for N-55838*)

N-55839*

Polytechnic Institute of Brooklyn. ON SOME EXACT SOLUTIONS OF LAMINAR MIXING IN THE PRESENCE OF AXIAL PRESSURE GRADIENTS. Luigi G. Napolitano. December 1955. 22p. Polytechnic Inst. of Brooklyn. PIBAL Report 302. (Ask for N-55839*)

The well-known power and exponential velocity distributions in the Stewartson plane are shown to still yield similar solutions in the case of compressible mixing provided an additional requirement, concerning the Mach number distributions of the two streams, is satisfied. Analysis of the corresponding incompressible problem shows that no similar solutions are possible except for the simplest case of zero pressure gradient. For the mixing of two uniform streams the ordinary differential equation giving the similar solutions is shown to reduce to the Blasius equation in both the compressible and the incompressible cases. Consequently with this approach the time-consuming iteration process which arises in the previously given methods of analysis is eliminated. The possibility of a rapid investigation of temperature effect on wake characteristics is stressed.

N-55840*

Polytechnic Institute of Brooklyn. EXPERIMENTAL INVESTIGATION OF THE MIXING OF TWO HOMOGENEOUS STREAMS IN CHANNELS OF GIVEN GEOMETRY. Luigi G. Napolitano and Marian Visich, Jr. January 1957. 88p. diagrs., photos. Polytechnic Inst. of Brooklyn. PIBAL Report 321. (Ask for N-55840*)

Four series of tests were performed in a constant area channel, each series being characterized by a value of the Mach number of stream A and a value of the height of stream B at the origin of mixing. $M = 1.6$ and 2.5; the heights of stream B at the origin of mixing were equal to 1 and 2 inches. Two additional series of tests were performed in a variable area channel at $M = 2.5$ for the two previously mentioned heights of stream B. Overall characteristics of mixing process are presented in terms of static pressure distributions along the channel, Mach

UNPUBLISHED PAPERS

number profiles at the discharge end, static pressures at the origin of mixing, and schlieren photographs of relevant flow patterns. Effects of several parameters are discussed and a correlation of some of the experimental data is presented. Applications of the results to some practical problems such as supersonic ejector design and base bleed are outlined.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification November 8, 1957.

#NACA MR L6G12a, by Gilman and Harman
(5321 Army-Navy UPA-11/1)

NACA RM A53K20

INVESTIGATION OF A TRAILING-EDGE PADDLE-CONTROL SURFACE ON A TRIANGULAR WING OF ASPECT RATIO 2 AT SUBSONIC AND SUPERSONIC SPEEDS. Louis H. Ball. February 1954. 18p. diagrs., tab. (NACA RM A53K20)

This report presents the results of an experimental investigation of external airfoils known as paddle-control surfaces as the longitudinal control device on a triangular wing of aspect ratio 2. The lift, drag, pitching moment, and hinge moment were obtained for Mach numbers of 0.60, 0.80, 0.90, 1.20, 1.30, 1.50, 1.70, and 1.90 at a constant Reynolds number of 3.0×10^6, for angles of attack from about -4° to 18° and for paddle-control deflections from approximately 4° to -16°.

NACA RM A54K09

LONGITUDINAL STABILITY CHARACTERISTICS AT MACH NUMBERS UP TO 0.92 OF A WING-BODY-TAIL COMBINATION HAVING A WING WITH 45° OF SWEEPBACK AND A TAIL IN VARIOUS VERTICAL POSITIONS. Jack D. Stephenson, Angelo Bandettini, and Ralph Selan. January 1955. 64p. diagrs., photos., tabs. (NACA RM A54K09)

Data are presented showing lift, drag, and static longitudinal stability characteristics of a wing-body-tail combination having a 45° sweptback wing with an aspect ratio of 5.5. Lowering the horizontal tail to the wing chord plane extended resulted in significant improvements in the stability of the model both with an unmodified wing and with fences or chord extensions on the wing.

NACA RM E9K29

ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF THRUST AUGMENTATION OF AXIAL- AND CENTRIFUGAL-COMPRESSOR TURBOJET ENGINES BY INJECTION OF WATER AND ALCOHOL IN COMBUSTION CHAMBERS. David S. Gabriel, Harry W. Dowman, and William L. Jones. April 13, 1950. 43p. diagrs., photo. (NACA RM E9K29)

Thrust augmentation by injection of water and water-alcohol mixtures into combustion chambers was investigated at sea-level zero-ram conditions on axial- and centrifugal-flow turbojet engines. Thrust augmentation, compressor characteristics, fuel flow, and turbine-outlet-temperature distributions are presented for various injection rates and water-alcohol mixtures. A method of computing thrust augmentation produced by injection into the combustion chambers is presented. Computed augmented-thrust ratios were within 1 percent of the experimental results. Water injection into the centrifugal-flow engine produced little thrust augmentation.

#NACA RM SE50J12, by Cook and Butze

NACA RM E50K22

EXPERIMENTAL INVESTIGATION OF TAIL-PIPE-BURNER DESIGN VARIABLES. W. A. Fleming, E. William Conrad, and A. W. Young. March 5, 1951. 75p. diagrs., photos., tab. (NACA RM E50K22)

The results of several experimental tail-pipe-burner investigations at the NACA Lewis Laboratory are summarized to indicate the effects of tail-pipe-burner design variables on performance and operating characteristics. Most of the configurations were operated over wide ranges of altitudes and flight Mach numbers. The data indicate the effect of changes in principal design variables, such as flame-holder type, burner length, burner diameter, and fuel distribution on performance, and indicate the features of a tail-pipe burner that will operate with high combustion efficiency up to an altitude of approximately 50,000 feet.

NACA RM E51A25

INVESTIGATION OF ALTITUDE IGNITION, ACCELERATION AND STEADY-STATE OPERATION WITH SINGLE COMBUSTOR OF J47 TURBOJET ENGINE. William P. Cook and Helmut F. Butze. March 5, 1951. 35p. diagrs., photo., tab. (NACA RM E51A25)

Satisfactory ignition was obtained with a J47 single combustor up to and including an altitude of 40,000 feet at conditions simulating equilibrium windmilling of the engine at flight speed of 400 miles per hour. At 30,000 feet, excess temperature rise available for combustion was limited by the ability of the combustor to provide temperature rise, whereas at high engine speeds the maximum allowable turbine-inlet temperature became the restricting factor.

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Altitude operational limits increased from about 51,500 feet at 55-percent rated speed to about 64,500 feet at 85-percent rated speed. Combustion efficiencies varied from 39.0 to 92.6 percent.

#NACA RM E51K06, by Prince and Wintler

NACA RM E51K20

ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF INLET-ENGINE MATCHING FOR TURBOJET-POWERED AIRCRAFT AT MACH NUMBERS UP TO 2.0. Carl F. Schueller and Fred T. Esenwein. February 1952. 31p. diagrs., photos. (NACA RM E51K20)

An analysis of inlet-turbojet-engine matching for a range of Mach numbers up to 2.0 indicates large performance penalties when fixed-geometry inlets are used. Use of variable-geometry inlets, however, nearly eliminates these penalties. The analysis was confirmed experimentally by investigating at Mach numbers of 0, 0.63, and 1.5 to 2.0 two single oblique-shock-type inlets of different compression-ramp angles, which simulated a variable-geometry configuration. The experimental investigation indicated that total-pressure recoveries comparable with those attainable with well designed nose inlets were obtained with the side inlets when all the boundary layer ahead of the inlets was removed. Serious drag penalties resulted at a Mach number of 2.0 from the use of blunt-cowl leading edges. However, sharp-lip inlets produced large losses in thrust for the take-off condition. These thrust penalties which are associated with the low-speed operation of the sharp-lip inlet designs can probably be avoided without impairing the supersonic performance of the inlet by the use of auxiliary inlets or blow-in doors.

NACA RM E51K29

LOITERING AND RANGE PERFORMANCE OF TURBOJET-POWERED AIRCRAFT DETERMINED BY OFF-DESIGN ENGINE CYCLE ANALYSIS. Stanley L. Koutz and Reece V. Hensley. February 1952. 45p. diagrs., tab. (NACA RM E51K29)

The loitering and range performance of airplanes equipped with several different turbojet engines was analytically investigated by applying the results of off-design cycle analyses to specific airplane characteristics. The method of off-design cycle analysis is presented herein and is verified by a check with experimental data. For all engines considered, the loitering and the range fuel flows obtained with rated tail-pipe nozzle area, variable engine speed operation were within 2 or 3 percent of the optimum fuel flow obtainable with any method of engine operation. The optimum loitering altitude generally occurred between approximately 25,000 and 35,000 feet with corresponding optimum flight Mach numbers of 0.4 to 0.65. In general, the optimum range fuel flows occurred at 3000 to 5000 feet higher altitude and at approximately 0.15 higher flight Mach numbers than the optimum loitering fuel flow.

NACA RM E52K04

INTERNAL PERFORMANCE OF SEVERAL TYPES OF JET-EXIT CONFIGURATIONS FOR SUPERSONIC TURBOJET AIRCRAFT. William A. Fleming. January 1953. 28p. diagrs. (NACA RM E52K04)

Internal performance characteristics of a convergent nozzle, fixed convergent-divergent nozzles, an adjustable plug-type convergent-divergent nozzle, and jet ejectors were investigated over a wide range of pressure ratios. These data are summarized to provide an overall picture of jet-exit performance and thereby serve as an aid in selecting the most suitable jet-exit configurations for supersonic aircraft.

NACA RM E52K14

FORCE AND PRESSURE RECOVERY CHARACTERISTICS AT SUPERSONIC SPEEDS OF A CONICAL SPIKE INLET WITH BYPASSES DISCHARGING IN AN AXIAL DIRECTION. J. L. Allen and Andrew Beke. January 1953. 27p. diagrs., photos., tab. (NACA RM E52K14)

Force and pressure-recovery characteristics of a nacelle-type conical-spike inlet with two fixed-area bypasses are presented for flight Mach numbers of 1.6, 1.8, and 2.0 and for angles of attack from 0° to 9°. The inlet was designed to attain a mass-flow ratio of unity at a flight Mach number of 2.0. The horizontally opposed bypasses were 6 inlet diameters aft of the inlet entrance. At a flight Mach number of 2.0, the discharge of 23 percent of the critical mass flow of the inlet by means of bypasses (thus retaining critical inlet flow) increased the drag only one-fifth of the additive drag that would result if the same amount of air were spilled behind on inlet normal shock. The total-pressure recovery of the diffuser was not significantly reduced. Similar results were obtained at other flight Mach numbers.

NACA RM E52K17

PERFORMANCE OF DOUBLE-SHROUD EJECTOR CONFIGURATION WITH PRIMARY PRESSURE RATIOS FROM 1.0 TO 10. Donald P. Hollister and William K. Greathouse. February 1953. 34p. diagrs., tabs. (NACA RM E52K17)

A brief investigation was made to determine the performance characteristics of a double-shroud cooling-air ejector configuration. Two convergent primary nozzles were used to simulate a specific manufacturer's iris-type variable-area nozzle in the open and closed positions. The investigation comprised four phases: (1) obtained performance with no secondary or tertiary air flow (cooling-air passages blocked), (2) determining the tendency for backflow to occur in either cooling-air passage, (3) determining the sensitivity of flow in one passage to that in the other, and (4) obtaining pumping and thrust characteristics with secondary and tertiary

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air flow. The experimental results showed that the performance with the cooling-air passages blocked was typical of that for single ejectors having diameter and spacing ratios similar to those used in this investigation. There was a tendency for backflow to occur, but the magnitude of such flow was relatively small. The weight flow of each ejector was shown to be essentially independent of the other, and the closed primary-nozzle configuration was found to be generally capable of pumping more cooling air than the open primary-nozzle configuration. Gains in gross thrust were observed for both configurations, with losses occurring only at low secondary and tertiary pressure ratios.

NACA RM E52K18

INVESTIGATION AT SUPERSONIC SPEEDS OF AN INLET EMPLOYING CONICAL FLOW SEPARATION FROM A PROBE AHEAD OF A BLUNT BODY. Donald P. Hearth and Gerald C. Gorton. January 1953. 32p. diagrs., photos., tab. (NACA RM E52K18)

An experimental investigation was conducted on an inlet employing conical flow separation from a probe extending upstream from a hemispherical-nosed centerbody. Data were obtained at free-stream Mach numbers from 1.6 to 2.0 and angles of attack from 0° to 9°. Pressure-recovery and drag characteristics for the inlet were very nearly comparable with those for a conical-spike inlet at zero angle of attack and design Mach number of 2.0, but compared less favorably at Mach numbers below 2.0. A large reduction in pressure recovery and mass flow was obtained at angle of attack. However, an investigation on the use of probes offset from the inlet center line indicated that the angle-of-attack performance could be appreciably improved if the probe were alined with the stream direction.

NACA RM E52K26

ANALYSIS OF SEVERAL METHODS OF PUMPING COOLING AIR FOR TURBOJET-ENGINE AFTERBURNERS. John C. Samuels and Herbert Yanowitz. February 1953. 54p. diagrs. (NACA RM E52K26)

Several methods of pumping air to an annular cooling passage surrounding a typical axial-flow turbojet-engine afterburner were evaluated and compared on the basis of thrust and specific fuel consumption of the systems. Each system was analyzed over a range of afterburner-wall temperatures, flight Mach numbers, and exhaust-gas temperatures at sea level and 35,000 feet. Ram pressure recovery, boundary-layer pressure recovery, and the engine-jet actuated ejector appear to be satisfactory systems at high Mach numbers. Cooling with compressor-exit air bleed was found to be unsatisfactory, but the use of compressor-exit bleed air as the primary fluid in a high-performance ejector was satisfactory. The use of an auxiliary compressor driven from the engine shaft increased the thrust and decreased the specific fuel consumption of the engine for many of the conditions investigated.

NACA RM E53K03

ANALYSIS OF PERFORMANCE OF FOUR SYMMETRICAL-DIAGRAM-TYPE SUBSONIC INLET-STAGE AXIAL-FLOW COMPRESSORS. Robert J. Jackson. January 1954. 72p. diagrs., photos. (NACA RM E53K03)

The main results of an experimental investigation of four axial-flow single-stage compressors having a hub-tip radius ratio of 0.5 and designed for symmetrical velocity diagrams at all radii were as follows: Because of the action of radial equilibrium, the high-pressure-ratio and low-weight-flow type of design incurred high tip-region blade loadings and, consequently, high losses. Therefore, the most suitable use for the symmetrical-velocity-diagram type of design is for higher specific weight flow and (for a given Mach number limit) lower pressure ratio designs. A diffusion factor correlation was obtained, for a given solidity, among compressor and cascade-predicted deviation angles, and among compressor losses for the range of diffusion factor exceeding approximately 0.5. The available data indicated that the assumption of simplified radial equilibrium was a valid one. In order to predict the radial variation of air velocities, it was necessary to consider the radial variation of entropy, which was especially significant after the stators.

NACA RM E54I27a

PRELIMINARY INVESTIGATION OF THE STRENGTH AND ENDURANCE OF PLASTIC-IMPREGNATED FIBERGLASS COMPRESSOR BLADES. Donald F. Johnson and André J. Meyer, Jr. January 1955. 21p. diagrs., photos. (NACA RM E54I27a)

A complete set of third-stage compressor rotor blades fabricated from laminated fiberglass cloth and bonded with a phenolic resin were operated in a conventional engine for 105 hours. All blades were in perfect condition upon disassembly. Also, a number of laboratory tests were conducted on additional blades to determine moduli of elasticity and rigidity, strength in both tension and bending, internal damping, and the fatigue limit of the blade material.

NACA RM E54K02

PRELIMINARY INVESTIGATION OF A TECHNIQUE OF PRODUCING A HEATED CORE IN A SUPERSONIC WIND-TUNNEL STREAM. Morris D. Rousso and Milton A. Beheim. February 1955. 22p. photos., diagrs. (NACA RM E54K02)

An investigation conducted at Mach numbers 1.9 and 3.0 has shown that a central core of air of high stagnation temperature can be produced in the test section of a supersonic wind tunnel. Air heated by combustion was injected into the tunnel in a streamwise direction near the tunnel throat. The effects of core-nozzle location and dimensions, core to main air stream total-pressure ratio, and core stagnation temperature on the size and shape of temperature contours and on Mach number profiles in the test section were determined.

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NACA RM L8K04a

FLIGHT TESTS AT TRANSONIC AND SUPERSONIC SPEEDS OF AN AIRPLANE-LIKE CONFIGURATION WITH THIN STRAIGHT SHARP-EDGE WINGS AND TAIL SURFACES. Clarence L. Gillis and Jesse L. Mitchell. January 5, 1949. 37p. diagrs., photos., tab. (NACA RM L8K04a)

Rocket-powered models of a configuration having thin, straight, sharp-edge wings and tail surfaces were flight-tested at transonic and low supersonic speeds. Rather large longitudinal trim changes occurred. Decreased longitudinal control effectiveness was evident at supersonic speeds. The static directional stability appears adequate but a snaking oscillation generally existed at supercritical Mach numbers.

NACA RM L8K05

DRAG MEASUREMENTS IN FLIGHT ON THE 10-PERCENT-THICK AND 8-PERCENT-THICK WING X-1 AIRPLANES. John J. Gardner. November 19, 1948. 17p. diagrs., photo. (NACA RM L8K05)

Contains results of drag measurements of X-1 airplanes with 8-percent-thick wing, 6-percent-thick tail and 10-percent-thick wing, 8-percent-thick tail in Mach number range from 0.7 to 1.3. Brief comparison made between airplane and wing section lift-drag ratios.

NACA RM L9D08

ESTIMATED TRANSONIC FLYING QUALITIES OF A TAILLESS AIRPLANE BASED ON A MODEL INVESTIGATION. Charles J. Donlan and Richard E. Kuhn. June 8, 1949. 63p. diagrs., photos., tabs. (NACA RM L9D08)

An analysis of the estimated flying qualities of a tailless airplane with the wing quarter-chord line swept back 35°, an aspect ratio of 3, and taper ratio of 0.6 in the Mach number range from 0.40 to 0.91 has been made. The longitudinal stability and control were investigated and estimates made of the period and damping of the short-period longitudinal and lateral oscillations. Also included are the wind-tunnel test data on which the analysis is based. Data include longitudinal and lateral stability and control-force data, effect of speed brakes, canopies, fins, and wing-alone tests. Tuft studies of flow on wings, fins, and behind speed brakes are included throughout the Mach number range.

NACA RM L9J07a

INVESTIGATION OF THE DYNAMIC LATERAL STABILITY AND CONTROL CHARACTERISTICS OF A MODEL OF A FIGHTER AIRPLANE WITHOUT A HORIZONTAL TAIL AND EQUIPPED WITH EITHER SINGLE OR TWIN VERTICAL TAILS. John W. Draper and Robert W. Rose. November 15, 1949. 20p. diagrs., photos., tab. (NACA RM L9J07a)

An investigation has been conducted in the Langley free-flight tunnel to compare the lateral stability and control characteristics of a model of a fighter airplane without a horizontal tail and equipped either with a single vertical tail mounted on the fuselage or with twin vertical tails of the same tail volume mounted on the wing. The investigation included force and flight tests of the model with both tail configurations.

#NACA RM SL50B23, by Michal

#NACA RM SL50H23a, by Ulmann and Lord

NACA RM L50K03

INVESTIGATION OF THE AERODYNAMIC EFFECTS OF AN EXTERNAL STORE IN COMBINATION WITH 60° DELTA AND LOW-ASPECT-RATIO TAPERED WINGS AT A MACH NUMBER OF 1.9. Ellery B. May, Jr. January 9, 1951. 46p. diagrs., photos. (NACA RM L50K03)

A wind-tunnel investigation was made of an external store of fineness ratio 8.6 which was located on the chord plane of several wings in the Langley 9- by 12-inch supersonic blowdown tunnel. The work was carried out at a Mach number of 1.9 on wings having 60° leading-edge sweepback and unswept trailing edges with taper ratios of 0 and 0.28, and on an unswept wing having a taper ratio of 0.625. Investigation was made to determine the aerodynamic effects of store position, the loading breakdown between the store and the inner and outer wing panel of one wing, and the effects of the store on control characteristics. The test Reynolds numbers ranged between 2.3×10^6 and 4.0×10^6.

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NACA RM L50K16

WING-ON AND WING-OFF LONGITUDINAL CHARACTERISTICS OF AN AIRPLANE CONFIGURATION HAVING A THIN UNSWEPT TAPERED WING OF ASPECT RATIO 3, AS OBTAINED FROM ROCKET-PROPELLED MODELS AT MACH NUMBERS FROM 0.8 TO 1.4. Clarence L. Gillis and A. James Vitale. March 14, 1951. 52p. diagrs., photos., tabs. (NACA RM L50K16)

Flight tests were conducted on three rocket-propelled models of an airplane configuration, two models having thin unswept tapered wings of aspect ratio 3 and hexagonal airfoil sections, and the third having no wing. The two winged models had wings of different stiffness characteristics. Aerodynamic derivatives defining the static and dynamic longitudinal stability, control, trim, and drag characteristics of the configuration were obtained over a Mach number range from 0.8 to 1.4. For some of the aerodynamic derivatives the separate effects of the wing, tail, and fuselage were determined. Some buffeting and maximum lift information was obtained at high subsonic speeds.

NACA RM L51K05

TOTAL-PRESSURE RECOVERY OF A CIRCULAR UNDERSLUNG INLET WITH THREE DIFFERENT NOSE SHAPES AT A MACH NUMBER OF 1.42. Charles F. Merlet and Howard S. Carter. February 1952. 37p. diagrs., photos. (NACA RM L51K05)

Total-pressure recoveries at the inlet and after diffusion and shadowgraphs are presented for a circular underslung inlet located well forward on a body of revolution. Three nose shapes, varying in bluntness, were tested at three angles of attack and one angle of yaw in a free-air jet at a Mach number of 1.42, and over a range of mass-flow ratios from 0.3 to 0.9.

NACA RM L51K06

LONGITUDINAL STABILITY AND DRAG CHARACTERISTICS AT MACH NUMBERS FROM 0.75 TO 1.5 OF AN AIRPLANE CONFIGURATION HAVING A 60° SWEPT WING OF ASPECT RATIO 2.24 AS OBTAINED FROM ROCKET-PROPELLED MODELS. A. James Vitale, John C. McFall, Jr., and John D. Morrow. April 1952. 43p. diagrs., photos., tabs. (NACA RM L51K06)

Flight tests were conducted on a rocket-propelled airplane configuration model and on a drag model, each having a 60° swept wing of aspect ratio 2.24 with different fuselages. The longitudinal stability, control, and drag characteristics of the airplane configuration were determined over a Mach number range of 0.75 to 1.50. Wing-plus-interference minimum drag was obtained from the drag model over a Mach number range of 0.90 to 1.50. For some of the aerodynamic derivatives the separate effects of the wing, tail, and fuselage were obtained.

NACA RM L51K20

SUMMARY OF SOME EFFECTIVE AERODYNAMIC TWISTING-MOMENT COEFFICIENTS OF VARIOUS WING-CONTROL CONFIGURATIONS AT MACH NUMBERS FROM 0.6 TO 1.7 AS DETERMINED FROM ROCKET-POWERED MODELS. H. Kurt Strass. January 1952. 22p. diagrs., photo., 2 tabs. (NACA RM L51K20)

This paper presents a summary of some effective aerodynamic twisting-moment coefficients of various wing-control configurations at Mach numbers from 0.6 to 1.7 as determined by the use of rocket propelled test vehicles which indicated that, within the framework of the necessary assumptions, the value of the effective twisting-moment coefficient decreased as the sweepback of the aileron hinge axis is increased. Large changes in the value of the effective twisting-moment coefficient were obtained in the Mach number region from $M \approx 0.8$ to $M \approx 1.2$ with changes in aileron span and location upon the same wing plan form. Above $M \approx 1.2$, the values tended to agree more closely. This factor limits the use of these data to wing-control configurations similar to those tested. Comparative tests of an outboard 0.3-span, 0.25-chord aileron, and a midspan spoiler of approximately the same span length indicate that the twisting moment of the spoiler is about one-third that of the aileron for equal values of rolling effectiveness.

NACA RM L52K17

INVESTIGATION AT TRANSONIC SPEEDS OF A FORWARD-LOCATED UNDERSLUNG AIR INLET ON A BODY OF REVOLUTION. P. Kenneth Pierpont and John A. Braden. January 1953. 109p. diagrs., photos., tabs. (NACA RM L52K17)

Results are given for an experimental investigation of a forward-located underslung scoop mounted on a basic body at Mach numbers from 0.6 to 1.1 and for angles of attack from 0° to 10°. The inlet area was 17.3 percent of the body frontal area. For mass-flow ratios from 0.3 to within 5 percent of the maximum, total pressure recovery in the diffuser in excess of 97 percent was realized at all Mach numbers and angles of attack. External drag of the scoop model at high mass-flow condition was approximately equal to that of the basic body.

NACA RM L52K20a

EFFECTS OF SIZE OF EXTERNAL STORES ON THE AERODYNAMIC CHARACTERISTICS OF AN UNSWEPT AND A 45° SWEPTBACK WING OF ASPECT RATIO 4 AND A 60° DELTA WING AT MACH NUMBERS OF 1.41, 1.62, AND 1.96. Carl R. Jacobsen. January 1953. 55p. diagrs., photos., tab. (NACA RM L52K20a)

An investigation has been made in the Langley 9- by 12-inch supersonic blowdown tunnel to determine the effects of external stores of various sizes on the lift, drag, and pitching-moment characteristics of three wings; an unswept and a 45° sweptback wing having aspect ratios of 4 and taper ratios of 0.6, and a 60° delta wing at Mach numbers of 1.41, 1.62, and 1.96.

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The size of a Douglas Aircraft Company, Inc., store having a fineness ratio of 8.58 was systematically varied at the 80-percent-semispan station of the unswept and sweptback wing and at the 60-percent-semispan station of the delta wing. Several stores were also tested at various other store locations on the outer 60 percent of each of the wing semispans. For wing areas of 500, 600, and 750 square feet for an unswept, a sweptback, and a delta wing, respectively, the store sizes covered in the investigation provide data for stores ranging in size from a 200-pound bomb to a large jet engine nacelle.

NACA RM L52K21

EFFECT OF LEADING-EDGE CHORD-EXTENSIONS ON SUBSONIC AND TRANSONIC AERODYNAMIC CHARACTERISTICS OF THREE MODELS HAVING 45° SWEPTBACK WINGS OF ASPECT RATIO 4. Kenneth W. Goodson and Albert G. Few, Jr. January 1953. 31p. diagrs., photos., tab. (NACA RM L52K21)

This paper presents the effects of wing leading-edge chord-extensions on the subsonic and transonic high-lift pitching moment and the performance characteristics of three models having wings of 45° sweepback, aspect ratio 4, taper ratio 0.30, and NACA 65A006 airfoil sections parallel to the free stream. The test Reynolds numbers varied from about 0.6×10^6 to 3.25×10^6, depending upon the wing and Mach number. Some tests were made with a full-chord fence installed.

NACA RM L52K28

HINGE-MOMENT CHARACTERISTICS FOR SEVERAL TIP CONTROLS ON A 60° SWEPTBACK DELTA WING AT MACH NUMBER 1.61. K. R. Czarnecki and Douglas R. Lord. January 1953. 31p. diagrs., photos. (NACA RM L52K28)

An investigation has been made at a Mach number of 1.61 and a Reynolds number of 4.2×10^6 to determine the hinge-moment characteristics of a group of tip controls on a 60° sweptback delta wing. The control configurations varied in plan form and in amount of aerodynamic balance. Tests were made over an angle-of-attack range of 0° to 15° and a flap deflection range of -30° to 30°. A comparison of the experimental results with theory is included.

#NACA RM SL53H11, by Falanga

NACA RM L53K03

EFFECT OF LARGE DEFLECTIONS OF A CANARD CONTROL AND DEFLECTIONS OF A WING-TIP CONTROL ON THE STATIC-STABILITY AND INDUCED-ROLL CHARACTERISTICS OF A CRUCIFORM CANARD MISSILE AT A MACH NUMBER OF 2.01. M. Leroy Spearman. December 1953. 20p. diagrs., tabs. (NACA RM L53K03)

An investigation has been conducted in the Langley 4- by 4-foot supersonic pressure tunnel at a Mach number of 2.01 to determine the effect of large deflections of a canard and deflections of a wing-tip control on the static stability and induced-roll characteristics of a cruciform-wing canard-type missile. The missile had a body fineness ratio of 15.7. The tests covered an angle-of-attack range from 0° up to about 27°, a canard deflection range up to 30°, and a wing-tip control deflection up to 20°

NACA RM L53K11

EFFECTS OF A SERIES OF INBOARD PLAN-FORM MODIFICATIONS ON THE LONGITUDINAL CHARACTERISTICS OF TWO UNSWEPT WINGS OF ASPECT RATIO 3.5, TAPER RATIO 0.2, AND DIFFERENT THICKNESS DISTRIBUTIONS AT MACH NUMBERS OF 1.61 AND 2.01. John R. Sevier, Jr. February 1954. 43p. diagrs., photos. (NACA RM L53K11)

Tests of a series of inboard plan-form modifications of two unswept wings of aspect ratio 3.5 and taper ratio 0.2 were made at the Langley 4- by 4-foot supersonic pressure tunnel at Mach numbers of 1.61 and 2.01. Results indicated that, by properly modifying the wing thickness and plan form, significant increases in wing volume can be attained with little or no penalties in drag and actual increases in maximum lift-drag ratio.

NACA RM L53K27

WIND-TUNNEL INVESTIGATIONS AT LOW AND TRANSONIC SPEEDS OF THE FEASIBILITY OF SELF-ACTUATING SPOILERS AS A LATERAL-CONTROL DEVICE FOR A MISSILE. Harleth G. Wiley and William C. Hayes, Jr. January 1954. 24p. diagrs., tab. (NACA RM L53K27)

Results are presented of wind-tunnel investigations of the lateral-control effectiveness of self-actuating spoilers on a thin 60° delta wing up to an angle of attack of about 20° at low speeds and of the aerodynamic moments acting on an isolated self-actuating spoiler through an angle-of-rotation range of 180° at transonic speeds. Presented also are the results of brief tests of spoiler actuating times at low speeds.

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NACA RM L54K02

A LIMITED FLIGHT INVESTIGATION OF THE EFFECT OF DYNAMIC VIBRATION ABSORBERS ON THE RESPONSE OF AN AIRPLANE STRUCTURE DURING BUFFETING. Jim Rogers Thompson and John E. Yeates, Jr. January 1955. 29p. diagrs., photos. (NACA RM L54K02)

Limited flight measurements have been made in the high-speed low-lift buffet region of the effect on the buffeting response of dynamic vibration absorbers mounted on the wing tips. The absorbers had 70-pound-moving weights and greatly reduced the response in the tuned mode. Approximate calculations indicated that significant reductions could be produced by an installation weighing considerably less than that tested. The device shows promise both as a buffet alleviator and as a research instrument.

NACA RM L54K11a

EXPERIMENTAL AERODYNAMIC FORCES AND MOMENTS AT LOW SPEED OF A MISSILE MODEL DURING SIMULATED LAUNCHING FROM THE MIDSEMISPAN LOCATION OF A 45° SWEPTBACK WING-FUSELAGE COMBINATION. William J. Alford, Jr., H. Norman Silvers, and Thomas J. King, Jr. February 1955. 36p. diagrs., photo., tabs. (NACA RM L54K11a)

An investigation was made at low speed in the Langley 300-mph 7- by 10-foot tunnel to determine the aerodynamic forces and moments of a missile model during simulated launching from the mid-semispan location of a 45° sweptback wing-fuselage combination. Various chordwise and vertical locations were investigated with and without a flat-sided pylon installed. The angle-of-attack range generally extended from -8° to 28°.

NACA RM L54K12

TRANSONIC LONGITUDINAL AERODYNAMIC EFFECTS OF SWEEPING UP THE REAR OF THE FUSELAGE OF A ROCKET-PROPELLED AIRPLANE MODEL HAVING NO HORIZONTAL TAIL. James H. Parks. January 1955. 30p. diagrs., photo. (NACA RM L54K12)

The transonic longitudinal aerodynamic effects of sweeping up the rear of the fuselage have been investigated in free flight by using rocket-propelled models having no horizontal tails. The models had aspect-ratio-4 wings with both the wings and vertical tails swept back 45°. Static and dynamic longitudinal stability parameters, trim conditions, drag at trim lift, and local downflow values are presented.

NACA RM L54K15a

A THEORETICAL INVESTIGATION OF THE EFFECT OF AUXILIARY DAMPING ON THE LONGITUDINAL RESPONSE OF A TRANSONIC BOMBER CONFIGURATION IN FLIGHT THROUGH CONTINUOUS TURBULENCE. T. F. Bridgland, Jr. March 1955. 26p. diagrs., tab. (NACA RM L54K15a)

A theoretical investigation has been made of the effects of auxiliary pitch-rate damping on the longitudinal response of a transonic bomber configuration in low-altitude flight through continuous rough air. The methods of generalized harmonic analysis are utilized in obtaining the statistical character of the airframe responses to a random gust velocity input. The results of this investigation indicate that, for the airframe and speed range considered, reductions in root-mean-square normal acceleration of about 24 percent and reductions in root-mean-square pitch angle of about 74 percent are possible through the use of auxiliary pitch-rate damping.

NACA RM L54K30

FREE-FLIGHT INVESTIGATION, INCLUDING SOME EFFECTS OF WING AEROELASTICITY, OF THE ROLLING EFFECTIVENESS OF AN ALL-MOVABLE HORIZONTAL TAIL WITH DIFFERENTIAL INCIDENCE AT MACH NUMBERS FROM 0.6 TO 1.5. Roland D. English. January 1955. 11p. diagrs., photo. (NACA RM L54K30)

A free-flight investigation has been made to determine the rolling effectiveness at zero angle of attack of an all-movable horizontal tail at a constant angle of differential incidence of 7° per fin mounted behind a notched delta wing over a Mach number range from 0.6 to 1.5. Two models were tested, one with a stiff wing and one with a flexible wing. The rolling effectiveness of both models was of about the same magnitude at subsonic and supersonic speeds. The rolling effectiveness of the flexible-wing model was about 1.6 times that of the stiff-wing model except in the transonic region.

NACA RM L55A24

FLIGHT AND PREFLIGHT TESTS OF A RAM JET BURNING MAGNESIUM SLURRY FUEL AND UTILIZING A SOLID-PROPELLANT GAS GENERATOR FOR FUEL EXPULSION. Walter A. Bartlett, Jr., and William K. Hagginbothom, Jr. April 1955. 35p. diagrs., photos. (NACA RM L55A24)

Data obtained from the first flight test of a ram jet utilizing a magnesium slurry fuel are presented. The ram jet accelerated from a Mach number of 1.75 to a Mach number of 3.48 in 15.5 seconds. During this period a maximum acceleration of 4.6g was obtained. Maximum values of air specific impulse and gross thrust coefficient were calculated to be 151 seconds and 0.658, respectively. The rocket gas generator used as a fuel-pumping system operated successfully.

*AVAILABLE ON LOAN ONLY.

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NACA RM L55K09

WIND-TUNNEL INVESTIGATION AT TRANSONIC SPEEDS OF A JET CONTROL ON A 35° SWEPT WING. TRANSONIC-BUMP METHOD. Raymond D. Vogler and Thomas R. Turner. February 1956. 17p. diagrs. (NACA RM L55K09)

Results are presented of a wind-tunnel investigation at transonic speeds and at angles of attack of -4° to 16° to determine the characteristics of a jet control on a 35° swept-semispan wing. The control consisted of numerous holes normal to the wing surface located on the 65-percent chord line and extending in a spanwise direction from 0.133 to 0.70 of the semispan. Force and moment data were obtained by using ejected air with pressure ratios as high as 9.7 to 1 between the total pressure in the jets and free-stream static pressure.

NACA RM L55K11

EXPERIMENTAL INVESTIGATION AT HIGH SUBSONIC SPEED OF THE ROLLING STABILITY DERIVATIVES OF A COMPLETE MODEL HAVING A CLIPPED-DELTA WING AND A HIGH HORIZONTAL TAIL. William C. Sleeman, Jr., and Albert G. Few, Jr. February 1956. 32p. diagrs., tab. (NACA RM L55K11)

Rolling-stability derivatives are presented for a complete model having an aspect-ratio-3 clipped-delta wing and a high horizontal tail for a Mach number range of 0.60 to 0.92 and for an angle-of-attack range from 0° to a maximum of 13° for the lower Mach numbers. The wing and delta plan-form horizontal tail were swept back 45° at the leading edge and had NACA 65A006 airfoil sections. Breakdown tests were made to determine contributions of the various component parts to the rolling-stability derivatives.

NACA RM L56C06

PREFLIGHT AND FLIGHT-TEST INVESTIGATION OF A 50-PERCENT-MAGNESIUM 50-PERCENT JP-4 SLURRY FUEL IN A TWIN-ENGINE RAM-JET VEHICLE. Otto F. Trout, Jr., and Thomas L. Kennedy. May 1956. 27p. diagrs., photos. (NACA RM L56C06)

Performance data obtained from the preflight and flight tests of a 50-percent-magnesium 50-percent JP-4 slurry fuel are presented. Using this fuel, the ram-jet vehicle accelerated from a Mach number of 2.23 to 2.56 while climbing from an altitude of 3,320 to 37,940 feet. Data are presented for the values of air specific impulse and gross thrust coefficients over the range of altitudes tested.

NACA RM L56I24a

FLIGHT INVESTIGATION OF A RAM JET BURNING MAGNESIUM SLURRY FUEL AND HAVING A CONICAL SHOCK INLET DESIGNED FOR A MACH NUMBER OF 4.1. Walter A. Bartlett, Jr., and Charles F. Merlet. January 1957. 23p. diagrs., photos. (NACA RM L56I24a)

A ram-jet vehicle having a conical shock inlet diffuser designed for a Mach number of 4.1 and utilizing a magnesium slurry fuel was tested in free flight. Data are presented which show that the vehicle accelerated from a Mach number of 1.73 to a maximum Mach number of 3.84 in 13.2 seconds. During this period a maximum acceleration of 6.1g was measured. Maximum values of air specific impulse of 150 seconds and gross thrust coefficient of 0.76 were calculated.

National Advisory Committee for Aeronautics

Research Abstracts and Reclassification Notice

REC'D JAN 10 1958

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1305

MEASUREMENT OF AERODYNAMIC FORCES FOR VARIOUS MEAN ANGLES OF ATTACK ON AN AIRFOIL OSCILLATING IN PITCH AND ON TWO FINITE-SPAN WINGS OSCILLATING IN BENDING WITH EMPHASIS ON DAMPING IN THE STALL. A. Gerald Rainey. 1957. iii, 33p. diagrs., photos., (NACA Rept. 1305. Supersedes TN 3643)

The oscillating air forces on a two-dimensional wing oscillating in pitch about the midchord have been measured at various angles of attack and at Mach numbers of 0.35 and 0.7. Large regions of unstable damping in pitch were found. Measurements of the aerodynamic damping of a 10-percent-thick and a 3-percent-thick finite-span wing oscillating in, essentially, the first bending mode indicate no regions of unstable damping for this type of motion over the range of variables covered.

NACA RM A57I09

EFFECTS OF STING-SUPPORT INTERFERENCE ON THE DRAG OF AN OGIVE-CYLINDER BODY WITH AND WITHOUT A BOATTAIL AT 0.6 TO 1.4 MACH NUMBER. George Lee and James L. Summers. December 1957. 28p. diagrs., photos. (NACA RM A57I09)

Various sting-support configurations were tested on two bodies of revolution to determine the interference effects on the foredrag and base drag. The tests were made at a Reynolds number of 8×10^6 based on model length and over a Mach number range of 0.6 to 1.4.

NACA TM 1417

ON THE SPECTRUM OF NATURAL OSCILLATIONS OF TWO-DIMENSIONAL LAMINAR FLOWS. (Über das Spektrum bei Eigenschwingungen ebener Laminarströmungen.) D. Grohne. December 1957. 34p. diagrs. (NACA TM 1417. Translation from Zeitschrift für angewandte Mathematik und Mechanik, v. 34, no. 8-9, August-September 1954, p. 344-357)

If the stability of a laminar flow is investigated by the method of small oscillations, a complicated eigenvalue problem is encountered. Heretofore, attention has been directed toward the isolation of those normal modes of oscillation which are either neutrally stable or which grow in time. The present paper deals with the entire spectrum of characteristic values and the form taken by the associated oscillations.

NACA TN 4017

MOMENTUM TRANSFER FOR FLOW OVER A FLAT PLATE WITH BLOWING. H. S. Mickley and R. S. Davis, Massachusetts Institute of Technology. November 1957. 64p. diagrs., tabs. (NACA TN 4017)

The effect on the boundary layer of blowing air through a porous flat plate into a main airstream flowing parallel to the plate was studied experimentally. Measurements were made of velocity profiles and wall friction coefficients. Mainstream velocities ranging from 17 to 60 feet per second were used, the main-stream Euler number was zero, and a length Reynolds number variation of 4×10^4 to 3×10^6 was investigated.

NACA TN 4029

TURBULENCE MEASUREMENTS IN MULTIPLE INTERFERING AIR JETS. James C. Laurence and Jean M. Benninghoff. December 1957. 37p. diagrs., photos. (NACA TN 4029)

Turbulent and mean-flow characteristics of several noise-suppression multiple-jet nozzles have been determined from hot-wire-anemometer measurements for flow conditions of Mach number 0.3 and Reynolds number of 2.06×10^6 per foot. Turbulent mixing, as indicated by reduced intensity and scale of the turbulence, occurs closer to the nozzle in interfering than in noninterfering jets. The turbulence spectra show that the multiple jets redistribute energy. The more rapid mixing of the interfering jets and shifting of the spectral energy of the interfering jets may explain, in part, the suppression of noise by these nozzles.

NACA TN 4081

EFFECT OF OVERHEATING ON CREEP-RUPTURE PROPERTIES OF S-816 ALLOY AT 1,500° F. John P. Rowe and J. W. Freeman, University of Michigan. December 1957. 75p. diagrs., photos., tabs. (NACA TN 4081)

The effects of overheats to temperatures of 1650°, 1800°, 1900°, and 2000° F were evaluated in terms of the changes in creep-rupture characteristics at 1500° F of S-816 alloy under stresses within the range of rupture strengths of the alloy for 100 to 1000 hours. Overheat periods were predominantly

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of 2-minute duration and were applied cyclically at approximately 5- or 12-hour intervals. The possible damage from overheating was believed to include internal metal structure changes induced by exposure to the higher temperatures and loss of life by creep if stress was present during the overheats.

NACA TN 4082

ABNORMAL GRAIN GROWTH IN NICKEL-BASE HEAT-RESISTANT ALLOYS. R. F. Decker, A. I. Rush, A. G. Dano, and J. W. Freeman, University of Michigan. December 1957. 70p. diagrs., photos., tabs. (NACA TN 4082)

Controlled laboratory experiments were carried out on samples of bar stock of air- and vacuum-melted Waspaloy, Inconel X-550, and Nimonic 80A alloys to find conditions of heating and hot-working which resulted in abnormal grain growth. These experiments were mainly limited to normal conditions of heating for hot-working and for heat treatment. All the results indicate that small reductions of essentially strain-free material were the basic cause of abnormal grain growth.

NACA TN 4083

EFFECT OF OVERHEATING ON CREEP-RUPTURE PROPERTIES OF HS-31 ALLOY AT 1,500° F. John P. Rowe and J. W. Freeman, University of Michigan. December 1957. 78p. diagrs., photos., tabs. (NACA TN 4083)

The effects of overheating to temperatures of 1,650°, 1,800°, 1,900°, and 2,000° F were evaluated in terms of the changes in creep-rupture characteristics at 1,500° F of HS-31 alloy under stresses within the range of rupture strengths of the alloy for about 100 to 700 hours. Overheat periods were predominantly of 2-minute duration and were applied cyclically at approximately 5- or 12-hour intervals. The possible damage from overheating was believed to include internal metal structure changes induced by exposure to the higher temperatures and loss of life by creep if stress was present during the overheats.

NACA TN 4084

ABNORMAL GRAIN GROWTH IN M-252 AND S-816 ALLOYS. R. F. Decker, A. I. Rush, A. G. Dano, and J. W. Freeman, University of Michigan. November 1957. 61p. diagrs., photos., tabs. (NACA TN 4084)

An experimental investigation was carried out on air- and vacuum-melted M-252 and S-816 alloys to find conditions of heating and hot-working which resulted in abnormal grain growth. The experiments were mainly limited to normal conditions of heating for hot-working and heat treatment and normal temperatures of solution treatment were used to allow grain growth after susceptibility to abnormal grain growth was developed by various experimental conditions. Results indicated that small reductions of essentially strain-free metal were the basic cause of such grain growth.

NACA TN 4092

EXPERIMENTAL DROPLET IMPINGEMENT ON FOUR BODIES OF REVOLUTION. James P. Lewis and Robert S. Ruggeri. December 1957. 61p. diagrs., photos. (NACA TN 4092)

The rate and area of cloud droplet impingement on four bodies of revolution were obtained experimentally in the NACA Lewis icing tunnel. Spheres, ellipsoidal forebodies of fineness ratios of 2.5 and 3.0, and a conical forebody of 30° included angle were studied at angles of attack of 0° to 6°, rotational speeds up to 1200 rpm, and an airspeed of 157 knots. The results are presented in the form of dimensionless impingement parameters in order to cover a wide range of flight and atmospheric conditions.

NACA TN 4102

VELOCITY AND FRICTION CHARACTERISTICS OF LAMINAR VISCOUS BOUNDARY-LAYER AND CHANNEL FLOW OVER SURFACES WITH EJECTION OR SUCTION. E. R. G. Eckert, Patrick L. Donoughe and Betty Jo Moore. December 1957. 57p. diagrs., tabs. (NACA TN 4102)

Dimensionless flow parameters common to both channel and boundary-layer flow were developed in order to determine the extent to which the boundary conditions imposed on the flow by the various geometries influence the flow characteristics. By using these parameters to compare the various flows, the flow on surfaces with fluid ejection and on solid surfaces was found to depend mainly on the local boundary-layer thickness, on the pressure gradient in main-flow direction, and on the rates of ejection. This information forms the basis for general correlations, shows the conditions under which channel and boundary-layer data are interchangeable, and should be useful for calculations by integral methods.

NACA TN 4111

INVESTIGATION OF THE COMPRESSIVE STRENGTH AND CREEP OF 7075-T6 ALUMINUM-ALLOY PLATES AT ELEVATED TEMPERATURES. William D. Deveikis. November 1957. 28p. diagrs., photos., tabs. (NACA TN 4111)

Elevated-temperature compressive-strength test results from room temperature to 600° F and creep test results from 350° F to 500° F are presented for V-groove edge-supported plates of 7075-T6 aluminum alloy. The test results are analyzed to verify procedures for estimating maximum strength from material stress-strain curves and creep-failure stresses from isochronous stress-strain curves. The strength and creep results are also compared with similar results for 2024-T3 aluminum-alloy plates.

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NACA TN 4125

HEAT TRANSFER AND RECOVERY TEMPERATURES ON A SPHERE WITH LAMINAR, TRANSITIONAL, AND TURBULENT BOUNDARY LAYERS AT MACH NUMBERS OF 2.00 AND 4.15. Ivan E. Beckwith and James J. Gallagher. December 1957. 59p. diagrs., photos. (NACA TN 4125)

An investigation was made of the pressure, equilibrium temperatures, and aerodynamic heat transfer on a sphere and on the nose of a hemisphere cylinder. The heat-transfer coefficients and recovery temperatures from the stagnation point to transition showed good agreement with theories for the laminar boundary layer. Transition occurred at an angular distance from the stagnation point of 10° to 30° at Mach number 2.00 and from 30° to 90° at Mach number 4.15. The heat-transfer coefficients and recovery temperatures in the turbulent boundary layer were in reasonable agreement with simple theories for turbulent flow.

NACA TN 4128

A THERMOCOUPLE SUBCARRIER OSCILLATOR FOR TELEMETERING TEMPERATURES FROM PILOTLESS AIRCRAFT. Clifford L. Fricke. December 1957. 50p. diagrs., photos., tabs. (NACA TN 4128)

An oscillator is described which, in conjunction with the NACA telemetering system, gives a satisfactory method for telemetering temperatures. The design uses a diode-bridge modulator in a phase-shift oscillator; the thermocouple voltage is changed to alternating current and used to shift the phase and hence to change the frequency of oscillation. This method results in an oscillator having a small size, low microphonics, high input resistance, and satisfactory stability if a switch is used to commutate calibration voltages along with the pickups.

NACA TN 4131

TRANSITION-FLIGHT INVESTIGATION OF A FOUR-ENGINE-TRANSPORT VERTICAL-TAKE-OFF AIRPLANE MODEL UTILIZING A LARGE FLAP AND EXTENSIBLE VANES FOR REDIRECTING THE PROPELLER SLIPSTREAM. Louis P. Tosti. December 1957. 35p. diagrs., photos., tab., film suppl. available on request. (NACA TN 4131)

An investigation of the stability and control of a four-engine vertical-take-off transport airplane during the transition from hovering to normal forward flight has been conducted with a remotely controlled free-flight model. The model had a 65-percent-chord flap which was deflected 85° in hovering flight, eight extensible vanes arranged above the wing in a cascade relation, and four propellers located along the wing with the thrust axes essentially parallel to the fuselage axis. It was found that the model could be flown through the transition range satisfactorily except for some difficulty with a yawing divergence at low speeds.

NACA TN 4138

CREEP DEFORMATION PATTERNS OF JOINTS UNDER BEARING AND TENSILE LOADS. E. G. Bodine, R. L. Carlson, and G. K. Manning, Battelle Memorial Institute. December 1957. 36p. diagrs., tabs. (NACA TN 4138)

The interaction of bearing and tensile loads on the creep behavior of joints was studied. A specimen was designed for this study which possessed some of the general features of pin and rivet joint connections and an apparatus was constructed to apply both bearing and tensile loads to the joint model. Deformation measurements were made by use of a photogrid printed on the joint model.

NACA TN 4141

THE USEFUL HEAT CAPACITY OF SEVERAL MATERIALS FOR BALLISTIC NOSE-CONE CONSTRUCTION. Jackson R. Stalder. November 1957. 19p. diagrs. (NACA TN 4141)

An analysis has been made of the heat-absorption characteristics of copper, Inconel-X, graphite, and beryllium. It was found that significant weight saving could be achieved in a ballistic missile heat sink by the use of graphite or beryllium in place of copper. Inconel-X was found to be unsatisfactory because of its low thermal conductivity. It is indicated that large errors in computed temperature distributions in materials can arise if the variation of thermal properties with temperature is not taken into account.

NACA TN 4142

EFFECTS OF LEADING-EDGE BLUNTING ON THE LOCAL HEAT TRANSFER AND PRESSURE DISTRIBUTIONS OVER FLAT PLATES IN SUPERSONIC FLOW. Marcus O. Creager. December 1957. 54p. diagrs., tabs. (NACA TN 4142)

Surface pressures and heat-transfer rates were measured on flat plates with various values of blunting for a Mach number of 4 and Reynolds numbers per inch of 2380 and 6600. Surface pressures were correlated for a wide range of variables by a linear combination of terms obtained from shock-wave boundary-layer interaction theory and blast wave theory. A method was developed to correlate local Reynolds numbers from the present data with data from other sources covering a wide range of test conditions.

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NACA TN 4152

LAMINAR BOUNDARY LAYER WITH HEAT TRANSFER ON A CONE AT ANGLE OF ATTACK IN A SUPERSONIC STREAM. Eli Reshotko. December 1957. (i), 64p. diagrs., tabs. (NACA TN 4152)

The equations of the compressible laminar boundary layer for the windward streamline in the plane of symmetry of a cone at angle of attack are presented and solved. The heat-transfer rate to this streamline increases significantly with angle of attack. For a surface temperature of absolute zero, the increase is somewhat less than for an insulated surface.

NACA TN 4154

APPROXIMATE CALCULATION OF THE COMPRESSIBLE TURBULENT BOUNDARY LAYER WITH HEAT TRANSFER AND ARBITRARY PRESSURE GRADIENT. Eli Reshotko and Maurice Tucker. December 1957. 34p. diagrs. (NACA TN 4154)

An approximate method for the calculation of compressible turbulent boundary layer with heat transfer and arbitrary pressure gradient is presented. The method involves the momentum integral and moment-of-momentum equations as simplified by using Stewartson's transformation. The Ludwieg-Tillmann skin-friction relation is used in these equations in a form suitable for compressible flow with heat transfer through application of the reference enthalpy concept. A tentative extension of Reynolds analogy is suggested for estimating heat-transfer effects for isothermal surfaces.

NACA TN 4166

AN EXPERIMENTAL AND THEORETICAL STUDY OF THE EFFECT OF FUEL ON PITCHING-TRANSLATION FLUTTER. John L. Sewall. December 1957. 42p. diagrs., tabs. (NACA TN 4166)

Analytical flutter studies were made for 2 two-dimensional fuel-loaded wing models, and the results are compared with experimental results for bending-to-torsion frequency ratios near 1. One of the models was made so that water, simulating fuel, could be carried internally in three compartments separated by sealed spanwise partitions. The flutter speeds of this model for all fuel loads were highest for the compartmental-emptying sequence from front to rear. In the other model, fluid was carried externally in a pylon-mounted fuel tank without baffles. Good agreement between theory and experiment was obtained for both models.

NACA TN 4170

A REEXAMINATION OF THE USE OF SIMPLE CONCEPTS FOR PREDICTING THE SHAPE AND LOCATION OF DETACHED SHOCK WAVES. Eugene S. Love. December 1957. 53p. diagrs. (NACA TN 4170)

A reexamination has been made of the use of simple concepts for predicting the shape and location of detached shock waves. The results show that simple concepts and modifications of existing methods can yield good predictions for many nose shapes and for a wide range of Mach numbers.

NACA TN 4173

AN ANALYTICAL INVESTIGATION OF THE GUST-ALLEVIATING PROPERTIES OF A SIMPLE PITCH DAMPER. Norman L. Crabill. December 1957. 47p. diagrs., tab. (NACA TN 4173)

The response to atmospheric gusts of a lightly damped airplane model flying at a Mach number of 0.7 at sea level has been studied analytically for a fixed elevator and for varying amounts of viscous restraint of a mass-overbalanced elevator. The results indicate that, in a sharp-edge gust, the damping of the airframe mode subsequent to the first peak in the normal-acceleration response can be more than trebled, and, in continuous gusts, a 20-percent reduction in root-mean-square normal acceleration at the center of gravity can be attained over a broad range of elevator viscous restraint.

NACA TN 4181

INVESTIGATION OF THE EFFECTS OF PROPELLER DIAMETER ON THE ABILITY OF A FLAPPED WING, WITH AND WITHOUT BOUNDARY-LAYER CONTROL, TO DEFLECT A PROPELLER SLIPSTREAM DOWNWARD FOR VERTICAL TAKE-OFF. Kenneth P. Spreemann. December 1957. 47p. diagrs., photos. (NACA TN 4181)

Without boundary-layer control an increase in the ratio of flap chord to propeller diameter increased the turning angle but decreased the ratio of resultant force to thrust either in or out of the region of ground effects. The increment of turning angle and the increment of the ratio of resultant force to thrust due to boundary-layer control were, in general, independent of the ratio of flap chord to propeller diameter. The ratios of flap chord to propeller diameter investigated appeared to be too low to provide the turning angles normally required for vertical take-off without boundary-layer control.

CURRENT NACA RESEARCH REPORTS

NACA TN 4184

MEASUREMENT OF STATIC PRESSURE ON AIRCRAFT. William Gracey. November 1957. ii, 71p. diagrs. (NACA TN 4184)

Existing data on the measurement of static pressure by means of static-pressure tubes and fuselage vents at subsonic, transonic, and supersonic speeds are presented. Static-pressure errors are given for isolated tubes and vents and for installations ahead of the fuselage nose, wing tip, and vertical tail fin, and on the fuselage. Various methods of calibrating installations in flight are briefly discussed.

NACA TN 4191

ANALYSIS OF HORIZONTAL-TAIL LOADS IN PITCHING MANEUVERS ON A FLEXIBLE SWEPT-WING JET BOMBER. William S. Aiken, Jr. December 1957. 58p. diagrs., photo., tabs. (NACA TN 4191)

Horizontal-tail loads measured by means of strain gages in pitching maneuvers are analyzed to determine wing-fuselage aerodynamic-center position, zero-lift pitching-moment coefficients, airplane pitching moment of inertia, and radius of gyration. The flight-determined values of aerodynamic-center position for rigid conditions and the zero-lift pitching-moment coefficients were in some disagreement with the wind-tunnel data for the Mach number range of the tests (0.42 to 0.81). The pitching moment of inertia determined from the flight data for rigid-wing conditions agreed with calculations based on ground tests.

NACA TN 4192

THREE-DEGREE-OF-FREEDOM EVALUATION OF THE LONGITUDINAL TRANSFER FUNCTIONS OF A SUPERSONIC CANARD MISSILE CONFIGURATION INCLUDING CHANGES IN FORWARD SPEED. Ernest C. Seaberg. December 1957. 29p. diagrs., photo., tabs. (NACA TN 4192. Supersedes RM L54C02)

The longitudinal transfer functions presented are in the form of frequency-response plots for several flight conditions. For a constant Mach number, the frequency response is shown to vary with angle of attack, mainly in the region of low-frequency airframe operation. A comparison of the frequency responses thus obtained with those in which the forward speed change is neglected also shows significant variation in the low-frequency region. The additional derivatives necessary for this study were obtained for a Mach number range from transonic to approximately 1.8.

MISCELLANEOUS

Errata on NACA Report 1305, by Rainey. 1957.

Errata No. 2 on NACA RM L56I07, by Rabbott, Jr., and Churchill. October 1956.

Errata on NACA RM L57A03, by Ashby, Jr. April 17, 1957.

Errata on NACA TN 4129, by Copp and Walker. November 1957.

N-3074, Suppl. 6

INDEX OF NACA TECHNICAL PUBLICATIONS, JULY 1956 - JUNE 1957. x, 265p. NACA. (Ask for N-3074, Suppl. 6)

There is a classified listing of subject categories; a chronological listing of NACA publications under each subject category; an alphabetical index to the subject categories; an author index; and a list of NACA reports declassified during this period.

UNPUBLISHED PAPERS

N-56067*

CERTAIN REGULARITIES IN THE PLASTIC DEFORMATION AND FRACTURE OF METALS IN TENSION. (Nekotorye zakonomernosti plasticheskoi deformatsii i razrusheniya metallov pri rastyazhenii). V. A. Pavlov and K. A. Vshivtseva. May 1957. 14 p. diagrs., photo., tab. Translation from Fizika Metallov i Metallovedenie, v.1, issue 2, 1955. (Ask for N-56067*)

Experimental data are presented regarding the dependence on temperature of the total and uniform elongation and of the change in the character of fracture under tension of cadmium, tin, magnesium, and iron. The temperature range covered was in most cases from -180° C to +150° C, and in the case of magnesium, to about +270° C. Regularities in the behavior of the flow limit, ultimate strength, total and uniform elongation are noted, and certain peculiarities in the behavior of iron are pointed out. The connection between these regularities and the type of fracture at different temperatures is discussed.

UNPUBLISHED PAPERS

N-56796*

SPECTRUM ANALYSIS OF HOMOGENEOUS TURBULENCE. (Spektralanalyse der homogenen Turbulenz.) Walter Tollmien. 12p. diagr. Translation from Zeitschrift fur Flugwissenschaften, v.4, no.5-6, May-June 1956, p.195-198. (Ask for N-56796*)

The basic considerations on the spectrum of homogeneous turbulence are deduced by starting from the spectrum of the velocity fluctuations. This manner of deduction is more instructive than earlier methods and also gives some new results.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification November 8, 1957.

*NACA Conference on Turbines dated January 16, 1947.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification December 13, 1957.

NACA RM A51L17a

THE EFFECT OF VARIOUS MISSILE CHARACTERISTICS ON AIRFRAME FREQUENCY RESPONSE. Howard F. Matthews and Walter E. McNeill. January 1952. 16p. diagrs. (NACA RM A51L17a)

The frequency response of two important airframe characteristics were calculated for a cruciform, variable-incidence, air-to-air missile. Plots of amplitude ratio and phase angle as a function of angular frequency are presented to show the effects of the importance, accuracy, and the nonlinearity of certain aerodynamic derivatives, altitude and Mach number variation, and aeroelasticity.

NACA RM A54L08

THE LONGITUDINAL CHARACTERISTICS AT MACH NUMBERS UP TO 0.92 OF SEVERAL WING-FUSELAGE-TAIL COMBINATIONS HAVING SWEPT-BACK WINGS WITH NACA FOUR-DIGIT THICKNESS DISTRIBUTIONS. Fred B. Sutton and Jerald K. Dickson. March 1955. 128p. diagrs., photos., tab. (NACA RM A54L08)

The investigation was conducted in the Ames 12-foot pressure wind tunnel through an angle-of-attack range at a Reynolds number of 8 million at low speed and at Mach numbers from 0.25 to 0.92 at a Reynolds number of 2 million. Wing sweepback was 40°, 45°, and 50°. Several wing fences were tested at each sweep angle and the effects of a horizontal tail were determined at several tail heights.

NACA RM A54L20

EFFECTS OF TAPER RATIO ON THE LONGITUDINAL CHARACTERISTICS AT MACH NUMBERS FROM 0.6 TO 1.4 OF A WING-BODY-TAIL COMBINATION HAVING AN UNSWEPT WING OF ASPECT RATIO 3. James L. Summers, Stuart L. Treon, and Lawrence A. Graham. March 1955. 45p. diagrs., photo. (NACA RM A54L20)

A wind-tunnel investigation from 0.6 to 1.4 Mach number has been made to determine the effects of a variation in wing taper ratio from 0 to 1.0 on the lift, pitching-moment, and drag characteristics of a wing-body combination having a wing with an unswept 0.50-chord line. The wings were of aspect ratio 3 with NACA 64A003 airfoil sections normal to the midchord line. The Reynolds number was 1.5 million. The wing-body combinations were also tested with a tail.

NACA RM A55K21a

FULL-SCALE WIND-TUNNEL TESTS OF THE LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF THE XV-1 CONVERTIPLANE IN THE AUTOROTATING FLIGHT RANGE. David H. Hickey. May 1956. 64p. diagrs., photos., tabs. (NACA RM A55K21a)

Force and moments were measured for the XV-1 convertiplane at 75 to 150 knots. Rotor on and off and propeller powered and off configurations were investigated. The characteristics of the V-tab horizontal tail and its downwash field were studied. Lift interference between fixed wing and rotor and possible means of drag reduction were considered.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM A55L13

THE INFLUENCE OF SURFACE INJECTION ON HEAT TRANSFER AND SKIN FRICTION ASSOCIATED WITH THE HIGH-SPEED TURBULENT BOUNDARY LAYER. Morris W. Rubesin. February 1956. 16p. diagrs. (NACA RM A55L13)

It is shown from existing analyses that distributed surface injection reduces greatly both skin friction and heat transfer of turbulent boundary layers. Data for skin friction and heat transfer at Mach numbers 0, 2.0, and 2.7 are shown to compare rather well with the analyses. Also, an example is included to indicate the effectiveness of transpiration cooling.

NACA RM A55L13c

AERODYNAMICS OF BODIES, WINGS, AND WING-BODY COMBINATIONS AT HIGH ANGLES OF ATTACK AND SUPERSONIC SPEEDS. Jack N. Nielsen, J. Richard Spahr, and Frank Centolanzi. February 1956. 12p. diagrs. (NACA RM A55L13c)

Maximum lift coefficients are presented for triangular and rectangular wings, together with downwash measurements behind a rectangular wing at large angles of attack. It is shown that nonlinear variations of panel normal force, hinge moment, and bending moment for cruciform missiles at high angles of attack can be calculated using a vortex model.

#NACA RM E7K07, by Rowe, Ordin, and Diehl

NACA RM E50D04

INVESTIGATION OF COMBUSTION IN 16-INCH RAM JET UNDER SIMULATED CONDITIONS OF HIGH ALTITUDE AND HIGH MACH NUMBER. T. J. Nussdorfer, D. C. Sederstrom, and E. Perchonok. June 27, 1950. 53p. diagrs., photos., tabs. (NACA RM E50D04)

Results obtained with three different burner configurations in a connected-pipe investigation of a 16-inch ram jet are presented. The radial position of the fuel injector and the engine-outlet area both affected burner performance. For a given configuration, only slight changes in total-pressure ratio across the combustion chamber were obtained over the complete range of operation. With one burner, combustion efficiencies obtained at a combustion-chamber-inlet static pressure of 800 pounds per square foot absolute were greater than those obtained at 1920 pounds per square foot absolute.

NACA RM E50H31

NACA RESEARCH ON COMBUSTORS FOR AIRCRAFT GAS TURBINES. I - EFFECT OF OPERATING VARIABLES ON STEADY-STATE PERFORMANCE. Walter T. Olson and J. Howard Childs. October 18, 1950. 55p. diagrs., tab. (NACA RM E50H31)

Some of the systematic research conducted by the NACA on aircraft gas-turbine combustors is reviewed. Trends depicting the effect of inlet-air pressure, temperature, and velocity and fuel-air ratio on performance characteristics, such as combustion efficiency, maximum temperature rise attainable, pressure loss, and combustor-outlet temperature distribution are described for a variety of turbojet combustors of the liquid-fuel type. These trends are further discussed as effects significant to the turbojet engine, such as altitude operational limits, specific fuel consumption, thrust, acceleration, and turbine life.

NACA RM E50I07

TURBOJET COMBUSTOR EFFICIENCY AT HIGH ALTITUDES. Walter T. Olson, J. Howard Childs, and Edmund R. Jonash. October 27, 1950. 51p. diagrs., photo. (NACA RM E50I07)

Results of investigations of turbojet combustor efficiency at high altitudes are presented to illustrate the effects of (1) combustor operating conditions, (2) combustor design, and (3) fuel characteristics. Decreased combustion efficiencies obtained at low combustor pressures and temperatures were improved by providing for increased volume in the flame zone, gradual admission of air into the combustion space, and increased fuel volatility. Matching of the combustor design, the fuel injection characteristics, and the fuel volatility is required for optimum-combustion-efficiency operation.

NACA RM E50J03

VAPOR-FUEL-DISTRIBUTION EFFECTS ON COMBUSTION PERFORMANCE OF A SINGLE TUBULAR COMBUSTOR. Richard J. McCafferty. December 13, 1950. 27p. diagrs., photo. (NACA RM E50J03)

The effect of hydrocarbon fuel distribution and fuel state on combustion performance of a single tubular combustor at simulated altitude conditions was determined by operating with liquid MIL-F-5616 and gaseous propane fuels and distributing the propane in the primary combustion zone with four fuel-injector designs. Results indicate that performance is influenced by fuel distribution because the altitude operational limits and combustion efficiencies could be varied considerably by use of different fuel injectors that provided different fuel-air mixtures. Vapor fuel gave better performance than the liquid fuel injected by standard pressure-atomizing nozzle.

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NACA RM E51B21

LIQUID-FUEL-DISTRIBUTION AND FUEL-STATE EFFECTS ON COMBUSTION PERFORMANCE OF A SINGLE TUBULAR COMBUSTOR. Richard J. McCafferty. May 1, 1951. 38p. diagrs., tab. (NACA RM E51B21)

The effect of liquid-hydrocarbon-fuel distribution on combustion performance of a single tubular combustor at simulated-altitude conditions was determined by distributing liquid MIL-F-5624 fuel with pressure-atomizing nozzles and solid-stream injectors. The effect of fuel state on performance was obtained by comparison with gaseous-fuel-distribution data from a previous investigation. Results indicate liquid-fuel distribution within the primary combustion zone affects performance but to a lesser degree than gaseous-fuel distribution. Gaseous fuel provided higher altitude operational limits and efficiencies than liquid fuel.

NACA RM E51K30

COMBUSTION EFFICIENCY PERFORMANCE OF A MIL-F-5624 TYPE FUEL AND MONOMETHYL-NAPHTHALENE IN A SINGLE VAPORIZING-TYPE COMBUSTOR. Anthony W. Jones and William P. Cook. February 1952. 26p. diagrs., photos., tabs. (NACA RM E51K30)

The performance (combustion efficiency and blowout) of a conventional turbojet fuel, MIL-F-5624 (JP-3), and a low-volatility, high-density hydrocarbon, monomethylnaphthalene, in a single vaporizing type combustor for variations in inlet conditions is presented in this report. The MIL-F-5624 type fuel burned over a wider range of operating conditions and gave combustion efficiencies 2 to 16 percent higher than monomethylnaphthalene. Heat-input rate had little effect on the combustion efficiency of each fuel in the range investigated.

NACA RM E51L04

EVALUATION OF FIVE CONICAL CENTER-BODY SUPERSONIC DIFFUSERS AT SEVERAL ANGLES OF ATTACK. Gerald W. Englert and Leonard J. Obery. May 1952. 29p. diagrs., photos., tab. (NACA RM E51L04)

Five supersonic inlets having conical center bodies were investigated in a 16-inch ram-jet engine with and without combustion at Mach numbers of 1.7, 1.9, and 2.0 and angles of attack from 0° to 10°. Four of the inlets were of the low-mass-flow-ratio type whereas the fifth inlet was of the high-mass-flow-ratio type. The stable operating range of the four low-mass-flow-ratio inlets decreased considerably as the angle of attack was increased despite an increase of the cone angle or the use of boundary-layer bleed. The stable range of the high-mass-flow-ratio inlet increased considerably both at 0° and at greater angles of attack as the free-stream Mach number was decreased. Free-stream Mach number, angle of attack, and inlet type had negligible effects on combustion efficiency, temperature ratio, or combustion-chamber inlet Mach number in the supercritical region.

NACA RM E51L14

ALTITUDE PERFORMANCE INVESTIGATION OF SINGLE- AND DOUBLE-ANNULAR TURBOJET-ENGINE COMBUSTORS WITH VARIOUS SIZE FUEL NOZZLES. James L. Harp, Jr., and Kenneth R. Vincent. June 1952. 60p. photos., diagrs., tab. (NACA RM E51L14)

An investigation of the performance of an annular-combustor-type turbojet engine was conducted and the performance of an NACA single-annular combustor having controlled air distribution was compared with that of the standard double-annular combustor. The turbine-discharge temperature profiles, combustion efficiency, altitude limits, and engine performance using both combustors were investigated and compared over a range of altitudes and engine speeds at two flight Mach numbers with four sets of fuel nozzles having different flow rates. The most significant advantages of the single-annular combustor were improved turbine-discharge temperature profile and combustion efficiency. However, these gains were not fully realized in increased thrust and specific fuel consumption because of high pressure loss through the single-annular combustor.

NACA RM E51L21

EFFECT OF FUEL DENSITY AND HEATING VALUE ON RAM-JET AIRPLANE RANGE. Hugh M. Henneberry. February 1952. 56p. diagrs., tabs. (NACA RM E51L21)

An analytical investigation of the effects of fuel density and heating value on the cruising range of a ram-jet airplane was made. Results indicate that with present-day knowledge of chemical fuels, neither very high nor very low fuel densities have any advantages for long-range flight. Of the fuels investigated, the borohydrides and metallic boron have the greatest range potential. Aluminum and aluminum hydrocarbon slurries were inferior to pure hydrocarbon fuel and boron-hydrocarbon slurries were superior on a range basis. It was concluded that the practical difficulties associated with the use of liquid hydrogen fuel cannot be justified on a range basis.

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NACA RM E51L24

AN INVESTIGATION AT MACH NUMBERS 2.98 AND 2.18 OF AXIALLY SYMMETRIC FREE-JET DIFFUSION WITH A RAM-JET ENGINE. Henry R. Hunczak. February 1952. 30p. photos., diagrs. (NACA RM E51L24)

An investigation was conducted to determine the effectiveness of a free-jet diffuser in reducing the overall pressure ratios required to operate a free jet with a large air-breathing engine as a test vehicle. Efficient operation of the free jet was determined with and without the considerations required for producing suitable engine-inlet flow conditions. A minimum operating pressure ratio of 5.5 was attained with a ratio of nozzle-exit to engine-inlet area of 1.85. Operation of the free jet with unstable engine-inlet flow (buzz) is also included.

NACA RM E52H25

EFFECT OF WATER VAPOR ON COMBUSTION OF MAGNESIUM-HYDROCARBON SLURRY FUELS IN SMALL-SCALE AFTERBURNER. Leonard K. Tower. October 1952. 39p. diagrs., tabs. (NACA RM E52H25)

Both JP-3 fuel and a slurry of 60 percent powdered magnesium in JP-3 fuel were evaluated in a small-scale afterburner in the presence of large quantities of water vapor. Combustion of the slurry was stable to the highest water-air ratio investigated, 0.18; whereas JP-3 fuel would not burn beyond a water-air ratio of 0.08. By means of small-scale-afterburner data, maximum augmented thrust ratio obtainable from a full-scale engine with water injection and afterburning was calculated to be 1.58 with JP-3 fuel and 2.00 with slurry. The use of slurry in place of JP-3 fuel may shorten take-off distance of some aircraft 17 to 24 percent.

NACA RM E52J23

PRELIMINARY EXPERIMENTS WITH PILOT BURNERS FOR RAM-JET COMBUSTORS. John M. Farley, Robert E. Smith, and John H. Povolny. January 1953. 45p. diagrs., photos., tabs. (NACA RM E52J23)

As part of an overall program to develop a high-performance, high-altitude, low-drag ram-jet combustor, a preliminary development program on can-type pilots has been conducted. A 5-inch-diameter circular pilot and an annular-segment pilot were developed which gave stable operation at an inlet pressure of 10 inches of mercury absolute over a satisfactory range of fuel-air ratios for static-pressure ratios across the pilot ranging from about 1.02 to 1.08. The effects of first-row hole size, longitudinal variation in hole area, fuel-system design, and shroud design on the performance of the pilots were determined. It was estimated that in an actual combustor installation the percentage of air flow through the pilot would be equal to about 35 percent of the cross-sectional area blocked by the pilot.

NACA RM E53B19

EFFECT OF FUEL-AIR RATIO CONCENTRATION IN COMBUSTION ZONE ON COMBUSTION PERFORMANCE OF A 16-INCH RAM-JET ENGINE. A. J. Cervenka, D. W. Bahr, and E. E. Dangle. April 1953. 24p. diagrs., tab. (NACA RM E53B19)

The results of fuel-air ratio and temperature surveys made in the flame stabilizing zone of a 16-inch ram-jet combustor indicated that the distribution of combustible mixture immediately downstream of a flame holder should be mechanically controlled if a preferred mixture composition is to be maintained in that zone. A sloping-baffle combustor configuration gave combustion efficiencies of 90 percent or greater over a range of fuel-air ratios from 0.010 to 0.045.

NACA RM E53C24

INVESTIGATION OF 70 PERCENT TRIMETHYL BORATE - 30 PERCENT METHYL ALCOHOL FUEL MIXTURE IN A SINGLE J33 COMBUSTOR AND IN A J33 TURBOJET ENGINE. Louis J. Schafer, Jr., and Robert O. Hickel. January 1957. 26p. diagrs., photos., tab. (NACA RM E53C24)

An experimental investigation was conducted on a single turbojet engine combustor and on a turbojet engine using a fuel mixture consisting of 70 percent trimethyl borate and 30 percent methyl alcohol. In the single combustor, use of the trimethyl borate fuel resulted in excessive boric oxide deposits in the areas surrounding the air entry holes in the liner of the combustor. In the turbojet engine the boric oxide deposits were excessive; they were most severe on the domes and liners of the combustors, on the outlet screens of the rear bearing cooling-air passages, and in the tailcone and tailpipe.

NACA RM E53F15

EFFECT OF FUEL INJECTOR LOCATION AND MIXTURE CONTROL ON PERFORMANCE OF A 16-INCH RAM-JET CAN-TYPE COMBUSTOR. A. J. Cervenka, Eugene Perchonok, and E. E. Dangle. July 1953. 33p. diagrs., tab. (NACA RM E53F15)

A 16-inch connected-pipe investigation was undertaken to evaluate an existing can-type combustor configuration and to develop this configuration to give a wide operable fuel-air ratio range of high combustion efficiency. Only fuel-injector changes were investigated. Without increasing the combustor cold-flow pressure-drop coefficient of 1.5, acceptable performance was achieved by providing the combustor with a fuel-injection system in which a mixture control sleeve was added upstream of the flame holder to provide a locally stoichiometric mixture at lean as well as rich overall fuel-air ratios.

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Combustion efficiencies from 92 to 97 percent were obtained with MIL-F-5624A grade JP-4 fuel over a fuel-air ratio range from 0.012 to 0.056 (the rich limit of the facility) at conditions corresponding to flight at a Mach number of 2.9 and an altitude of 67,000 feet. A comparison is made between the connected-pipe burner performance and the performance of one of the injector configurations which had previously been evaluated during a study of a 16-inch ram-jet engine at a Mach number of 2.0 in the Lewis 8- by 6-foot supersonic wind tunnel.

NACA RM E53I01

EXPERIMENTAL INVESTIGATION OF SCREECHING COMBUSTION IN FULL-SCALE AFTERBURNER. Karl H. Usow, Carl L. Meyer, and Frederick W. Schulze. December 1953. 62p. diagrs., photos., tab. (NACA RM E53I01)

In an effort to extend the existing knowledge of screeching combustion in afterburners, a number of systematic configuration modifications were made to an afterburner installed on an engine in the altitude wind tunnel to determine their effect on the screech characteristics. These modifications included changes in the afterburner diffuser, the fuel system, and the flame holder. Screech characteristics of each modification were observed over a range of simulated altitude flight conditions corresponding to afterburner-inlet total pressures from 2200 to 4200 pounds per square foot absolute. The observations made during this investigation indicate that some changes in the geometry of the afterburner diffuser and flame holder have a pronounced effect on the range of conditions over which screeching combustion is encountered; in some cases screech was completely eliminated. In contrast, it was generally found that screeching combustion could not be eliminated by changes in the geometry of the fuel system.

NACA RM E53I03

EFFECT OF INLET-AIR TEMPERATURE ON PERFORMANCE OF A 16-INCH RAM-JET COMBUSTOR. A. J. Cervenka, E. E. Dangle, and Robert Friedman. October 1953. 24p. diagrs., tab. (NACA RM E53I03)

The effect of inlet-air temperature on the combustion efficiency of a 16-inch ram-jet engine was determined in a connected-pipe installation. The engine was operated over a range of fuel-air ratio with several different combustor configurations and two fuel types. Combustion efficiency was found to be as much as 35 percentage points lower at an inlet-air temperature of 160° F than at 600° F. The variation in efficiency was a function of fuel-air ratio and combustor design. With flame-holder designs in which the local fuel-air ratio was maintained near stoichiometric in the burning zone, or at overall ratios near stoichiometric, the temperature effect was slight. When the local fuel-air ratio varied appreciably from stoichiometric, a greater effect was found. These findings are in accordance with previous observations, discussed in a survey of literature, in which the effect of temperature was shown to diminish at the regions of high combustion efficiency. The performance of a sloping-baffle flame holder at an inlet-air temperature of 160° F with gasoline fuel was about the same as with MIL-F-5624A grade JP-4 fuel at 600° F over a range of fuel-air ratio from 0.020 to 0.062.

NACA RM E53L07

PRELIMINARY INVESTIGATION OF AN ANNULAR TURBOJET COMBUSTOR HAVING A CATALYTIC-COATED LINER. Carl T. Norgren and J. Howard Childs. January 1954. 11p. diagrs. (NACA RM E53L07)

The performance of an experimental annular turbojet combustor was investigated at a low-pressure operating condition with an uncoated liner, with an identical liner having a ceramic coating on the inner walls, and with this same liner having a catalytic coating added onto the ceramic coating. The combustion efficiency was approximately the same for all three liners, indicating no gain in performance through the use of the catalytic coating.

NACA RM E53L11b

AERODYNAMIC CHARACTERISTICS OF TWO FLAT-BOTTOMED BODIES AT MACH NUMBER OF 3.12. John R. Jack and Barry Moskowitz. April 1954. 9p. diagrs. (NACA RM E53L11b)

The aerodynamic characteristics of two flat-bottomed bodies having a semicircular and a semielliptical cross section have been determined at a Mach number of 3.12 for a range of angles of attack from -10° to 10° and for Reynolds numbers of 8×10^6 and 14×10^6 (based on model length). A comparison of the flat-bottomed body characteristics with those previously determined for an equivalent cone-cylinder body of revolution shows that significant increases in lift and lift-drag ratio are obtained with a flat bottom. Additional improvement in lift and lift-drag ratio was achieved at positive angles of attack by expanding the plan form in the spanwise direction.

NACA RM E53L15

INVESTIGATION OF CONICAL SUBSONIC DIFFUSERS FOR RAM-JET ENGINES. John M. Farley and Henry J. Welna. March 1954. 40p. diagrs., photos., tabs. (NACA RM E53L15)

The efficiency of a 30° conical diffuser was improved as much as 20 percent and separation was eliminated by the use of vortex generators. The use of splitter cones gave only small efficiency gains, but relatively uniform diffuser-outlet velocity profiles were obtained with the better designs. A configuration which

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incorporated both vortex generators and a splitter cone gave efficiencies higher than those obtained with any other splitter-cone configuration and also higher than those obtained when the same vortex generators were used without the splitter cone. Moderate diffuser-efficiency increases were obtained with guide vanes; however, in all cases combustion occurred in the vane wakes.

#NACA RM E53L17, by Morgan and Morse.

NACA RM E53L18a

ALTITUDE PERFORMANCE AND OPERATIONAL CHARACTERISTICS OF AN XT38-A-2 TURBOPROP ENGINE. R. H. Essig and F. W. Schulze. March 1954. 43p. diagrs., photos., tab. (NACA RM E53L18a)

The overall engine performance and the starting and windmilling characteristics of an XT38-A-2 turboprop engine have been investigated in the NACA Lewis altitude wind tunnel. The simulated flight conditions ranged from altitudes of 5,000 to 45,000 feet at a flight Mach number of 0.30 and from Mach numbers of 0.301 to 0.557 at an altitude of 35,000 feet. The engine, equipped with a standard-area exhaust nozzle, was operated with independent control of fuel flow and propeller pitch; operation was thereby allowed over a wide range of engine conditions. Windmilling characteristics were obtained at altitudes of 15,000 and 35,000 feet. Analysis of the performance maps obtained at each flight condition revealed that both altitude and flight Mach number had a major effect on corrected engine variables. The large reductions in corrected shaft horsepower occurring when the altitude was increased were the result of decreases in compressor and turbine efficiencies. Windmilling engine starts were made at altitudes as high as 35,000 feet at an engine speed of 2,000 rpm.

NACA RM SE53L18b, by Craig, Nakanishi, and Bloomer.

NACA RM E53L22

REVIEW OF HIGH-PERFORMANCE AXIAL-FLOW-COMPRESSOR BLADE-ELEMENT THEORY. Seymour Lieblein. April 1954. 34p. diagrs. (NACA RM E53L22)

This report presents a review of current compressor blade-element theory with particular emphasis on application to the transonic high-performance compressor. A discussion of the significant parameters of total-pressure loss and deviation angle is presented, and an indication of the extent of available knowledge and the problems involved in the determination of blade-element characteristics is given. Some recent results and considerations in this pursuit and suggestions for further avenues of investigation are indicated.

NACA RM E53L29a

DESIGN AND EXPERIMENTAL INVESTIGATION OF TRANSONIC TURBINE WITH SLIGHT NEGATIVE REACTION ACROSS ROTOR HUB. Warner L. Stewart, Robert Y. Wong, and David G. Evans. March 1954. 40p. diagrs., photo., tabs. (NACA RM E53L29a)

The design and experimental investigation of a transonic turbine are presented herein. This turbine was designed for a slight overall negative reaction across the hub. Because of the increased flow Mach number level, the design procedure used was on a quasi-three-dimensional basis. The results of the experimental investigation indicated that the design point was obtained at a total efficiency of 0.85 with one point in efficiency lost in exit whirl. Design equivalent specific-work output occurred 3 percent below the turbine limiting-loading point. This checked closely with the value of 5 percent obtained theoretically with design conditions. From the experimental results it was concluded that, under the prescribed design conditions, transonic turbines can be operated with efficiencies of at least 0.85. The quasi-three-dimensional design procedure was found to be sufficiently rigorous that the design conditions, although critical from a limiting-loading standpoint, could be met.

NACA RM E54B02

A SUMMARY OF PRELIMINARY INVESTIGATIONS INTO THE CHARACTERISTICS OF COMBUSTION SCREECH IN DUCTED BURNERS. Lewis Laboratory Staff. April 1954. 60p. diagrs., photos. (NACA RM E54B02)

Operation of afterburners and ram-jet combustors at progressively higher fuel-air ratios has increased the occurrence and intensity of screech. Because of the destructive characteristics of screech, considerable effort has been expended in an attempt to understand and control this phenomenon. The present report summarizes NACA work on screech prior to November 1953. To determine the effects of design and operational variables on screech frequency and intensity, studies have been conducted in combustors ranging from 6 to 37 inches in diameter. Attempts to eliminate screech by reducing the driving potential of the gas stream were generally unsuccessful, but the use of an acoustic damper completely eliminated screech in all burner configurations in which it was used.

#NACA RM E54F25, by Morris and Lord.

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NACA RM E54F25a

LOW-PRESSURE PERFORMANCE OF EXPERIMENTAL PREVAPORIZING TUBULAR COMBUSTOR USING APPROXIMATELY STOICHIOMETRIC ADMISSION OF FUEL-AIR MIXTURE INTO THE PRIMARY ZONE. Robert R. Hibbard, Allen J. Metzler, and Wilfred E. Scull. August 1954. 38p. diagrs., tabs. (NACA RM E54F25a)

To evaluate the precept of prevaporized, stoichiometric mixture addition to the primary zone of a combustor, an experimental tubular combustor was developed which utilized the outer surface of the flame tube as a fuel vaporizer. The experimental combustor gave higher efficiencies than those obtained with a production model at all conditions and indicated a low tendency to form carbon. However, operation of the experimental combustor was limited by flashback into the vaporizing area at low air velocities or high pressures.

NACA RM E54L15

A METHOD FOR THE ANALYSIS OF COMPOUNDS CONTAINING BORON, CARBON, AND HYDROGEN. Harrison Allen, Jr., and Stanley Tannenbaum. March 1955. 9p. diagrs., tabs. (NACA RM E54L15)

A method is presented for the analysis of boron, carbon, and hydrogen from the combustion of a single sample of an organoboron compound. The method is based on the quantitative combustion of the sample in a steel bomb at high temperature and pressure, with subsequent analysis of the combustion products. It was applied successfully to the analysis of several trialkyl borates and trialkyl boranes; applicability of the method to hydrocarbon analysis was also investigated.

#NACA RM E54L16a, by Caves and Morris.

NACA RM E54L20a

COMPRESSOR-BLADE VIBRATION AND PERFORMANCE IN A J47-23 TURBOJET ENGINE UNDER CONDITIONS OF ROTATING STALL. Morgan P. Hanson, Donald F. Johnson, and André J. Meyer, Jr. June 1955. 18p. diagrs., tab. (NACA RM E54L20a)

An investigation was made of a J47-23 turbojet engine to determine the effects of rotating stall on compressor blade vibration and compressor performance. One to nine stall zones were measured, with the seven stall in predominance. Under normal operation, the maximum vibratory stress measured was ±26,200 psi in the second-stage blades. However, under simulated rapid acceleration conditions, a stress of ±60,000 psi was measured in the second stage. Compressor performance is presented of the operating conditions investigated.

NACA RM E54L23

ANALYSIS OF A PRESSURE-JET POWER PLANT FOR A HELICOPTER. Richard P. Krebs and William S. Miller, Jr. March 1955. 56p. diagrs. (NACA RM E54L23)

A study of the performance of a pressure-jet power plant for a helicopter was made to determine suitable values for the principal design parameters of the system. Compressor pressure ratio, tip-jet temperature, duct area, burner area, and rotor tip speed were varied through appropriate ranges and power-available charts are presented for several combinations of these power-plant parameters. Comparison of a series of pressure-jet power plants installed in a helicopter of 30,000 pounds gross weight is made on the basis of hovering duration and flight range.

NACA RM E54L29

PERFORMANCE OF A SUPERSONIC COMPRESSOR WITH SWEPT AND TILTED DIFFUSER BLADES. Arthur W. Goldstein and Ralph L. Schacht. March 1955. 32p. diagrs., photo. (NACA RM E54L29)

Experimentally determined characteristics are described for a stage consisting of a rotor with supersonic relative velocities and a stator having swept and tilted blades over a range of equivalent tip speeds from 740 to 1702 ft/sec in air. Measurements were made of static-pressure distributions, overall performance, and of the magnitude, frequency, and rotative speed of pressure fluctuations, which were found to be very large and which are believed to have prevented the stator from attaining the flow configuration for which it was designed.

NACA RM E55K21

QUALITATIVE STUDY OF FLOW CHARACTERISTICS THROUGH SINGLE-STAGE TURBINES AS MADE FROM ROTOR-EXIT SURVEYS. Robert Y. Wong, James W. Miser, and Warner L. Stewart. March 1956. 26p. diagrs. (NACA RM E55K21)

The flow characteristics through a single-stage turbine can be deduced from survey results taken at the rotor exit. Some of the major factors that influence the measured flow patterns may be qualitatively isolated, thus facilitating their analysis. The survey results of two similar transonic turbines, both with relatively high diffusion on different surfaces of the rotor blade, indicate considerable circumferential variation in the momentum in the regions of free-stream flow out of the stator. At the rotor exit, angular momentum and total-pressure loss varied radially.

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NACA RM E55L02a

CRITERIA FOR INITIAL FLOW REVERSAL IN SYMMETRICAL TWIN-INTAKE AIR-INDUCTION SYSTEMS OPERATING AT SUPERSONIC SPEEDS. Andrew Beke. February 1956. 17p. diagrs. (NACA RM E55L02a)

Asymmetric flow and initial flow reversal of supersonic twin-intake air-induction systems can be predicted satisfactorily. Observations of conditions at decreased air flows in several typical supersonic twin air intakes having generally the same static-pressure recovery characteristics indicated that initial flow reversal (that is, zero flow in one duct) occurred simultaneously with critical inlet flow in the other duct. Consequently, with such inlets engine air flow cannot be reduced to less than half the total inlet critical air flow before initial flow reversal occurs.

NACA RM E56C06

FABRICATION TECHNIQUES AND HEAT-TRANSFER RESULTS FOR CAST-CORED AIR-COOLED TURBINE BLADES. John C. Freche and Robert E. Oldrieve. June 1956. 35p. diagrs., photos. (NACA RM E56C06)

Techniques were developed for casting air-cooled blades with a large number of relatively small cooling passages near the airfoil surface; two such blades of HS-21 material were run in a turbojet engine modified for air cooling. One blade was operated without failure for 78 hours at a centrifugal stress of 42,150 psi and an average inlet gas temperature of 1,735° F. Of this total, 50 hours were obtained at a coolant-to-gas flow ratio of 0.015 and 28 hours at a flow ratio of 0.004.

NACA RM E56I04

THEORETICAL ANALYSIS OF TOTAL-PRESSURE LOSS AND AIRFLOW DISTRIBUTION FOR TUBULAR TURBOJET COMBUSTORS WITH CONSTANT ANNULUS AND LINER CROSS-SECTIONAL AREAS. Charles C. Graves and Jack S. Grobman. January 1957. 85p. diagrs., tab. (NACA RM E56I04)

Generalized curves showing the combustor total-pressure-loss coefficient and liner air-flow distribution for various geometric configurations and operating conditions were obtained from compressible- and incompressible-flow calculations. The calculations include the effects of heat release, annulus wall friction, and variation in discharge coefficient of liner wall openings along the combustor. The results pertain to tubular turbojet combustors having (1) constant annulus and liner cross-sectional areas along the combustor axis and (2) flush circular holes in the liner wall.

NACA RM E56J22

PERFORMANCE OF AN EXPERIMENTAL ANNULAR TURBOJET COMBUSTOR WITH METHANE AND PROPANE. Carl T. Norgren. January 1957. 27p. diagrs., tabs. (NACA RM E56J22)

Combustion efficiencies obtained with gaseous methane were compared with reported data obtained with gaseous propane for the same experimental combustor configuration. The combustion efficiencies obtained with methane were 98, 91, and 77 percent at simulated flight altitudes of 56,000, 70,000, and 80,000 feet, corresponding to combustor inlet-air pressures from 15 to 5 inches of mercury absolute. Combustion efficiencies with propane were equivalent to those with methane up to a simulated altitude of 70,000 feet. At the most severe conditions investigated propane operated with a higher efficiency and over a wider range of fuel-air ratio than methane.

NACA RM E57C15

EXPERIMENTAL INVESTIGATION OF MODIFIED CAST-CORED BLADES HAVING HOLLOW TIP SECTIONS. Robert E. Oldrieve and John C. Freche. June 1957. 36p. diagrs., photos., (NACA RM E57C15)

Two modified cast-cored blades, 11 percent lighter than a fully cored blade, were experimentally investigated in a turbojet engine modified for air-cooling. One blade had 37 (0.060-in.) passages and the other 20 oval (0.100- by 0.060-in.) passages located near the airfoil surface. Both blades were hollow from 9/16 span to the tip. Fabrication techniques are presented. Generally, the 37-hole blade cooled more effectively than the 20-hole blade and showed a lower cooling-air pressure drop.

NACA RM E57D24

SURVEY OF HYDROGEN COMBUSTION PROPERTIES. Isadore L. Drell and Frank E. Belles. July 1957. (ii), 86p. diagrs., tabs. (NACA RM E57D24)

This literature digest of hydrogen-air combustion fundamentals presents data on flame temperature, burning velocity, quenching distance, flammability limits, ignition energy, flame stability, detonation, spontaneous ignition, and explosion limits. The data are assessed, recommended values are given, and relations among various combustion properties are discussed. New material presented includes: theoretical treatment of variation in spontaneous-ignition lag with temperature, pressure, and composition, based on reaction kinetics of hydrogen oxidation; and calculated adiabatic flame temperatures over the entire hydrogen-air composition range for 0.01 to 100 atmospheres and initial temperatures of 0° to 1400° K.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM H55L29a

SOME RECENT RESEARCH ON THE HANDLING QUALITIES OF AIRPLANES. Walter C. Williams and William H. Phillips. February 1956. 19p. diagrs. (NACA RM H55L29a)

Results of recent research on the handling qualities of airplanes are reviewed. Among the subjects considered are dynamic longitudinal stability, transonic trim changes, pitch-up due to decreasing airspeed, dynamic lateral stability, aileron control, and mechanical characteristics of power control systems.

NACA RM L50L27

FLIGHT PERFORMANCE OF A TWIN-ENGINE SUPERSONIC RAM JET FROM 2,300 TO 67,200 FEET ALTITUDE. H. Rudolph Dettwyler and Aleck C. Bond. February 19, 1951. 23p. diagrs., photos., tab. (NACA RM L50L27)

A flight investigation was made of a supersonic twin ram-jet test vehicle using short flame-length burners. The test demonstrated a maximum acceleration of 4.13g and a maximum flight Mach number of 3.12. Data were obtained over a Mach number range of 1.80 to 3.12, an altitude range from 2,300 to 67,200 feet, and a computed fuel-air-ratio range from 0.0245 to 0.0463.

NACA RM L50L29

SUMMARY OF SPIN AND RECOVERY CHARACTERISTICS OF 12 MODELS OF FLYING-WING AND UNCONVENTIONAL-TYPE AIRPLANES. Ralph W. Stone, Jr., and Burton E. Hultz. March 1, 1951. 95p. diagrs., photo., tabs. (NACA RM L50L29)

The free-spinning model results of investigations of the spin and recovery characteristics of 12 flying-wing and unconventional-type designs have been summarized. Dimensional data, mass data, and three-view drawings of the 12 designs are presented. The model test results presented include the spin and recovery characteristics of each model for various combinations of control deflections and for various loading and dimensional configurations.

NACA RM L51L10a

LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF MODEL AIRPLANE CONFIGURATION EQUIPPED WITH A SCALED X-1 AIRPLANE WING. James H. Parks. April 1952. 37p. diagrs. (NACA RM L51L10a)

A rocket-propelled model of an airplane-like configuration having a scaled X-1 wing, 8 percent thick, was flight tested at Reynolds numbers ranging from 2×10^6 to 4×10^6. Aerodynamic derivatives defining the static and dynamic longitudinal stability, control, trim, and drag characteristics of the configuration were obtained over a Mach number range from 0.6 to 1.17. Buffeting and maximum lift information were obtained at subsonic speeds. Some separate aerodynamic effects of the wing on the configuration were determined.

NACA RM L52L04

LONGITUDINAL STABILITY, CONTROL EFFECTIVENESS, AND DRAG CHARACTERISTICS AT TRANSONIC SPEEDS OF A ROCKET-PROPELLED MODEL OF AN AIRPLANE CONFIGURATION HAVING AN UNSWEPT TAPERED WING OF ASPECT RATIO 3.0 AND NACA 65A004.5 AIRFOIL SECTIONS. John C. McFall, Jr., and James A. Hollinger. January 1953. 30p. diagrs., photos. (NACA RM L52L04)

A flight investigation was conducted on a rocket-propelled airplane model having an unswept wing of aspect ratio 3.0 with NACA 65A004.5 airfoil sections. The longitudinal stability, control effectiveness, and drag characteristics of the configuration were determined over a Mach number range of 0.73 to 1.33 and compared with data from similar models having hexagonal airfoil sections.

NACA RM L52L08

STABILITY OF BODIES OF REVOLUTION HAVING FINENESS RATIOS SMALLER THAN 1.0 AND HAVING ROUNDED FRONTS AND BLUNT BASES. Stanley H. Scher and James S. Bowman, Jr. January 1953. 23p. diagrs., tabs. (NACA RM L52L08)

An investigation has been made of the stability of several bodies of revolution having fineness ratios smaller than 1.0 and having rounded fronts and blunt bases. Free-drop tests were made in the vertical Langley 20-foot free-spinning tunnel to determine the behavior of the various bodies in descent, and a method was developed for calculating approximately the stability of bodies of the subject type.

NACA RM L53F29

TRANSONIC FLIGHT MEASUREMENT OF THE AERODYNAMIC LOAD ON THE EXTENDED SLAT OF THE DOUGLAS D-558-II RESEARCH AIRPLANE. James R. Peele. August 1953. 34p. diagrs., photos., tab. (NACA RM L53F29)

The results of transonic flight measurements of the aerodynamic load encountered over a partial-span leading-edge slat on the 35° sweptback wing of the Douglas D-558-II research airplane are presented for the lift range at Mach numbers from 0.45 to 0.98.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM L53L17

AERODYNAMIC CHARACTERISTICS OF A FULL-SPAN TRAILING-EDGE CONTROL ON A 60° DELTA WING WITH AND WITHOUT A SPOILER AT MACH NUMBER 1.61. Douglas R. Lord and K. R. Czarnecki. March 1954. 49p. diagrs., photos., tab. (NACA RM L53L17)

An investigation has been made at a Mach number of 1.61 and a Reynolds number of 4.2×10^6 to determine the aerodynamic characteristics of a full-span trailing-edge control on a 60° delta wing with and without a partial-span spoiler mounted on the wing just ahead of the control. Tests were made over an angle-of-attack range from 0° to 15° and a control deflection range from -30° to 30°. A few illustrative pressure distributions are presented, and the control effectiveness and hinge-moment-coefficient variations for the basic wing-control configuration are compared with those predicted by linear theory and those obtained from the spoiler configurations.

NACA RM L53L18

LOW-SPEED CHORDWISE PRESSURE DISTRIBUTIONS NEAR THE MIDSPAN STATION OF THE SLOTTED FLAP AND AILERON OF A 1/4-SCALE MODEL OF THE BELL X-1 AIRPLANE WITH A 4-PERCENT-THICK, ASPECT-RATIO-4, UNSWEPT WING. William C. Moseley, Jr., and Robert T. Taylor. March 1954. 59p. diagrs., photos., tabs. (NACA RM L53L18)

An investigation was made to determine the chordwise pressure distribution at two spanwise stations on a 4-percent-thick, aspect-ratio-4, unswept wing of a 1/4-scale model of the Bell X-1 airplane. These pressure stations were selected to give typical pressure distributions across the slotted flap and aileron of the model.

NACA RM L53L24a

EFFECT OF SOME SECTION MODIFICATIONS AND PROTUBERANCES ON THE ZERO-LIFT DRAG OF DELTA WINGS AT TRANSONIC AND SUPERSONIC SPEEDS. Carl A. Sandahl and William E. Stoney. February 1954. 43p. diagrs., photos., tabs. (NACA RM L53L24a)

An investigation was made to determine the effects on the zero-lift drag of a 60° delta wing of some section modifications fore and aft of the position of maximum thickness. In addition, one configuration employed simulated control-actuator housings. For the subsonic leading-edge condition of the tests, leading-edge radius had no effect on the drag coefficient. Some thickening of the airfoil aftersection resulted in a slight increase in drag coefficient as long as the trailing-edge thickness was zero. At supersonic speeds, the drag coefficient varied nearly linearly with those values of trailing-edge thickness tested. Increasing the section thickness ratio from 0.03 to 0.06 near the wing tip resulted in no increment in drag coefficient. Linear theory generally predicted larger values of wing pressure drag coefficient than those obtained experimentally, but predicted effects of section changes accurately.

NACA RM L54L17a

FREE-FLIGHT INVESTIGATION TO DETERMINE SOME EFFECTS OF TAIL DAMPING AND WING-TAIL INTERFERENCE ON THE ROLLING EFFECTIVENESS OF INBOARD AND OUTBOARD AILERONS ON AN UNTAPERED SWEPTBACK WING. Roland D. English. March 1955. 18p. diagrs., photos. (NACA RM L54L17a)

An investigation has been made to determine some effects of tail damping and wing-tail interference on the rolling effectiveness of inboard and outboard ailerons on sweptback wings. The results of the investigation indicate that the substitution of fixed tail fins for a free-to-roll tail on a wing-body combination reduced the rolling effectiveness of an inboard aileron considerably over the entire test Mach number range (0.6 to 1.5) but caused no consistent change in the rolling effectiveness of an outboard aileron.

NACA RM L54L20

INVESTIGATION OF THE LATERAL STABILITY CHARACTERISTICS OF THE DOUGLAS X-3 CONFIGURATION AT MACH NUMBERS FROM 0.6 TO 1.1 BY MEANS OF A ROCKET-PROPELLED MODEL. Jesse L. Mitchell and Robert F. Peck. February 1955. 37p. diagrs., photo., tabs. (NACA RM L54L20)

A rocket-propelled model of the Douglas X-3 airplane was flown in the Mach number range from 0.6 to 1.1 to obtain lateral stability data from the response to pulse-type disturbances. The model was, in general, statically and dynamically stable throughout the Mach number range of the test; however, there was some evidence of neutral dynamic stability at small angles of sideslip. A vector-analysis procedure was used to obtain some of the lateral stability derivatives. Comparisons made with other data indicate fair to good agreement.

NACA RM L54L29

AN ANALYSIS OF THE TRANSONIC AND SUPERSONIC PERFORMANCE OF SEVERAL FIXED-GEOMETRY AIR INLETS. Robert E. Pendley and Robert R. Howell. March 1955. 36p. diagrs., tab. (NACA RM L54L29)

An analysis has been made of the influence of several factors on the magnitude of the deviation of the maximum power performance of several fixed-geometry inlets from ideal values. Experimentally determined drag and total-pressure recovery characteristics were used in calculating the performance variations. Generally, it was shown that, when properly sized,

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the performance of a fixed-geometry inlet is very near optimum over a broad range of operating conditions. It was also shown that the performance of the inlet is greatly affected by the rate of increase in engine air-flow requirements with Mach number.

NACA RM L55I23a

INVESTIGATION AT HIGH SUBSONIC SPEEDS OF THE STATIC LONGITUDINAL STABILITY CHARACTERISTICS OF A MODEL HAVING CROPPED-DELTA AND UNSWEPT WING PLAN FORMS AND SEVERAL TAIL CONFIGURATIONS. Albert G. Few, Jr. November 1955. 107p. diagrs., photo., tab. (NACA RM L55I23a)

The present paper presents some effects of horizontal-tail length and tail configuration on the high subsonic static longitudinal stability characteristics of a complete model having thin cropped-delta and unswept wings of aspect ratio 3 and taper ratios of 0.14 and 0.20, respectively. The model was tested with a high T-tail (mounted on the vertical tail), a low tail (on the wing chord extended), and with "a bitail" consisting of the combination of the high and low tails. The Mach number range was from about 0.80 to 0.92 which corresponds to Reynolds numbers ranging from about 4.0×10^6 to 4.2×10^6 for average test conditions.

NACA RM L55L09

LONGITUDINAL STABILITY INVESTIGATION FOR A MACH NUMBER RANGE OF 0.8 TO 1.7 OF AN AIRPLANE CONFIGURATION WITH A 45° SWEPT WING AND A LOW HORIZONTAL TAIL. John C. McFall, Jr. February 1956. 32p. diagrs., photos., tab. (NACA RM L55L09)

A flight investigation has been conducted on a rocket-boosted airplane model having a 45° swept wing of aspect ratio 4.0, taper ratio 0.3, and NACA 65A006 airfoil section. The configuration had a swept empennage with a low horizontal tail. Longitudinal stability and drag characteristics were determined over a Mach number range of 0.8 to 1.7.

NACA RM L55L12

AERODYNAMIC LOADINGS ASSOCIATED WITH SWEPT AND UNSWEPT SPOILERS ON A FLAT PLATE AT MACH NUMBERS OF 1.61 AND 2.01. Douglas R. Lord and K. R. Czarnecki. March 1956. 174p. diagrs., photos., tabs. (NACA RM L55L12)

An investigation has been made at Mach numbers of 1.61 and 2.01 for a range of Reynolds numbers from 0.12×10^6 to 0.56×10^6 per inch to examine the flow, force, and moment characteristics associated with spoilers mounted on a flat plate at sweep angles from 0° to 75°. For the unswept condition, the spoiler characteristics could be correlated for a given Mach number on the basis of the height and location of the spoiler top. The three-dimensional behavior of the flow over the swept spoilers and the limited data available precluded the establishment of any simple method for extending the unswept-spoiler results to the swept case. Regions of reversal in lift effectiveness and large decreases in pitching moment were observed near the spoiler apex for the swept spoilers; whereas the section drag and hinge moment decreased as distance from the apex increased.

NACA RM L55L14a

SUPERSONIC WAVE INTERFERENCE AFFECTING STABILITY. Eugene S. Love. March 1956. 19p. diagrs., photos. (NACA RM L55L14a)

Some of the significant interference fields that may affect stability of aircraft at supersonic speeds are briefly summarized. Illustrations and calculations are presented to indicate the importance of interference fields created by wings, bodies, wing-body combinations, jets, and nacelles.

NACA RM L55L20

SOME EFFECTS OF AILERONS ON THE VARIATION OF AERODYNAMIC CHARACTERISTICS WITH SIDESLIP AT LOW SPEED. Kenneth W. Goodson. March 1956. 40p. diagrs., tab. (NACA RM L55L20)

Results are presented of an investigation to determine the effects of aileron deflection on the low-speed aerodynamic characteristics of a typical high-speed airplane model in sideslip. Some data are presented for the model with inboard, outboard, and combined inboard-outboard ailerons on a 45° swept-back wing.

NACA RM L55L21

A FREE-FLIGHT INVESTIGATION OF THE EFFECTS OF A SONIC JET ON THE TOTAL-DRAG AND BASE-PRESSURE COEFFICIENTS OF A BOAT-TAIL BODY OF REVOLUTION FROM MACH NUMBER 0.83 TO 1.70. Ralph A. Falanga. March 1956. 18p. diagrs., photo., tab. (NACA RM L55L21)

Two 7.5° conical boattail bodies of revolution with constant base annuli and varying jet static-pressure ratios and with simulated-turbojet exhaust rocket motors were flight-tested to determine the jet interference effects on drag and base-pressure coefficients over a Mach number range from approximately 0.83 to 1.70. It was found that for jet static-pressure ratios of 1.83 to 2.40, the total power-on drag coefficients were lower than the corresponding power-off values throughout power-on test Mach number range. Power-on base-pressure coefficients were reduced with a reduction of jet static-pressure ratios and also with increasing supersonic Mach numbers.

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NACA RM L55L21a

LOW-SPEED STATIC STABILITY CHARACTERISTICS OF A CAMBERED-DELTA-WING MODEL. John M. Riebe and William C. Moseley, Jr. March 1956. 27p. diagrs. (NACA RM L55L21a)

The present paper presents the results of an investigation in the Langley 300 MPH 7- by 10-foot tunnel to determine the stability characteristics of a cambered 60° delta-wing configuration. Tests were made at several wing dihedral angles in combination with a circular fuselage and various tail configurations. Proper selection of V-tails which were investigated with the 20° and 50° wing dihedral angles resulted in model configurations which had longitudinal and directional stability throughout the lift-coefficient range.

NACA RM L55L23a

SPINNING AND RELATED PROBLEMS AT HIGH ANGLES OF ATTACK FOR HIGH-SPEED AIRPLANES. Walter J. Klinar. March 1956. 8p. diagrs. (NACA RM L55L23a)

A discussion is presented of the type of control manipulation and various techniques that may be required for satisfactory spin recovery of contemporary fighter designs. The effects in spins of jet-engine installations and the effectiveness of canard surfaces in alleviating a directional divergence near the stall and subsequent spin entry on one configuration are also discussed.

NACA RM L55L26a

EFFECTS OF WING-BODY GEOMETRY ON THE LATERAL-FLOW ANGULARITIES AT SUBSONIC SPEEDS. Frank S. Malvestuto, Jr., and William J. Alford, Jr. February 1956. 15p. diagrs. (NACA RM L55L26a)

The lateral flow characteristics along a vertical tail station have been investigated experimentally and theoretically at low subsonic speeds. The effects of changes in wing-body geometry such as nose-position and shape, fuselage cross-sectional shape, and wing vertical height are described. The theoretical model which represented separated flow phenomena by a simple vortex model is described in an appendix.

NACA RM L55L28

EXPERIMENTAL RESULTS FROM A TEST IN ROUGH AIR AT HIGH SUBSONIC SPEEDS OF A TAILLESS ROCKET MODEL HAVING CRUCIFORM TRIANGULAR WINGS, AND A NOTE ON THE CALCULATION OF MEAN SQUARE LOADS OF AIRCRAFT IN CONTINUOUS ROUGH AIR. A. James Vitale and Jesse L. Mitchell. April 1956. 25p. diagrs., photo., tab. (NACA RM L55L28)

Flight tests in continuous rough air at transonic speeds have been made of a tailless rocket model having cruciform 60° triangular wings. The variation of root-mean-square acceleration with Mach number is presented. The cruciform-wing arrangement is evaluated as a means of improving rocket-propelled-model rough-air tests. A simplified chart, based on power-spectral methods of generalized harmonic analysis, is presented which permits a rapid estimation of the mean square acceleration of aircraft for flight through continuous rough air.

NACA RM L55L29

RESULTS OF ROCKET MODEL TEST OF AN AIRPLANE CONFIGURATION HAVING AN ARROW WING AND SLENDER FLAT-SIDED FUSELAGE. LIFT, DRAG, LONGITUDINAL STABILITY, LATERAL FORCE, AND JET EFFECTS AT MACH NUMBERS BETWEEN 1.0 AND 2.3. Robert F. Peck. February 1956. 26p. diagrs., photo. (NACA RM L55L29)

A rocket-propelled model of an airplane configuration having an arrow wing (with 55° leading-edge sweep) in combination with a slender, flat-sided fuselage mounting swept horizontal and vertical tails has been used by the Langley Pilotless Aircraft Research Division to investigate its aerodynamic characteristics at Mach numbers between 1.0 and 2.3 through use of the pulsed-control technique. Lift and stability data agreed well with theoretical estimates and jet-effects data were in agreement with expectations based on previous data.

NACA RM L55L30

EFFECTS OF LEADING-EDGE RADIUS ON THE LONGITUDINAL STABILITY CHARACTERISTICS OF TWO 60° SWEPTBACK WINGS AT HIGH REYNOLDS NUMBERS. William C. Schneider. March 1956. 46p. diagrs. (NACA RM L55L30)

Force-test data showing the effects of changes in leading-edge radius, aspect ratio, Reynolds number, and Mach number are presented for a 60° sweptback wing. Data are presented for leading-edge radii of 0.89 and 1.30 percent chord, aspect ratios of 2 and 3, Reynolds numbers up to 10.40×10^{6}, and Mach numbers up to 0.30. These data are a continuation of the data presented in NACA RM L55F06 and RM L55H04.

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NACA RM L55L30a

LOW-SPEED INVESTIGATION OF THE EFFECTS OF WING DIHEDRAL ANGLE AND FIN LENGTH ON THE STATIC STABILITY CHARACTERISTICS OF A MODEL HAVING AN 82° DELTA WING. Kenneth P. Spreemann. April 1956. 30p. diagrs. (NACA RM L55L30a)

An investigation was conducted in the Langley 300 MPH 7- by 10-foot tunnel at dynamic pressures of 40 and 60 pounds per square foot and corresponding Reynolds numbers of 6.09×10^6 and 7.42×10^6, based on the mean aerodynamic chord, to determine the effects of changes in wing dihedral angle and length and position of fins on the static stability characteristics of an 82° delta-wing—body configuration. Wing dihedral angles of 0° and ±30° and three fins of different lengths mounted above and below the fuselage were investigated.

NACA RM L57C14

SOME EFFECTS OF HEAT TRANSFER AT MACH NUMBER 2.0 AT STAGNATION TEMPERATURES BETWEEN 2,310° AND 3,500° R ON A MAGNESIUM FIN WITH SEVERAL LEADING-EDGE MODIFICATIONS. William M. Bland, Jr., and Walter E. Bressette. April 1957. 29p. diagrs., photos., tab. (NACA RM L57C14)

Four models of a thin magnesium fin, with the leading edge swept back 35°, have been tested in the preflight high-temperature jet of the Langley Pilotless Aircraft Research Station at Wallops Island, Va., at a Mach number of 2.0 for various stagnation temperatures between 2,310° and 3,500° R. This exploratory investigation was made to determine some effects of aerodynamic heating at high stagnation temperatures on the leading edges of fins and to determine the relative effectiveness of several leading-edge protective schemes.

#NACA Conference on Ram Jets dated October 29, 1946.

#NACA Conference on Combustion dated March 26, 1947.

#NACA Conference on Supersonic Aerodynamics dated June 19-20, 1947.

#NACA Conference on Aerodynamic Problems of Transonic Airplane Design dated November 5-6, 1947.

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Research Abstracts and Reclassification Notice

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1302

ON PANEL FLUTTER AND DIVERGENCE OF INFINITELY LONG UNSTIFFENED AND RING-STIFFENED THIN-WALLED CIRCULAR CYLINDERS. Robert W. Leonard and John M. Hedgepeth. 1957. ii, 19p. diagrs. (NACA Rept. 1302. Supersedes TN 3638)

A preliminary theoretical investigation of the panel flutter and divergence of infinitely long, unstiffened and ring-stiffened thin-walled circular cylinders is described. Analytical criteria for the location of stability boundaries are presented along with a limited number of computed results.

NACA Rept. 1304

FLIGHT INVESTIGATION OF THE EFFECTIVENESS OF AN AUTOMATIC AILERON TRIM CONTROL DEVICE FOR PERSONAL AIRPLANES. William H. Phillips, Helmut A. Kuehnel, and James B. Whitten. 1957. ii, 15p. diagrs., photos. (NACA Rept. 1304. Supersedes TN 3637)

An analytical and flight investigation has been made to determine the effectiveness of an automatic aileron trim control device in conjunction with preloaded aileron centering springs in improving spiral stability characteristics of a personal airplane. The results indicate that the device can maintain the airplane in level flight under instrument conditions despite disturbances due to moderate turbulence or trim changes with airspeed and flight condition.

NACA Rept. 1310

AN INVESTIGATION OF FOUR WINGS OF SQUARE PLAN FORM AT A MACH NUMBER OF 6.9 IN THE LANGLEY 11-INCH HYPERSONIC TUNNEL. Charles H. McLellan, Mitchel H. Bertram, and John A. Moore. 1957. ii, 18p. diagrs., photos. (NACA Rept. 1310. Supersedes RM L51D17)

The results of tests of four wings at a Mach number of about 6.86 and a Reynolds number of 0.98×10^6 are presented. The wings had square plan forms with 5-percent-thick diamond, half-diamond, wedge, and half-circular-arc sections. The boundary layer was found to have a large effect on the pressure distributions. Reasonable agreement was indicated between the aerodynamic coefficients from experimental pressure data and inviscid theory. Total-drag measurements showed good agreement with the theory at low angles of attack when the effects of surface friction were included. At the higher angles of attack, both lift coefficient and drag coefficient were slightly below the values predicted by the two-dimensional theory.

NACA Rept. 1311

DETERMINATION OF VORTEX PATHS BY SERIES EXPANSION TECHNIQUE WITH APPLICATION TO CRUCIFORM WINGS. Alberta Y. Alksne. 1957. iii, 13p. diagrs., photos. (NACA Rept. 1311. Supersedes TN 3670)

A series method is applied to the computation of vortex positions behind a slender equal-span cruciform wing at any angle of bank as a function of the distance behind the trailing edge. Calculated paths are compared with the results of water-tank experiments and of a closed expression given in NACA TN 2605. The forces on an equal-span interdigitated cruciform tail behind a slender equal-span cruciform wing are calculated for five angles of bank from the vortex positions found by use of the series.

NACA Rept. 1312

SOME EFFECTS OF BLUNTNESS ON BOUNDARY-LAYER TRANSITION AND HEAT TRANSFER AT SUPERSONIC SPEEDS. W. E. Moeckel. 1957. ii, 14p. diagrs. (NACA Rept. 1312. Supersedes TN 3653)

Large downstream movements of transition observed when the leading edges of a hollow cylinder or a flat plate are slightly blunted are explained in terms of the reduction in Reynolds number at the outer edge of the boundary layer due to the detached shock wave. This Reynolds number reduction leads to a predicted downstream movement of transition which is in good agreement with the hollow-cylinder result at Mach 3.1. Application of this theory to other Mach numbers yields the result that blunting the tip of slender cones or the leading edge of thin wedges should produce downstream movements of transition by factors ranging from 2 at Mach number 3.0 to 30 at Mach number 15.

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NACA Rept. 1313

EXPLORATORY INVESTIGATION OF BOUNDARY-LAYER TRANSITION ON A HOLLOW CYLINDER AT A MACH NUMBER OF 6.9. Mitchel H. Bertram. 1957. ii, 27p. diagrs., photos. (NACA Rept. 1313. Supersedes TN 3546)

The Reynolds number for transition on the outside of a hollow cylinder with heat transfer from the boundary layer to the wall has been investigated at a Mach number of 6.9 in the Langley 11-inch hypersonic tunnel. The type of boundary layer was determined from impact-pressure surveys and optical viewing. From a correlation of results obtained from various sources at lower Mach numbers (in the range 2.0 to 4.5) and data from the present tests with variable Reynolds number per inch, leading-edge thickness and free-stream Reynolds number per inch appear to be important considerations in flat-plate transition results. At a given Mach number, it appears that the Reynolds number based on leading-edge thickness is an important parameter that must be considered in comparisons of flat-plate transition data from various installations.

NACA Rept. 1315

ON SLENDER-BODY THEORY AT TRANSONIC SPEEDS. Keith C. Harder and E. B. Klunker. 1957. ii, 6p. (NACA Rept. 1315. Supersedes TN 3815)

The basic ideas of the slender-body approximation have been applied to the nonlinear transonic-flow equation for the velocity potential in order to obtain some of the essential features of slender-body theory at transonic speeds. The results of the investigation are presented from a unified point of view which demonstrates the similarity of slender-body solutions in the various Mach number ranges. The transonic area rule and some conditions concerning its validity follow from the analysis.

NACA Rept. 1316

TORSIONAL STIFFNESS OF THIN-WALLED SHELLS HAVING REINFORCING CORES AND RECTANGULAR, TRIANGULAR, OR DIAMOND CROSS SECTION. Harvey G. McComb, Jr. ii, 14p. diagrs. (NACA Rept. 1316. Supersedes TN 3749)

A theoretical investigation is presented of the torsional stiffness of thin-walled aerodynamic surfaces filled with cores which stabilize the skins. Rectangular, slender triangular, and slender diamond cross sections are considered. Results for the torsional stiffness constants are shown graphically.

NACA Rept. 1318

THREE-DIMENSIONAL TRANSONIC FLOW THEORY APPLIED TO SLENDER WINGS AND BODIES. Max. A. Heaslet and John R. Spreiter. 1957. iii, 29p. diagrs. (NACA Rept. 1318. Supersedes TN 3717)

Integral equations for transonic flow around slender wings and bodies are derived assuming shock waves are present. For sonic flow, Oswatitsch's equivalence rule is extended to lifting cases at small angles of attack. Relationships are presented between the pressure distributions and integrated forces on slender wings and bodies having the same longitudinal distribution of cross-section area. Specific application is made to slender cone-cylinders of elliptic cross sections of varying eccentricity. The conclusions are supported both by formal analysis of the order of the error terms and by comparison with existing theoretical and experimental information.

NACA RM L57J15

LOW-SPEED BOUNDARY-LAYER-CONTROL INVESTIGATION ON A THIN RECTANGULAR SEMI-SPAN WING WITH LEADING-EDGE AND TRAILING-EDGE FLAPS. Delwin R. Croom and Thomas R. Turner. January 1958. 213p. diagrs., tabs. (NACA RM L57J15)

Results are presented, without discussion, of a wind-tunnel investigation to determine the longitudinal aerodynamic characteristics and the chordwise load distribution on a thin, untapered, unswept wing having an aspect ratio of 3.33 and NACA 65A004 airfoil sections. The wing was equipped with leading-edge and trailing-edge flaps. Boundary-layer control was obtained by blowing air over the trailing-edge flaps.

NACA RM L57J17

EFFECTIVENESS OF VARIOUS PROTECTIVE COVERINGS ON MAGNESIUM FINS AT MACH NUMBER 2.0 AND STAGNATION TEMPERATURES UP TO 3,600° R. William M. Bland, Jr. January 1958. 48p. diagrs., photos., tab. (NACA RM L57J17)

Eight thin magnesium fins, seven with the leading edges swept back 17° and one with the leading edge swept back 45°, have been tested in the preflight high-temperature jet of the Langley Pilotless Aircraft Research Station at Wallops Island, Va. Protective coverings, designed to alleviate the effects of aerodynamic heating on fins used during the first stages of rocket-propelled multistage hypersonic models, have been applied to these fins. Temperatures measured at various locations on the fins indicated the effectiveness of the various coverings. Effective air gaps between the layers of material were calculated using simple heat-balance relations.

CURRENT NACA RESEARCH REPORTS

NACA TM 1431

ON THE STATISTICAL THEORY OF TURBULENCE. (Zur statistischen Theorie der Turbulenz). W. Heisenberg. January 1958. 36p. diagrs. (NACA TM 1431. Translation from Zeitschrift für Physik, v. 124, 1948, p. 628-657)

A study is made of the spectrum of isotropic turbulence with the aid of the customary method of Fourier analysis. The spectrum of the turbulent motion is derived to the smallest wave lengths, that is, into the laminar region, and correlation functions and pressure fluctuations are calculated. A comparison with experimental results is included. Finally, an attempt is made to derive the numerical value of a constant characteristic of the energy dissipation in isotropic turbulence.

NACA TN 3987

EFFECT OF ENVIRONMENTS OF SODIUM HYDROXIDE, AIR, AND ARGON ON THE STRESS-RUPTURE PROPERTIES OF NICKEL AT 1500° F. Howard T. McHenry and H. B. Probst. January 1958. 23p. diagrs., photos., tab. (NACA TN 3987)

Stress-rupture lives of nickel tubes both containing sodium hydroxide and devoid of sodium hydroxide were determined for testing environments of argon and air. Sodium hydroxide had no effect on the strength of nickel in argon. Severe intergranular and surface oxidation of nickel tubes tested in air increased their rupture strength over that of similar specimens tested in argon. This strengthening was partly lost when the tubes contained sodium hydroxide.

NACA TN 4069

EFFECT OF ANGLE OF ATTACK AND THICKNESS ON AERODYNAMIC COEFFICIENTS OF A RIGID WING OSCILLATING AT VERY LOW FREQUENCIES IN TWO-DIMENSIONAL SUPERSONIC FLOW. Frank S. Malvestuto, Jr., and Julia M. Goodwin. January 1958. 65p. diagrs. (NACA TN 4069)

Analytical expressions are presented for the effect of angle of attack and thickness on the lift and pitching-moment derivatives of a wing performing a plunging motion and rotary oscillations at very low frequencies in two-dimensional flow. Design charts are presented which permit rapid calculation of these coefficients. The results presented are for a range of Mach number, angle of attack, and thickness for which the flow behind the shock attached to the leading edge is everywhere supersonic, although the effect of viscous separation at finite angles of attack restricts the validity of the results to a much smaller range of these parameters.

NACA TN 4086

DISCRETE POTENTIAL THEORY FOR TWO-DIMENSIONAL LAPLACE AND POISSON DIFFERENCE EQUATIONS. Charles Saltzer, Case Institute of Technology. January 1958. 60p. diagrs., tabs. (NACA TN 4086)

A method is given for solving problems associated with Laplace and Poisson equations which, in general, requires considerably fewer equations than the usual methods and which gives a convergent solution by the method of successive approximations.

NACA TN 4109

LOW-SPEED YAWED-ROLLING CHARACTERISTICS AND OTHER ELASTIC PROPERTIES OF A PAIR OF 40-INCH-DIAMETER, 14-PLY-RATING, TYPE VII AIRCRAFT TIRES. Walter B. Horne and Robert F. Smiley. January 1958. 80p. diagrs., photos., tabs. (NACA TN 4109)

The low-speed cornering characteristics of the tires under yawed rolling were determined over a range of inflation pressures and yaw angles for two vertical loads. Static tests were also performed to determine the tire vertical, lateral, torsional, and fore-and-aft elastic characteristics. The quantities measured included lateral or cornering force, drag force, twisting moment or self-alining torque, pneumatic caster, vertical and lateral tire deflections, wheel torsion or yaw angle, rolling radius, and relaxation length.

NACA TN 4110

MECHANICAL PROPERTIES OF PNEUMATIC TIRES WITH SPECIAL REFERENCE TO MODERN AIRCRAFT TIRES. Robert F. Smiley and Walter B. Horne. January 1958. 166p. diagrs., photo., tabs. (NACA TN 4110)

A study is presented of most of the properties of pneumatic tires which are of interest to aircraft designers. The principal topics discussed are tire vertical-force-deflection characteristics; lateral, fore-and-aft, and torsional spring constants; footprint-area properties; relaxation lengths; rolling radius; cornering force, cornering power, self-alining torque, and pneumatic caster for yawed rolling conditions; effects of wheel tilt; and tire radial growth under the influence of centrifugal forces. For each tire property considered, semiempirical equations are set up which take into account the major factors pertinent to the property. Wherever possible each equation is compared with the available experimental data to establish its degree of reliability.

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NACA TN 4118

LOW-TEMPERATURE, VAPOR-PHASE OXIDATION OF FUEL-RICH HYDROCARBON MIXTURES. William T. House and Milton Orchin, University of Cincinnati. January 1958. 30p. diagrs., tabs. (NACA TN 4118)

The vapor-phase oxidation of methylcyclohexane was studied in a flow system in the temperature range of 300° to 400° C under the conditions of 0.1 the stoichiometric amount of oxygen, a contact time of 8 seconds, and a spiral Pyrex reactor 10.5 inches long with an inside diameter of 3/32 inch. The yields of acids, aldehydes, ketones, hydrogen peroxide, organic peroxides, olefin, water, and unreacted hydrocarbon were determined in the products.

NACA TN 4120

THEORETICAL CALCULATIONS OF SUPERSONIC WAVE DRAG AT ZERO LIFT FOR A PARTICULAR STORE ARRANGEMENT. Kenneth Margolis, Frank S. Malvestuto, Jr., and Peter J. Maxie, Jr. January 1958. 37p. diagrs., tab. (NACA TN 4120)

A linearized-theory analysis of the wave drag at zero lift is carried out for a simple two-body arrangement consisting of two wedgelike surfaces, each with a rhombic lateral cross section and emanating from a common apex. Such an arrangement could be used as two stores, either embedded within or mounted below a wing, or as auxiliary bodies wherein the upper halves could be used as stores and the lower halves for bomb or missile purposes. Consideration is also given the case of two similar bodies in a parallel arrangement. The calculations encompass the complete range of supersonic speeds.

NACA TN 4126

EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF SOME SHROUD DESIGN VARIABLES ON THE STATIC THRUST CHARACTERISTICS OF A SMALL-SCALE SHROUDED PROPELLER SUBMERGED IN A WING. Robert T. Taylor. January 1958. 23p. diagrs., photos. (NACA TN 4126)

An experimental investigation has been made to determine the effects of shroud-lip radius, shroud length, and shroud diffuser angle on the static thrust characteristics of a small-scale shrouded propeller submerged in the wing of an airplane. The relatively short shrouds necessary with this type of installation do not seem to affect adversely the static thrust characteristics of the shrouded propeller. The important variables were found to be shroud-lip radius and distance of the shroud exit from the ground.

NACA TN 4137

FATIGUE BEHAVIOR OF AIRCRAFT STRUCTURAL BEAMS. W. S. Hyler, H. G. Popp, D. N. Gideon, S. A. Gordon, and H. J. Grover, Battelle Memorial Institute. January 1958. 60p. diagrs., photos., tabs. (NACA TN 4137)

This investigation involved a study of the correlation of composite structural fatigue behavior, basic material, and simple-element behavior. Fatigue and related static tests were made on aluminum-alloy box beams and I-beams and also on elements simulating key failure locations in the two beams.

NACA TN 4144

EFFECT OF OXYGEN RECOMBINATION ON ONE-DIMENSIONAL FLOW AT HIGH MACH NUMBERS. Steve P. Heims. January 1958. 52p. diagrs. (NACA TN 4144)

A theoretical analysis of air flow in a stream tube, in which oxygen dissociation and recombination occur, has been made. The theory developed permits a finite reaction rate which varies from point to point along the flow. An estimate of the rate of reaction is made and a numerical example is worked out for a stream tube with a shape that might be expected for air flowing around a blunt body.

NACA TN 4146

CONTRIBUTION OF THE WING PANELS TO THE FORCES AND MOMENTS OF SUPERSONIC WING-BODY COMBINATIONS AT COMBINED ANGLES. J. Richard Spahr. January 1958. 62p. diagrs., photo., tabs. (NACA TN 4146)

A wind-tunnel investigation was made at a Mach number of 1.96 to determine the normal forces, pitching moments, and rolling moments contributed by each wing panel of a cruciform-wing and body combination over a wide range of combined angles of pitch and roll. The wings were triangular of aspect ratio 2, and the body was an ogive-cylinder combination. The effect on these characteristics of forebody length and roughness, Reynolds number, and panel-panel interference was investigated. A general theoretical method was developed which provided a satisfactory prediction of the panel results.

NACA TN 4148

THEORETICAL PRESSURE DISTRIBUTIONS FOR SEVERAL RELATED NONLIFTING AIRFOILS AT HIGH SUBSONIC SPEEDS. John R. Spreiter, Alberta Y. Alksne, and B. Jeanne Hyett. January 1958. (i), 52p. diagrs., tab. (NACA TN 4148)

Five related airfoils, including thin circular-arc airfoils, are considered. These airfoils have various locations for the point of maximum thickness

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ranging from 30- to 70-percent chord and are of arbitrary, although small, thickness ratio. The results are obtained by approximate solution, through an iteration process, of a nonlinear integral equation derived from the equations of transonic flow theory. It is shown that the pressure distributions display most of the principal phenomena observed in experimental studies, and are in good correspondence with those calculated by other methods for subcritical Mach numbers and for Mach numbers near 1.

NACA TN 4157

CORROSION RESISTANCE OF NICKEL ALLOYS IN MOLTEN SODIUM HYDROXIDE. H. B. Probst, C. E. May, and Howard T. McHenry. January 1958. 26p. diagr., photos., tabs. (NACA TN 4157)

Corrosion resistance of 11 materials at 1500° and 1700° F was compared with the excellent corrosion-resistant properties of pure nickel. The materials were noncommercial solid-solution alloys and two-phase materials. The latter were strengthened either by precipitation or mechanical dispersion of small particles. Intergranular attack in these materials was considerably less than that reported for commercial nickel-base alloys. The Ni + 30 percent Cu alloy exhibited resistance to corrosion comparable with that of pure nickel; other materials (Ni+Mo, Ni+Zr, Ni+Sn, Ni+TiC, Ni+MgO, and Ni+Al_2O_3) appeared promising.

NACA TN 4159

EXPERIMENTAL INVESTIGATION OF TURBOJET-ENGINE MULTIPLE-LOOP CONTROLS FOR NON-AFTERBURNING AND AFTERBURNING MODES OF ENGINE OPERATION. Donald B. Kirsch, Leon M. Wenzel, and Clint E. Hart. January 1958. 61p. diagrs., tab. (NACA TN 4159)

Multiple-loop controls optimized rotor speed and turbine-discharge temperature transients during thrust increase and afterburner ignition by manipulation of engine fuel flow and exhaust-nozzle area. Good engine transient performance characteristics were obtained with a control system in which engine speed was controlled by manipulation of exhaust-nozzle area and turbine-discharge temperature by engine fuel flow. Acceptable although more oscillatory transient responses were obtained with a control system in which speed was controlled by manipulation of engine fuel flow, turbine-discharge temperature was controlled by manipulation of exhaust-nozzle area, and a noninteraction gain term was incorporated from the speed- to the temperature-control loops.

NACA TN 4163

EFFECT OF TEMPERATURE ON ROLLING-CONTACT FATIGUE LIFE WITH LIQUID AND DRY POWDER LUBRICANTS. Thomas L. Carter. January 1958. 40p. diagrs., photos., tabs. (NACA TN 4163)

The fatigue life of AISI M-1 tool steel was determined at temperatures of 100°, 250°, and 450° F with di(2-ethylhexyl)sebacate lubricant and at 450° F with dry powder lubricants. With the sebacate, lubricant life decreased with increasing temperature. At 100° F a suspension of molybdenum disulfide in polyalkylene gylcol produced a definite limit on fatigue life because of stress-corrosion penetration to the subsurface zone of high shear stress. The lowering of fatigue life with dry powder lubricants at 450° F appeared to be due to the lubricant particles acting as stress raisers localized in the bands of pure rolling within the contact zone.

NACA TN 4164

TWO-DIMENSIONAL DIFFUSION THEORY ANALYSIS OF REACTIVITY EFFECTS OF A FUEL-PLATE-REMOVAL EXPERIMENT. Edward R. Gotsky, James P. Cusick, and Donald Bogart. January 1958. 30p. diagrs., photos., tab. (NACA TN 4164)

Effects of fuel plates successively withdrawn from the center fuel element of a seven- by three-core loading at the Oak Ridge Bulk Shielding Facility were evaluated by two-dimensional two-group diffusion calculations performed on the NACA reactor simulator. Two calculation methods were used: (1) The slowing-down properties of the experimental fuel element were represented by infinite media parameters; and (2) the finite size of the experimental fuel element was recognized, and the slowing-down properties of the surrounding core were attributed to this small region. Reasonable agreement existed between experimental and calculated effects.

NACA TN 4168

A METHOD FOR CALCULATION OF HYDRODYNAMIC LIFT FOR SUBMERGED AND PLANING RECTANGULAR LIFTING SURFACES. Kenneth L. Wadlin and Kenneth W. Christopher. January 1958. 34p. diagrs. (NACA TN 4168)

A method is presented for the calculation of lift coefficients for rectangular lifting surfaces of aspect ratios from 0.125 to 10 operating at finite depths beneath the water surface, including the zero depth or planing condition. Theoretical values are compared with experimental values obtained at various depths of submergence with lifting surfaces of aspect ratios from 0.125 to 10. The method can also be applied to hydrofoils with dihedral. Lift coefficients computed by this method are in good agreement with existing experimental data for aspect ratios from 0.125 to 10 and dihedral angles up to 30°.

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NACA TN 4172

NOISE SURVEY UNDER STATIC CONDITIONS OF A TURBINE-DRIVEN FULL-SCALE MODIFIED SUPERSONIC PROPELLER WITH AN ADVANCE RATIO OF 3.2. Max C. Kurbjun. January 1958. 17p. diagrs., photo., tabs. (NACA TN 4172)

Overall sound-pressure levels and frequency spectra of the noise emitted from a 10-foot-diameter, 1,700-rpm, three-blade modified supersonic propeller mounted on a turbine-powered airplane have been measured under static conditions around a circle with a 100-foot radius about the propeller hub. The results are compared with the results from a supersonic and a conventional subsonic propeller. The effects of power and rotational speed change on the noise levels and spectra are also shown.

NACA TN 4176

EFFECT OF FLOW INCIDENCE AND REYNOLDS NUMBER ON LOW-SPEED AERODYNAMIC CHARACTERISTICS OF SEVERAL NONCIRCULAR CYLINDERS WITH APPLICATIONS TO DIRECTIONAL STABILITY AND SPINNING. Edward C. Polhamus. January 1958. 54p. diagrs., photo., tab. (NACA TN 4176)

Cylinders with several cross-sectional shapes (including squares having various corner radii, rectangles, and a triangle) were studied. Since the flow incidences correspond to combined angles of attack and sideslip in the crossflow plane of three-dimensional bodies, the two-dimensional side-force results appear to have strong implications with regard to directional stability at high angles of attack and these implications, along with those associated with spin characteristics, are briefly discussed.

NACA TN 4177

WIND-TUNNEL INVESTIGATION OF THE STATIC LONGITUDINAL STABILITY AND TRIM CHARACTERISTICS OF A SWEPTBACK-WING JET-TRANSPORT MODEL EQUIPPED WITH AN EXTERNAL-FLOW JET-AUGMENTED FLAP. Joseph L. Johnson, Jr. January 1958. 89p. diagrs., tab. (NACA TN 4177)

The investigation included tests of the model to determine the effects of wing position, vertical position of the horizontal tail, and size of the horizontal tail for a range of momentum coefficients up to about 4. The model had a 30° sweptback wing with an aspect ratio of 6.60. Calculations were made to compare the relative merits of various trim devices for use on airplanes equipped with jet-augmented flaps.

NACA TN 4178

LOW-SPEED CASCADE INVESTIGATION OF COMPRESSOR BLADES HAVING LOADED LEADING EDGES. James C. Emery. January 1958. 76p. diagrs., photo., tabs. (NACA TN 4178. Supersedes RM L55J05)

Blade cambers having isolated-airfoil lift coefficients of 0.6, 1.2, 1.8, and 2.4 were tested over the usable angle-of-attack range for inlet-air angles of 30°, 45°, and 60° at solidities of 1.0 and 1.5. A comparative evaluation has been made of the results of this and previous cascade investigations of compressor blades having uniform chordwise loading as isolated airfoils and those having more loading at the trailing edge.

NACA TN 4179

ANALYTICAL INVESTIGATION OF ACCELERATION RESTRICTION IN A FIGHTER AIRPLANE WITH AN AUTOMATIC CONTROL SYSTEM. James T. Matthews, Jr. January 1958. 24p. diagrs. (NACA TN 4179)

A theoretical analysis was made to investigate the acceleration-restriction capabilities of several types of normal-acceleration control systems in a typical subsonic jet fighter airplane. The normal-acceleration response of the controlled airplane to simulated rough air was also investigated.

NACA TN 4182

PHYSICAL CHARACTERISTICS AND TEST CONDITIONS OF AN ETHYLENE-HEATED HIGH-TEMPERATURE JET. Roland D. English, Abraham Spinak, and Eldred H. Helton. January 1958. 28p. diagrs., photos. (NACA TN 4182)

A ground test facility has been developed at the Langley Pilotless Aircraft Research Station at Wallops Island, Va., that is capable of producing temperatures up to nearly 5,000° R. Conditions in the test section obtained from the calibration runs and from the calculated thermal properties of the exhaust gas are presented over the range of stagnation temperatures available.

NACA TN 4185

WIND-TUNNEL INVESTIGATION OF EFFECT OF SWEEP ON ROLLING DERIVATIVES AT ANGLES OF ATTACK UP TO 13° AND AT HIGH SUBSONIC MACH NUMBERS, INCLUDING A SEMIEMPIRICAL METHOD OF ESTIMATING THE ROLLING DERIVATIVES. James W. Wiggins. January 1958. 47p. diagrs., tab. (NACA TN 4185. Supersedes RM L54C26)

Results are presented of an investigation to determine the rolling derivatives for swept-wing—body configurations. The wing had sweep angles of 3.6°, 32.6°, 45°, and 60° at the quarter-chord line, an aspect ratio of 4, a taper ratio of 0.6, and an

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NACA 65A006 airfoil section parallel to the free stream. Some tests were made of the 45° swept wing with fences located at the 65-percent-semispan station.

NACA TN 4189

LIFT AND MOMENT ON THIN ARROWHEAD WINGS WITH SUPERSONIC EDGES OSCILLATING IN SYMMETRIC FLAPPING AND ROLL AND APPLICATION TO THE FLUTTER OF AN ALL-MOVABLE CONTROL SURFACE. H. J. Cunningham. January 1958. 58p. diagrs. (NACA TN 4189)

A method based on linearized supersonic potential-flow theory, applied previously to vertical translation and pitching oscillations, is applied herein to symmetric flapping and rolling oscillations to obtain section and total unsteady lift and moment coefficients. Spanwise distributions are illustrated and compared with results of a strip-theory method. The aerodynamic coefficients are applied to a coupled-mode flutter analysis of an all-movable control surface for which the flexibilities are concentrated in a supporting shaft.

NACA TN 4190

EXPERIMENTAL INVESTIGATION OF THE LATERAL TRIM OF A WING-PROPELLER COMBINATION AT ANGLES OF ATTACK UP TO 90° WITH ALL PROPELLERS TURNING IN THE SAME DIRECTION. William A. Newsom, Jr. January 1958. 27p. diagrs. (NACA TN 4190)

The investigation was conducted with a model having four propellers, the slipstream from which covered practically the entire span of the wing. Tests were made at angles of attack up to 90° for various differential flap deflections and differential blade pitch on the outboard propellers. The lateral trim of the configuration tested was marginal. It seems likely, therefore, that some tilting-wing vertical-take-off airplanes could be trimmed with all the propellers rotating in the same direction whereas others could not.

NACA TN 4193

SUBSONIC FLIGHT INVESTIGATION OF METHODS TO IMPROVE THE DAMPING OF LATERAL OSCILLATIONS BY MEANS OF A VISCOUS DAMPER IN THE RUDDER SYSTEM IN CONJUNCTION WITH ADJUSTED HINGE-MOMENT PARAMETERS. Harold L. Crane, George J. Hurt, Jr., and John M. Elliott. January 1958. 45p. diagrs., photos., tab. (NACA TN 4193. Supersedes RM L54D09)

A single-degree-of-freedom analysis used as a guide to adjust the parameters is presented. A brief discussion of related problems which may result from the application of such a viscous damping device is given. The results of rudder trailing-edge strips to control rudder floating tendency are presented.

NACA TN 4195

SHAPE OF INITIAL PORTION OF BOUNDARY OF SUPERSONIC AXISYMMETRIC FREE JETS AT LARGE JET PRESSURE RATIOS. Eugene S. Love and Louise P. Lee. January 1958. 29p. diagrs. (NACA TN 4195)

Calculations have been made of the initial portion of the boundary of axisymmetric free jets exhausting at large pressure ratios from a conically divergent nozzle having a jet exit Mach number of 2.5 and a semidivergence angle of 15°. The results of the calculations indicate the size and shape of the jet to be expected at large pressure ratios, the effects of ratio of specific heats, and the large initial inclinations of the boundary that are likely to be encountered by hypersonic vehicles at high altitude.

NACA TN 4198

EFFECTS OF AIRPLANE FLEXIBILITY ON WING STRAINS IN ROUGH AIR AT 35,000 FEET AS DETERMINED BY A FLIGHT INVESTIGATION OF A LARGE SWEPT-WING AIRPLANE. Richard H. Rhyne. January 1958. 23p. diagrs., tab. (NACA TN 4198)

A flight investigation was made on a large sweptback-wing bomber airplane and the results are compared with data previously obtained at low altitude (5,000 feet). The effects of wing flexibility on the wing strains were, on the average, about 20 percent larger at the higher altitude.

NACA TN 4199

A FLIGHT INVESTIGATION OF THE EFFECTS OF VARIED LATERAL DAMPING ON THE EFFECTIVENESS OF A FIGHTER AIRPLANE AS A GUN PLATFORM. Helmut A. Kuehnel, Arnold R. Beckhardt, and Robert A. Champine. January 1958. 30p. diagrs., photo., tabs. (NACA TN 4199. Supersedes RM L53F08a)

Flight tests were conducted at three conditions of damping and two atmospheric turbulence levels with fixed-reticle, gyro computing, and telescopic gunsights. Results of simulated strafing runs indicate that the gun-line dispersion could be expected to be decreased about 7 percent by increased lateral damping and to be increased about 85 percent by decreased damping and about 40 percent by rough air of the type encountered. Use of the telescopic sight indicated a 20-percent decrease in gun-line dispersion.

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NACA TN 4201

COLLECTION OF ZERO-LIFT DRAG DATA ON BODIES OF REVOLUTION FROM FREE-FLIGHT INVESTIGATIONS. William E. Stoney, Jr. January 1958. 373p. diagrs., tabs. (NACA TN 4201)

This report presents a compilation of most of the zero-lift drag results obtained from free-flight measurements made by the Langley Pilotless Aircraft Research Division on fin-stabilized bodies of revolution. The data are arranged on standard forms, which also contain the significant geometrical factors. Supplementary data have been provided to facilitate the determination of the body pressure drags from the measured total drags. Summary plots and discussions have been included to provide a unified and broad picture of the effects of body geometry on zero-lift drag.

NACA TN 4208

TURBULENT BOUNDARY LAYER ON A YAWED CONE IN A SUPERSONIC STREAM. Willis H. Braun. January 1958. 39p. diagrs. (NACA TN 4208)

The momentum integral equations are derived for the boundary layer on an arbitrary curved surface, using a streamline coordinate system. Computations of the turbulent boundary layer on a slightly yawed cone are made for a Prandtl number 0.70, wall to free-stream temperature ratios of 1/2, 1, and 2, and Mach numbers from 1 to 4. Deflection of the fluid in the boundary layer from outer stream direction, local friction coefficient, displacement surface, lift coefficient, and pitching-moment coefficient are presented.

BRITISH REPORTS

N-4980*

Aeronautical Research Council (Gt. Brit.)
INDEX OF REPORTS AND MEMORANDA PUBLISHED IN THE ANNUAL TECHNICAL REPORTS (1909 TO 1947). 1957 (revised). 29p. tabs. ARC R & M 2600. (Ask for N-4980*)

N-10531X*

Aeronautical Research Council (Gt. Brit.)
THE REDUCTION TO STANDARD CONDITIONS OF TAKE-OFF MEASUREMENTS ON TURBO-JET AIRCRAFT. G. Jackson. APPENDIX II. K. J. Lush. 1957. 20p. tabs. ARC R & M 2890; ARC 14,127. Supersedes AAEE/Res/253. (Ask for N-10531X*)

A reduction method intended for routine use is derived whereby the take-off distance required for a turbojet aircraft to clear a 50-ft screen under a specified set of standard conditions of air temperature and pressure, wind speed, aircraft weight, and engine speed can be deduced from the distance measured in an arbitrary set of conditions. The method is basically similar to that used for piston-engined aircraft and the only information required in addition to that which can be observed is a numerical constant for the engine type. The method is shown to be not inconsistent with available experimental data.

N-14217X*

Aeronautical Research Council (Gt. Brit.)
AN APPROXIMATION TO THE SLOW MODE OF LONGITUDINALLY DISTURBED MOTION OF AN AIRCRAFT IN LEVEL FLIGHT. A. W. Thorpe. 1957. 27p. diagrs., tabs. ARC R & M 2907; ARC 14,759. Supersedes RAE Aero 2438. (Ask for N-14217X*)

This report develops an approximate theory of longitudinal response which applies to the slow mode of motion after a disturbance. This theory is complementary to that for the quick-period motion given by Gates and Lyon (1944). It predicts the slow motions which occur after the quick-period motions have died out. The approximate equations given are of second order only and can therefore be solved algebraically. This has been done and the general solutions are given in tables 1 and 2. Some numerical examples have been computed to indicate the accuracy which can be expected. The agreement with the first approximation is quite good and in some components it can be improved by the use of a further correction term.

N-14287X*

Aeronautical Research Council (Gt. Brit.)
AERODYNAMIC COEFFICIENTS FOR AN OSCILLATING DELTA WING. Doris E. Lehrian, National Physical Laboratory. 1957. 10p. diagrs., tabs. ARC R & M 2841. Supersedes ARC 14,156; 0.951. (Ask for N-14287X*)

Aerodynamic coefficients are calculated by the method described by Jones in R & M 2470 for a delta wing of AR = 3 which is assumed to be describing pitching and vertical translational oscillations of small amplitude in incompressible inviscid flow. The coefficients are calculated for values of 0.26 and 0.8 of the mean frequency parameter $\omega_m (\equiv pc_m/V)$, and certain of the coefficients are also obtained for $\omega_m \to 0$. It appears that the method provides a reasonable basis for calculating flutter derivatives, but it is not satisfactory for estimating all the stability derivatives. A modified version has been developed for the latter.

*AVAILABLE ON LOAN ONLY.

BRITISH REPORTS

N-16026X*

Aeronautical Research Council (Gt. Brit.)
A METHOD OF PERFORMANCE ESTIMATION FOR AXIAL-FLOW TURBINES. D. G. Ainley and G. C. R. Mathieson. 1957. 30p. illus. ARC R & M 2974; ARC 14,882. Supersedes NGTE R.111. (Ask for N-16026X*)

A method for calculation of the performance of conventional axial-flow turbines is presented. It makes use of data derived from the analysis of a large number of turbine tests and other associated test work reported elsewhere. The method enables the performance of a turbine to be calculated over a wide part of its full operating range. It is estimated that the tolerance on the absolute values of gas mass flow and peak efficiency will be in the region of ±2.0 percent for efficiency and ±3 percent for gas mass flow on present-day types of turbine. The method is illustrated by a worked example.

N-20293X*

Aeronautical Research Council (Gt. Brit.)
LOW-SPEED WIND-TUNNEL TESTS ON TWO THIN CRANKED WINGS WITH 60-DEG SWEEPBACK INBOARD. C. J. Mansell. 1957. 55p. diagrs., photos., tabs. ARC R & M 2995; ARC 15,404. Supersedes RAE Tech. Note Aero 2158. (Ask for N-20293X*)

Tests were made on two thin wings of aspect ratio 3 with 60° leading-edge sweep at the root. Their plan forms represent two designs which are likely to retain good high-speed qualities and yet yield acceptable stalling characteristics. The aims of these tests were to investigate how the general character of flow over wings of 60° sweepback differed from that over wings with smaller angles of sweepback; to delay or prevent the onset of longitudinal instability by the addition of nose and trailing-edge flaps; and to determine n_v and l_v and aileron effectiveness.

N-23832X*

Aeronautical Research Council (Gt. Brit.)
LOW-SPEED WIND-TUNNEL MEASUREMENTS OF LONGITUDINAL OSCILLATORY DERIVATIVES ON THREE WING PLAN-FORMS. G. F. Moss. 1957. 35p. diagrs., photos., tabs. ARC R & M 3009; ARC 15,972. Supersedes RAE Tech. Note Aero 2208. (Ask for N-23832X*)

Tests have been made on a 90° apex delta wing, a 60° sweptback wing, and a 40° sweptback wing to obtain values of longitudinal oscillatory derivatives for various frequencies, amplitudes, and Reynolds numbers. Values of $m_{\dot{\theta}}$ were obtained for all three and z_w for the delta model using free oscillation methods. In addition, z_θ, $z_{\dot{\theta}}$, m_θ, and $m_{\dot{\theta}}$ were measured by a forced oscillation method for the delta wing and the 60° sweptback wing. The effects of reduced frequency (over the range 0.01 to 0.3) amplitude (±1/2° to ±2° in pitch) and Reynolds number (0.72×10^6 to 3.3×10^6) were found to be small.

N-26297X*

Aeronautical Research Council (Gt. Brit.)
AERODYNAMIC FLUTTER COEFFICIENTS FOR SUBSONIC, SONIC, AND SUPERSONIC FLOW (LINEAR TWO-DIMENSIONAL THEORY). P. F. Jordan. 1957. 54p. diagrs., tabs. ARC R & M 2932; ARC 16,029. Supersedes RAE Structures 141. (Ask for N-26297X*)

The solution is derived for a two-dimensional airfoil oscillating with arbitrary downwash at sonic speed and is shown to be the limit of both the subsonic and the supersonic solutions as the Mach number tends to unity. Linear theory is shown to be applicable at sonic speed for an oscillating airfoil of zero thickness. The four main aerodynamic force coefficients for an oscillating two-dimensional wing are presented in the form of tables and isometric graphs over the ranges of M = 0 to 2 and frequency parameter of 0 to 1.4 based on the wing chord.

N-26658X*

Aeronautical Research Council (Gt. Brit.)
CALCULATIONS OF THE PRESSURE DISTRIBUTIONS AND BOUNDARY-LAYER DEVELOPMENT ON A BODY OF REVOLUTION WITH VARIOUS PARABOLIC AFTERBODIES AT SUPERSONIC SPEEDS. L. E. Fraenkel. 1957. 39p. diagrs., tabs. ARC R & M 2966; ARC 16,050. Supersedes RAE Aero 2482. (Ask for N-26658X*)

Detailed calculations are made of the flow over a series of bodies at M = 1.2, 1.4, and 1.6 and RN = 48 to 72 millions. The bodies consist of a basic forebody and parallel portion to which are added truncated parabolic afterbodies of three different thickness ratios. The calculations are in three main parts: calculation of the inviscid flow over the bodies, mainly by the method of characteristics; calculation of the boundary-layer properties by what is essentially an extension to compressible flows of the method of Squire and Young; and calculation of the pressure distribution on the "modified" afterbodies which result from adding the displacement thicknesses to the original profiles, by Ferri's method of linearized characteristics.

N-27113X*

Aeronautical Research Council (Gt. Brit.)
THE HARMONICALLY OSCILLATING WING WITH FINITE VORTEX TRAIL. P. F. Jordan. 1957. 18p. diagrs., tabs. ARC R & M 3038; ARC 16,228. Supersedes RAE Structures 148. (Ask for N-27113X*)

The wing of infinite span oscillating harmonically in incompressible flow but having a vortex trail of finite length Sc is discussed theoretically. The "incomplete circulation functions" C_S which arises in this case is tabulated. As an example, the damping moment due to slow pitching oscillations is shown for several values of S. The result is of interest as a wind-tunnel correction, in particular in that range of small frequencies which occurs in flight stability oscillations. Agreement with an experiment in an open-jet wind tunnel is obtained. A contradiction between different experiments in closed-jet wind tunnels is mentioned.

*AVAILABLE ON LOAN ONLY.

BRITISH REPORTS

N-28105X*

Aeronautical Research Council (Gt. Brit.)
CALCULATION OF STABILITY DERIVATIVES FOR OSCILLATING WINGS. Doris E. Lehrian, National Physical Laboratory. 1957. 23p. diagrs., tabs. ARC R & M 2922. Supersedes ARC 15,695; 0.1045; S & C 2750. (Ask for N-28105X*)

A method of calculating stability derivatives for wings oscillating at low frequencies is developed from the modified vortex-lattice method outlined in R & M 2470. Derivatives are obtained for the following wings describing plunging (vertical translational) and pitching oscillations: delta wings of AR = 1.2, 2 and 3 with taper ratio 1/7; arrowhead wing of AR = 1.32 with a taper ratio 7/18 and angle of sweep of 63.4° at c/4; and a circular plate. Comparison is made with measured values of the derivatives for the delta wing of AR = 1.2 and the arrowhead wing oscillating in incompressible flow.

N-30303X*

Aeronautical Research Council (Gt. Brit.)
THE DESIGN AND TESTING OF AN AXIAL COMPRESSOR HAVING A MEAN STAGE TEMPERATURE RISE OF 30 DEG C. A. D. S. Carter, S. J. Andrews, and E. A. Fielder. 1957. 14p. diagrs. ARC R & M 2985; ARC 16,775. Supersedes NGTE R. 148. (Ask for N-30303X*)

This report describes a compressor which was designed to give a mean stage temperature rise of 30° C. It has six stages so that the overall pressure ratio at the design point is 4·5:1. Full details of the factors which led to the form adopted and of the design itself are given in the report. The test results fully substantiated the design assumptions. In particular, using standard design data, it is possible to achieve temperature rises of about 30° C without sacrificing unduly any desirable performance features. Such temperature rises were considerably above those being used at the time this work was carried out, and are in fact substantially above the mean value used in present-day designs. Details of the stage characteristics and the matching of the compressor have been given in the report, together with some other points of special interest.

N-30501X*

Aeronautical Research Council (Gt. Brit.)
FLIGHT TESTS ON A VAMPIRE Mk. 5 WITH A REDESIGNED ANTI-SNAKING RUDDER. W. J. G. Pinsker. 1957. 16p. diagrs., tab. ARC R & M 3014; ARC 16,815. Supersedes RAE Aero 2506. (Ask for N-30501X*)

A specially designed rudder has been fitted to a Vampire Mk. 5 to act as an aerodynamic yaw damper. Flight tests show that the damping of the lateral oscillation has been substantially increased, in consequence, a logarithmic decrement greater than unity being attained even at 40,000-ft altitude. This is a considerable improvement on the results obtained previously on the same aircraft, when the standard rudder was used as the damping surface. Air-to-air aiming is shown to have benefited from the effect of the damping rudder.

N-32122X*

Aeronautical Research Council (Gt. Brit.)
MEASUREMENTS OF THE PATHS OF THE VORTEX CORES SHED FROM THE WINGS OF A TYPICAL GUIDED-MISSILE MODEL AT M = 1.57. R. H. Plascott. 1957. 20p. diagrs., photos. ARC R & M 3016; ARC 16,942. Supersedes RAE Tech. Note Aero 2296. (Ask for N-32122X*)

The paths of the cores of the vortex sheets shed from the wings of a typical guided-missile model, having cruciform rectangular wings mounted on a long cone-cylinder body, have been traced in their movement downstream over a range of incidence and yaw from 5° to 20° and 0° to 20°, respectively, at M = 1.57.

N-32208X*

Aeronautical Research Council (Gt. Brit.)
THEORY OF AEROFOILS ON WHICH OCCUR BUBBLES OF STATIONARY AIR. L. C. Woods. 1957. 16p. diagrs. ARC R & M 3049. Supersedes ARC 16,277; S & C 2825; FM 1973. (Ask for N-32208X*)

Spoilers, split flaps, and sometimes (with thin airfoils) incidence alone cause the flow to separate from the airfoil surface. This flow often reattaches to form a closed bubble of virtually stationary air at a fairly constant pressure. The paper sets out a mathematical theory of the subsonic inviscid flow external to the bubble whose position is assumed. The influence of the bubble on the lift and moment coefficients is calculated and some comments are made about the stalling of thin airfoils.

N-32876X*

Aeronautical Research Council (Gt. Brit.)
AN ANALYSIS OF THE LONGITUDINAL STABILITY AND CONTROL OF A SINGLE-ROTOR HELICOPTER. F. O'Hara. 1957. 22p. diagrs. ARC R & M 2958; ARC 16,954. Supersedes AAEE/Res/280. (Ask for N-32876X*)

The general theory of longitudinal stability and control for a single-rotor helicopter is presented in a form similar to that for fixed-wing aircraft. It is shown to be possible to establish for the helicopter in forward flight, in the same way as for fixed-wing aircraft, stick-fixed static and maneuver margins, on which the stability and handling qualities depend to a marked extent. Theoretical relations are derived for static margin, K_n, and maneuver margin, H_m, in a general form covering the case of a tail plane linked to the rotor control. Relations are also given for determining K_n and H_m from measured control changes to trim.

BRITISH REPORTS

N-34058X*

Aeronautical Research Council (Gt. Brit.)
WIND-TUNNEL WALL INTERFERENCE EFFECTS ON OSCILLATING AEROFOILS IN SUBSONIC FLOW. W. P. Jones. 1957. 21p. diagrs., tabs. ARC R & M 2943. Supersedes ARC 16,430; 0.1091; FM 2005; S & C 2846. (Ask for N-34058X*)

A theory is developed for estimating the effect of wind-tunnel walls on the air forces acting on an airfoil oscillating in a subsonic airstream. It can only be applied for a range of frequencies well below the frequency at which transverse vibrations of the airstream may be induced. The possibility of resonance occurring for certain combinations of tunnel height, frequency of oscillation of airfoil, wind speed, and Mach number was first pointed out by Runyan and Watkins, and the present paper confirms their conclusions. The method is applied to calculate aerodynamic derivatives for an oscillating flat plate in a wind tunnel of height equal to 4.75 airfoil chord and M = 0.7.

N-34306X*

Aeronautical Research Council (Gt. Brit.)
SCALE EFFECTS AT HIGH SUBSONIC AND TRANSONIC SPEEDS, AND METHODS FOR FIXING BOUNDARY-LAYER TRANSITION IN MODEL EXPERIMENTS. A. B. Haines, Royal Aircraft Establishment; D. W. Holder and H. H. Pearcey, National Physical Laboratory. 1957. 37p. diagrs., photos. ARC R & M 3012; ARC 17,225. Supersedes RAE Tech. Note Aero 2338. (Ask for N-34306X*)

Several methods which can be used to fix transition are described, and the results obtained by using them are compared. In general, in experiments in two-dimensional flow, good agreement is found, and explanations can be advanced for cases in which discrepancies occur. Several uncertainties and difficulties that arise in fixing transition are discussed and illustrated by examples; three-dimensional tests are also discussed.

N-34390X*

Aeronautical Research Council (Gt. Brit.)
THE STRENGTH OF ANNEALED AND HEAT-TREATED GLASS. F. G. J. Brown and J. Ellis. 1957. 37p. diagrs., tabs. ARC R & M 3003; ARC 17,253. Supersedes RAE Structures 167. (Ask for N-34390X*)

This report develops statistical methods of choosing allowable design stresses for annealed and heat-treated glass. The results are easy to apply but additional fundamental knowledge of some properties of glass is needed before they can be used to the best advantage. The report draws attention to these gaps in existing knowledge and makes recommendations for further research. The report discusses the influence of the known causes of strength variations between nominally identical specimens in relation to two types of glass typical of those used by the aircraft industry, and shows that improved control of heat-treatment processes offers the best hope of a big increase in the useful strength of glass.

N-34618X*

Aeronautical Research Council (Gt. Brit.)
A SURVEY OF THE ALTERNATING PRESSURES EXCITING HIGH FREQUENCY VIBRATIONS IN GAS TURBINES. J. R. Forshaw. 1957. 20p. diagrs., photo., tabs. ARC R & M 2989; ARC 17,133. Supersedes NGTE R. 158. (Ask for N-34618X*)

A survey of the predominant harmonic components of the alternating pressures is made for three centrifugal compressors, three axial-flow compressors, and a single-stage turbine to ascertain the forces exciting vibration in a compressor or turbine stage. The amplitude of the alternating pressures is dependent on the work done in a blade or impeller vane passage, the incidence at entry to the stage, the exit conditions, and the general flow conditions and there is usually a relative reduction when operating near the design point. There is a reduction in the alternating pressures with distance from the source, particularly across a blade row. Three other sources of excitation at part load are also discussed.

N-34952, pt. 2*

Royal Aircraft Establishment (Gt. Brit.)
THE FORMATION OF REGIONS OF SEPARATED FLOW ON WING SURFACES. PART II - LAMINAR SEPARATION BUBBLES AND THE MECHANISM OF THE LEADING-EDGE STALL. L. F. Crabtree. July 1957. 22p. diagrs., tab. RAE Aero 2578. (Ask for N-34952, pt. 2*)

The characteristics of laminar separation bubbles on thin and moderately thin airfoil sections at low speeds are discussed and explained. Further experimental confirmation of Owen's criterion for distinguishing between long and short bubbles is presented. Results of this investigation also show that there is no universal value of the boundary-layer Reynolds number at separation, $(R_{\delta 1})_s$, at which short bubbles break down into long bubbles. Some of the main gaps in previously published pictures of laminar separation bubbles are filled in so that a reasonably complete and coherent explanation of the characteristics of such flows is now possible. At the same time, this picture of bubble flows enables a more satisfactory explanation to be given of the scale effect on maximum lift and stalling characteristics of those airfoils which experience such bubble separations.

*AVAILABLE ON LOAN ONLY.

BRITISH REPORTS

N-36532X*

Aeronautical Research Council (Gt. Brit.)
MEASUREMENTS OF THE EFFECT OF WINDSCREEN SHAPES ON THE DRAG OF COCKPIT CANOPIES AT TRANSONIC AND LOW SUPERSONIC SPEEDS USING THE FREE-FLIGHT–MODEL TECHNIQUE. C. Kell. 1957. 10p. diagrs., photos., tabs. ARC R & M 3024; ARC 17,611. Supersedes RAE Aero 2529. (Ask for N-36532X*)

The effect of changes in the shape of the windscreen on the drag of a cockpit canopy has been measured on models in free flight. Canopies were attached to the models by means of a flexible mounting in such a way as to allow the canopy drag to be measured directly. The drag of the canopy was measured over a range of Mach numbers between 0.85 and 1.55 and the results show the improvements to be obtained by variations in the sweep of a vee windscreen and changes in the angle of a sloping windscreen.

N-36622*

Aeronautical Research Council (Gt. Brit.)
ON AERODYNAMIC SURFACE SOUND. O. M. Phillips, Trinity College. March 28, 1955 (revised). 14p. ARC 16,963; FM 2099. (Ask for N-36622*)

When a fluid in irregular or turbulent motion moves across the surface of a rigid body, dipole sound radiation can be produced by the fluctuating stress distribution set up at the boundary. This radiation generated by the interaction of fluid in motion with rigid surfaces is called aerodynamic surface sound. It is the purpose of this paper to establish some of the fundamental properties of the generation of sound in this manner. An integral theorem is derived which relates the motion over the surface and which can be applied in several cases to derive properties of the surface radiation field in a given flow.

N-36845X*

Aeronautical Research Council (Gt. Brit.)
THE AERODYNAMIC EFFECTS OF ASPECT RATIO AND SWEEPBACK ON WING FLUTTER. W. G. Molyneux and H. Hall. 1957. 17p. diagrs., tabs. ARC R & M 3011; ARC 17,782. Supersedes RAE Structures 175. (Ask for N-36845X*)

The report describes tests to obtain direct measurements of the aerodynamic effects of aspect ratio and sweepback on wing flutter. The tests were made on rigid wings with root flexibilities. It is shown that measured effects of aspect ratio and sweepback on the flutter of these wings can be represented quite closely in flutter calculations based on two-dimensional-flow theory by multiplying the two-dimensional aerodynamic coefficients by appropriate factors. The effect of sweepback is represented by multiplying all aerodynamic coefficients by $\cos \Lambda$, where Λ is the wing leading-edge sweepback, and the effect of aspect ratio is represented by multiplying the aerodynamic damping coefficients by $1/f(A)$ and the stiffness coefficients by $1/[f(A)]^2$ where A is the aspect ratio. For the wings tested an average value for $f(A)$ is $f(A) = \{1 + (0.8/A)\}$.

N-36895X*

Aeronautical Research Council (Gt. Brit.)
DERIVATIVE MEASUREMENTS AND FLUTTER TESTS ON A RECTANGULAR WING WITH A FULL-SPAN CONTROL SURFACE, OSCILLATING IN MODES OF WING ROLL AND AILERON ROTATION. W. G. Molyneux and F. Ruddlesden. 1957. 26p. diagrs., photos., tabs. ARC R & M 3010; ARC 17,751. Supersedes RAE Structures 172. (Ask for N-36895X*)

Details are given of tests to measure the aerodynamic coefficients for a rectangular wing with a full-span aileron oscillating in modes of wing roll and aileron rotation. A new technique was used in which aileron rotation was geared to wing roll so that oscillation occurred in both degrees of freedom simultaneously. The measured coefficients are compared with those derived from two-dimensional theory, and with coefficients estimated by an empirical method. The agreement with theory is poor but the estimated coefficients agree well with those measured. Flutter calculations for the system were made using both measured and theoretical derivatives, and the results are compared with flutter test results. The calculated flutter speed using measured derivatives agrees closely with that measured, whereas using theoretical derivatives the agreement is poor.

N-38243X*

Aeronautical Research Council (Gt. Brit.)
THE INFLUENCE OF DESIGN PRESSURE RATIO AND DIVERGENCE ANGLE OF THE THRUST OF CONVERGENT-DIVERGENT PROPELLING NOZZLES. P. F. Ashwood and D. G. Higgins. 1957. 31p. diagrs., tabs. ARC CP 325. (Ask for N-38243X*)

Tests were made of two groups of Laval type convergent-divergent propelling nozzles over a range of pressure ratios up to 9:1 using air at sensibly ambient temperature. The nozzles of the first group were designed for pressure ratios of 4, 6, 8, 10, and 12 and had an included divergence angle of 20° while those of the second group were all designed for a pressure ratio of 8 and had included divergence angles of 5°, 10°, 20°, 30°, and 50°. The superior thrust performance at high-pressure ratios of the Laval type nozzles over that of a plain convergent nozzle has been demonstrated. The effect of divergence angle on the thrust has been examined and, within the range 5° to 25°, found to be small. A comparison between the Busemann type profiled nozzle and an equivalent nozzle having a straight conical divergence has shown that at the design point the profiled nozzle gives about 2 percent more thrust.

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N-38467X*

Aeronautical Research Council (Gt. Brit.)
FULL SCALE MEASUREMENT OF IMPACT LOADS ON A LARGE FLYING BOAT (SUNDERLAND MK.5). PART III - DATA FOR IMPACTS ON MAIN STEP. R. Parker. 1957. 37p. diagrs., tabs. ARC CP 340. (Ask for N-38467X*)

The results of a series of full-scale impact tests on the hull of a Sunderland Mk.5 flying boat at an all up weight of 50,000 pounds were compared with an appropriate theory and discussed generally in a previous report. As discrepancies between these data and the theory were shown and an explanation of this has not been forthcoming, this report presents complete time histories of a number of the actual measurements to permit comparison with other theories when such become available and application by empirical methods where appropriate.

N-38503X*

Aeronautical Research Council (Gt. Brit.)
THE DETERMINATION OF AERODYNAMIC COEFFICIENTS FROM FLUTTER TEST DATA. W. G. Molyneux. 1957. 12p. diagr., tabs. ARC CP 347. (Ask for N-38503X*)

A technique is described that enables the oscillatory aerodynamic coefficients for an airfoil to be determined from data measured in flutter tests on the airfoil. The method is attractive in that it dispenses with the excitation equipment that is usually required for oscillatory force measurements. Preliminary measurements have been made in a low-speed tunnel on two rigid rectangular wings, and the results show that the technique is worth developing.

N-38867X*

Aeronautical Research Council (Gt. Brit.)
PRELIMINARY ANALYSIS FOR A JET FLAP SYSTEM IN TWO-DIMENSIONAL INVISCID FLOW. E. C. Maskell and S. B. Gates. 1957. 23p. diagrs. ARC CP 359. (Ask for N-38867X*)

Work so far done on jet flap analysis in two-dimensional flow has been somewhat obscured by uncertainties as to the physical assumptions made by various workers. In these notes an attempt is made to clarify the background of the subject in two ways: (1) by establishing some properties of a thin jet in a uniform field of flow, and (2) by stating some momentum theorems connected with a jet issuing from a body in a uniform field of flow.

N-40188X*

Aeronautical Research Council (Gt. Brit.)
THE EFFECTS OF TAPER ON THE SUPERVELOCITIES ON THREE-DIMENSIONAL WINGS AT ZERO INCIDENCE. K. W. Newby. 1957. 75p. diagrs., tab. ARC R & M 3032; ARC 18,205. Supersedes RAE Aero 2544. (Ask for N-40188X*)

Relationships have been derived for expressing the velocities on three-dimensional tapered wings at zero incidence in terms of the velocities on untapered infinite swept wings. The theoretical investigation of the effects of taper is confined to simple wings having airfoil sections formed by cubic or parabolic arcs; some experimental evidence is given to show that the results of this investigation can probably be applied quantitatively to wings having conventional airfoil sections. The results given in this report show that plan form and thickness taper have a marked effect on the velocities near the center of a wing, but that these effects decrease with increase of sweepback. A calculation method is outlined in the text for applying the results obtained for wings having parabolic-arc airfoil sections, to wings having arbitrary section shapes.

N-42179X*

Aeronautical Research Council (Gt. Brit.)
WIND-TUNNEL TESTS ON SEAPLANE HULLS IN THE R.A.E. 5-FT DIAMETER OPEN JET TUNNEL AND THE N.P.L. COMPRESSED AIR TUNNEL. A. G. Smith. 1957. 50p. diagrs., photos., tabs. ARC R & M 3018; ARC 17,910. Supersedes MAEE F/Res/266. (Ask for N-42179X*)

Results of research work done in Britain and the following reports on the measurement and analysis of the air drag of seaplane hulls are collected in this report. Wind-tunnel and tank tests on the drag of seaplane hulls, by K. W. Clark and D. Cameron. Resistance measurements on seaplane hulls in the compressed air tunnel, by R. Jones, A. H. Bell, and E. Smyth. Tests on a flying boat hull with faired steps in the compressed air tunnel, by R. Jones and A. F. Brown. Drag measurements on a model of a flying boat hull in the c.a.t., by R. Jones, A. H. Bell, and A. F. Brown.

N-42337X*

Aeronautical Research Council (Gt. Brit.)
INVESTIGATION OF HIGH LENGTH/BEAM RATIO SEAPLANE HULLS WITH HIGH BEAM LOADINGS. HYDRODYNAMIC STABILITY. PART 20. THE EFFECT OF SLIPSTREAM ON STABILITY AND SPRAY CHARACTERISTICS. D. M. Ridland. 1957. 55p. diagrs., photos., tabs. ARC CP 349. (Ask for N-42337X*)

The effects of slipstream on longitudinal stability, spray, and elevator effectiveness are deduced from tests on four configurations of the basic model of the series which differed only in aerodynamic details. It was found that, in general, increases in thrust coefficient improved longitudinal stability, spray characteristics, and elevator effectiveness. A method of applying the detailed results to the stability limits of other models of the series is outlined.

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N-42470X*

Aeronautical Research Council (Gt. Brit.)
INVESTIGATION OF HIGH LENGTH/BEAM RATIO SEAPLANE HULLS WITH HIGH BEAM LOADINGS. HYDRODYNAMIC STABILITY. PART 14. THE EFFECT OF A TAILORED AFTERBODY ON STABILITY AND SPRAY CHARACTERISTICS WITH TEST DATA ON MODEL J. D. M. Ridland. 1957. 40p. diagrs., photos., tabs. ARC CP 351. (Ask for N-42470X*)

The effects of a tailored afterbody on longitudinal stability, spray, directional stability, and elevator effectiveness are deduced from the results of tests on two models of length/beam ratio 11, which were alike in every respect except that of afterbody shape; one afterbody was of standard form and the other was tailored. It was found that tailoring the afterbody considerably improved stability characteristics, both longitudinal and directional, improved spray characteristics, and slightly impaired elevator effectiveness. The detailed test results for the tailored afterbody model are also included and discussed.

N-42650X*

Aeronautical Research Council (Gt. Brit.)
EXPERIMENTAL AND THEORETICAL INVESTIGATIONS OF THE FLOW OF AIR THROUGH TWO SINGLE-STAGE COMPRESSORS. J. H. Horlock, Cambridge University. 1957. 36p. diagrs. ARC R & M 3031; ARC 17,517. Supersedes MOS TIB(BR)103. (Ask for N-42650X*)

This investigation involves the traversing of pressure and angle measuring instruments at the trailing edge and further downstream of blade rows, and comparisons of the axial velocity profiles obtained from these pressure and yaw angles at the various stations with theoretically predicted profiles. The changes in the axial velocity profiles at the trailing edges of blade rows due to the interference effect of neighboring rows are also studied, both in the stalled and unstalled regions of operation.

N-42676X*

Aeronautical Research Council (Gt. Brit.)
ON SOME ASPECTS OF THE USE OF SHOCK TUBES IN AERODYNAMIC RESEARCH. B. D. Henshall, Bristol U. 1957. 103p. diagrs., photos., tabs. ARC R & M 3044. Supersedes ARC 17,407; TP 449; Bristol U. P-4. (Ask for N-42676X*)

A survey of existing shock-tube theory and experimental results has been conducted; particular emphasis was placed on the features of actual shock-tube flow which diverged from ideal nonviscous theory. A basic ideal shock-tube theory has been formulated in detail. A new analytical approach led to the development of a theory of shock-tube flow which included the effects of boundary-layer growth on the walls of the shock tube and explained several features of the actual flow patterns which are at variance with ideal nonviscous theory. The design and construction of a shock-tube installation were undertaken. The probable future development and uses of shock tubes in aerodynamic research are discussed in the light of recent experimental and theoretical work.

N-42801X*

Aeronautical Research Council (Gt. Brit.)
INVESTIGATION OF HIGH LENGTH/BEAM RATIO SEAPLANE HULLS WITH HIGH BEAM LOADINGS. HYDRODYNAMIC STABILITY. PART 19. THE INTERACTION OF THE EFFECTS OF FOREBODY WARP, AFTERBODY LENGTH AND AFTERBODY ANGLE ON LONGITUDINAL STABILITY CHARACTERISTICS. J. K. Friswell. 1957. 45p. diagrs., tab. ARC CP 352. (Ask for N-42801X*)

In this report the interaction of the effects of the different parameters concerned in the investigation is considered. It is found that by a redefinition of stability it is possible to predict these interactions as far as the undisturbed lower limit is concerned, but that otherwise there seems to be no simple law governing them. Some broad generalizations are, however, possible.

N-42806, pt. 2*

Royal Aircraft Establishment (Gt. Brit.)
THE POLYMERISATION OF PHOSPHONITRILIC CHLORIDES. PART II. SOME DERIVATIVES OF THE TRIMER. F. G. R. Gimblett. July 1957. 13p. diagrs. RAE Tech. Note Chem. 1312. (Ask for N-42806, pt. 2*)

The preparation and attempted preparation of derivatives of the trimer $(PNCl_2)_3$ are described. Great difficulty was experienced in preparing these derivatives and the types of reactions undergone by this compound suggest that its chemical behavior is not akin to that of alkyl halides.

N-44358X*

Aeronautical Research Council (Gt. Brit.)
FULL SCALE MEASUREMENTS OF IMPACT LOADS ON A LARGE FLYING BOAT (SUNDERLAND 5). PART IV. DATA FOR IMPACTS ON THE AFTERBODY. R. Parker. 1957. 37p. diagrs., tabs. ARC CP 341. (Ask for N-44358X*)

A comprehensive series of landing impact tests has been carried out by MAEE in both calm and rough water on a Sunderland flying boat. Results are given in this report for landings in calm water at attitudes where appreciable pressures occur on the afterbody and comprise data on total forces and local pressures on the afterbody.

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N-44359X*

Aeronautical Research Council (Gt. Brit.)
FULL SCALE MEASUREMENTS OF IMPACT LOADS ON A LARGE FLYING BOAT (SUNDERLAND MK.5). PART V - RESULTS OF ROUGH WATER TESTS. R. Parker and J. K. Friswell. 1957. 47p. diagrs., tabs. ARC CP 342. (Ask for N-44359X*)

The results of a number of take-offs and landings in various sea conditions are presented in the form of statistical data, both local pressures and overall accelerations being given. During the tests the worst loading conditions were encountered in short to medium swells.

N-44558X*

Aeronautical Research Council (Gt. Brit.)
AN EXPERIMENTAL INTRODUCTION TO THE JET FLAP. N. A. Dimmock. 1957. 68p. diagrs., photos., tabs. ARC CP 344. (Ask for N-44558X*)

This paper records the experimental results obtained with two two-dimensional airfoils, each having a 12.5-percent-thick elliptical cross section with a narrow full-span jet slot at the trailing edge, the jet deflections being respectively 90° and 31.4°. It is shown that the values of the force and moment coefficients and derivatives obtained experimentally agree satisfactorily with those suggested by the theory of reference 2. Support is given to the thrust hypothesis in that the measured thrust was greater, under appropriate conditions, than the reaction component from the deflected jet. The losses in the system have been considered and some of them investigated, those due to Reynolds number and jet entrainment effects being included. Also, the influence of ground proximity on the lift and center of lift of the 31.4° model was measured at zero incidence and found not to be prohibitive. A tentative empirical expression is suggested for the pitching-moment coefficient.

N-46240*

Aeronautical Research Council (Gt. Brit.)
THE BUCKLING UNDER COMPRESSION OF A THIN RECTANGULAR PLATE OF VARIABLE THICKNESS. H. W. Parsons, University College. November 10, 1955 (Revised). 20p. diagrs., tabs. ARC 17,231; Strut 1759. (Ask for N-46240*)

The buckling under compression of a thin flat rectangular plate of uniform thickness has already been solved for various edge conditions. This paper extends these results to the case when the thickness of the plate is no longer uniform, and considers how the thickness of the plate should vary across its width, when the volume of material in the plate is given and the buckling load is to be as large as possible. The method of solution developed and described in detail in the appendix is an extension of that used by Timoshenko when all the edges of the plate are simply supported.

N-46416X*

Aeronautical Research Council (Gt. Brit.)
EXPERIMENTAL INVESTIGATION OF THE PRESSURE DISTRIBUTION AT THE CENTRE-SECTION OF A SWEPTBACK WING AT HIGH SUBSONIC SPEEDS. T. E. B. Bateman and A. J. Lawrence. 1957. 35p. diagrs., photos., tabs. ARC CP 367. (Ask for N-46416X*)

Measurements have been made on a 40° sweptback wing over the Mach number range of 0.50 - 0.94, at zero incidence. Given pressures are reached further aft at the center section than on a section of the infinite sheared wing. In particular, the supersonic region, when formed, occurs much further aft and the shock wave moves quickly to a position close behind the trailing edge. The isobars lose their sweep in the neighborhood of the center section and this reduces the critical Mach number from 0.38 for the sheared wing to 0.81 for the center section. The maximum local Mach number at the center section tends to a steady value of about 1.15 at high subsonic speeds. Theoretical estimates of the pressure distributions on the sheared wing at zero incidence are shown to agree well with the measured values for speeds at which no shock waves form but estimates for the center section agree well only at very low speeds.

N-46615X*

Aeronautical Research Council (Gt. Brit.)
THE USE OF AN ARALDITE COATED IRON CASTING AS A LINER FOR A SUPERSONIC WIND TUNNEL. C. S. Brown and K. G. Winter. 1957. 8p. diagrs. ARC CP 346. (Ask for N-46615X*)

The use of cast iron and araldite appears to overcome the disadvantages of wooden liners. The surface finishing is no more difficult than with wood and the overall manufacturing time is comparable. The use of a pair of male templets to define the profile is recommended. Considerable care should be taken in the manufacture of the templets, and use should be made of a curvature gage during manufacture.

CN-48808, pt. 2*

Royal Aircraft Establishment (Gt. Brit.)
RAIN EROSION PART II - AN ASSESSMENT OF VARIOUS MATERIALS. A. A. Fyall, R. B. King, and R. N. C. Strain. April 1957. 32p. diagrs., photos., tabs. RAE Chem. 510.
(Ask for CN-48808, pt. 2*)

This report discusses the rain-erosion resistance of a wide range of materials tested on the R. A. E. "whirling arm." These included homogeneous materials such as plastics, metals, ceramics, and glass, and several protective coatings for possible use on glass fabric-resin radomes. Test speeds ranged from 250 to 500 mph and rainfall rates from 0.5 to 3.5 in./hr, the majority of tests being conducted at 500 mph in 1 in./hr rainfall which has been taken as a standard. Polyurethanes and modified nylon (Calaton) were the most promising alternatives

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to the neoprene protective coating at present in service use. Of the homogeneous materials tested the maximum erosion resistance was obtained with stainless steel and ceramics.

N-48912X*

Aeronautical Research Council (Gt. Brit.)
INTERNAL AIR-COOLING FOR TURBINE BLADES. A GENERAL DESIGN SURVEY. D. G. Ainley. 1957. 40p. diagrs. ARC R & M 3013; ARC 17,669. Supersedes NGTE Note NT. 174. (Ask for N-48912X*)

The degree of cooling that might be achieved in gas-turbine blades with simple internal air cooling is surveyed with a view to pinpointing the essential requirements for effective cooling with small quantities of cooling air. It is shown that efficient blade cooling becomes progressively more difficult at lower values of turbine-flow Reynolds numbers, and cooling systems should be designed to give adequate cooling at the lowest operating Reynolds numbers since this represents the most onerous condition. The potentialities of blades with laminar-cooling and turbulent-cooling flow in the cooling passages are compared.

N-50039X*

Aeronautical Research Council (Gt. Brit.)
THE DEFORMATION OF A LONG SWEPT WING WITH CHORDWISE VARIATION OF THE THICKNESS. E. C. Capey. 1957. 33p. diagrs. ARC CP 348. (Ask for N-50039X*)

The stress distribution in a long, sweptback, solid, thin wing under a bending moment or a torsional moment is calculated using the inextensional theory for thin flat plates. Solutions are given for all sweptback angles for strips whose cross sections are rectangular, diamond shaped, parabolic, and double wedge shaped.

N-50050, pt. 1*

Royal Aircraft Establishment (Gt. Brit.)
DEVELOPMENT OF THE R.A.E. 6 INCH DIAMETER SHOCK TUBE. PART 1. BURSTING OF DIAPHRAGMS AT 200 ATMOSPHERES. S. G. Cox. May 1957. 12p. diagrs., photo. RAE Tech. Note Aero 2510. (Ask for N-50050, pt. 1*)

The problem of providing a diaphragm section for the R.A.E. high-temperature shock tube has been investigated experimentally with a test rig. From these tests it has been found that cold rolled S.3 steel, as received, is a satisfactory material for the diaphragm of a 6-inch-diameter tube at chamber pressures up to 200 atmospheres. With this material, scored lines across the diameters of the diaphragms gave no improvement. It is inadvisable to use diaphragms of less than 16 standard wire gage thickness if consistent results are to be obtained, since thin diaphragms tend to be torn away and petalling is very ragged. The final method of clamping the diaphragm with a free piston and sealing with "O" rings has proved very successful and diaphragms of different thicknesses can be inserted quickly and easily.

N-50050, pt. 2*

Royal Aircraft Establishment (Gt. Brit.)
DEVELOPMENT OF THE R. A. E. 6 INCH DIAMETER SHOCK TUBE. PART II - DESIGN, DEVELOPMENT, AND EARLY USE OF A SIMPLE GAS STOP VALVE. S. G. Cox. August 1957. 5p. diagr. RAE Tech. Note Aero 2528. (Ask for N-50050, pt. 2*)

This note describes the design, development, and early use of some very simple gas stop valves which have been used with oxygen, hydrogen, nitrogen, and air at all pressures up to 3600 lb/sq in. The valve consists of a spring loaded steel ball on a nylon seat. To open the valve, the ball is mechanically lifted from its seat by a push rod entering the valve body from the low-pressure end.

N-50051*

Royal Aircraft Establishment (Gt. Brit.)
A NOTE ON COMBUSTION DRIVEN SHOCK TUBES. G. A. Bird. May 1957. 18p. diagrs. RAE Tech. Note Aero 2511. (Ask for N-50051*)

The method of characteristics has been used to make a detailed study of the flow in a shock tube in which the high-pressure gas has been raised to a high temperature and pressure by combustion. A number of examples were considered in which the diaphragm is broken by the combustion process, which may be either a fast or slow combustion wave or a detonation wave. In all these cases it was found that the resultant shock could have a higher speed than that produced by constant volume combustion but its velocity changed as it traveled down the tube and the flow between it and the contact surface was not uniform even with friction and conduction effects neglected. It was concluded that, if it is desired to use the flow behind the shock as a short duration wind tunnel, constant volume combustion should be used.

N-50060X*

Aeronautical Research Council (Gt. Brit.)
EFFECTS OF ELEVATOR CIRCUIT STIFFNESS ON THE LOADING CONDITIONS IN LONGITUDINAL MANOEUVRES. D. R. Puttock. 1957. 31p. diagrs., tab. ARC CP 354. (Ask for N-50060X*)

An investigation of the effects of elevator circuit stiffness on the loading conditions of an aircraft in a rapid pilot-induced pullout maneuver is presented with a particular reference to the airworthiness aspects. The solution to the problem is given in general terms; it includes expressions for the incremental elevator angle, stick force, normal acceleration at the center of gravity, and the tail-plane load in

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response to a chosen sequence of pilot-induced stick movements to initiate a rapid pullout maneuver. The solution is a complex one and the influence of significant parameters such as the degree of mass balance of the elevator circuit, the forward speed of the aircraft, and the rate of application of the stick movement is discussed in relation to a numerical example. Brief mention is made of further implications of this investigation.

N-50082X*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE CIRCULATION IN CIRCUITS WHICH CUT THE STREAMLINES IN THE WAKE OF AN AEROFOIL AT RIGHT-ANGLES. J. H. Preston, Cambridge U. 1956. 8p. diagrs. ARC R & M 2957. Supersedes ARC 16,622; FM 2043. (Ask for N-50082X*)

It has been suggested that, in the two-dimensional flow of a real fluid, the circulations in all circuits enclosing the airfoil and cutting the streamlines in the wake at right angles would be very nearly the same. This is of fundamental importance in the calculations of the lift of airfoils allowing for the boundary layer. Recent developments in connection with the effect of a jet issuing from the trailing-edge region on the lift of an airfoil have raised the question of a satisfactory explanation of this effect and its prediction. Elementary considerations, which are set out below, suggest that, in the case of an airfoil with jet, the above is not true. It would also appear that it is not quite true with an airfoil with wake, since the same arguments can be applied. In the case of the airfoil with a strong jet, the existence of circulation in circuits not enclosing the airfoil but cutting the jet twice at right angles is of decisive importance in explaining the jet effects.

CN-50108X*

Aeronautical Research Council (Gt. Brit.)
A STUDY OF THE AIRCRAFT ARRESTING-HOOK BOUNCE PROBLEM. J. Thomlinson. 1957. 46p. diagrs. ARC R & M 2980; ARC 16,985. Supersedes RAE Tech. Note NA 263. (Ask for CN-50108X*)

The kinematics of an arresting-hook unit are studied in order to determine, within the limits of the assumption of a perfectly rigid hook unit, the damper force necessary to control hook bounce. The necessity for a smooth deck and the desirability of small trail angle for the hook unit are demonstrated from several aspects. The design requirements for a hook damper unit are discussed in all their functional aspects and methods are given for determining the up-swing motion of an arresting hook unit immediately following engagement of an arresting wire. The behavior of arresting wires after being depressed by the passage of aircraft wheels is also outlined.

N-50145X*

Aeronautical Research Council (Gt. Brit.)
FATIGUE LOADINGS IN FLIGHT-LOADS IN THE TAILPLANE OF A COMET I. Anne Burns. 1957. 19p. diagrs., photo., tabs. ARC CP 363. (Ask for N-50145X*)

Data are presented on the number of load cycles of various magnitudes occurring in the tail plane of a Comet IA during normal ground and flight conditions. The conditions include flight in turbulence, take-off, landing, taxiing, and ground running of the engine. The relative importance of the loads in the different conditions is illustrated by reference to the loads in a typical flight.

N-54139*

Royal Aircraft Establishment (Gt. Brit.)
THE INFLUENCE OF DRAG CHARACTERISTICS ON THE CHOICE OF LANDING APPROACH SPEEDS. D. Lean and R. Eaton. (Paper for presentation to the AGARD Flight Test Panel, London, May 1957.) April 1957. 25p. diagrs., tabs. RAE Tech. Note Aero 2503. (Ask for N-54139*)

A study has been made of the lift-drag characteristics of 19 jet aircraft which have minimum comfortable approach airspeeds that are fairly well established. On about half these aircraft, drag effects, which determine speed stability, were stated to limit the approach airspeeds, though there was naturally some lack of unanimity as to the level of the effect which could be classed as tolerable. Limiting values of speed stability are proposed for the three types of landing approach used for carrier, airfield, and instrument landings. The speeds corresponding to these stability levels are in fair agreement with those actually used, even for those aircraft whose approach speeds were not primarily limited by drag effects. It is considered that drag effects must be taken into account in estimating approach airspeeds, and that this process materially improves the prediction of approach speeds for the latest types of aircraft. Further data should be collected and analyzed in order to confirm or modify the form or level of the proposed limits.

N-54308X*

Aeronautical Research Council (Gt. Brit.)
ON THE NON-LINEAR THEORY OF HYDRODYNAMIC STABILITY. J. T. Stuart, National Physical Laboratory. August 28, 1957. 28p. diagrs. ARC 19,493; FM 2577. (Ask for N-54308X*)

In this paper, the effects of Reynolds stresses on the growth of small disturbances in an unstable basic flow are discussed. It is shown by means of energy considerations that often a finite disturbance of definite amplitude is possible, associated with a distorted mean flow. The cases treated include Poiseuille flow between parallel planes, flow between rotating cylinders, and thermal instability. For the case of flow between rotating cylinders, good agreement is obtained with G. I. Taylor's measurements of the torque required to maintain the cylinders in motion against the retardation due to the fluid.

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CN-57210X*

Aeronautical Research Council (Gt. Brit.)
AN EXPERIMENTAL VERIFICATION OF THE THEORETICAL CONCLUSIONS OF R. A. E. TECHNICAL NOTE NO. STRUCTURES 156 (A. R. C., C. P. NO. 286). "A CONSTRUCTIONAL METHOD FOR MINIMISING THE HAZARD OF CATASTROPHIC FAILURE IN A PRESSURE CABIN" WITH FURTHER COMMENTS ON ITS IMPLICATIONS. D. Williams. 1957. 13p. diagrs. ARC CP 357.
(Ask for CN-57210X*)

In a recent paper the author described a method of construction intended to make the shell of a pressure cabin immune from catastrophic failure at little or no cost in extra weight. The present note records the results of experiments carried out on a Comet I cabin that was modified to incorporate the new constructional method. These experiments, which include some very searching tests, amply confirm the benefits indicated by theory, and appear fully to vindicate the new method of construction. The note also touches on the momentous implications that arise once this type of construction is accepted as meeting the claims made for it.

N-57219*

National Gas Turbine Establishment (Gt. Brit.)
THE DEVELOPMENT OF A VARIABLE MACH NUMBER EFFUSER. J. B. McGarry. August 1957. 26p. diagrs., photo. NGTE R. 210.
(Ask for N-57219*)

A series of tests was undertaken on a simple, two-dimensional, variable Mach number effuser, or nozzle, designed for the range of supersonic flows up to Mach number 3.0. The performance of the nozzle was assessed from the magnitude of the percentage variation in its exit Mach number distribution. Studies of the effect on the performance of alterations to the position of the nozzle block pivots and other geometrical features were made. On the basis of these studies, a final build of nozzle was developed which produced flow of a uniformity sufficient for intake and engine model testing over the Mach number range from 1.5 to 3.0.

N-57270*

Aeronautical Research Council (Gt. Brit.)
LIST OF CURRENT PAPERS PUBLISHED BY THE AERONAUTICAL RESEARCH COUNCIL (NUMBERS 251-300). 1957. 5p. ARC CP 300.
(Ask for N-57270*)

N-57271*

Royal Aircraft Establishment (Gt. Brit.)
SOME OBSERVATIONS ON THE AIR AND CORROSION FATIGUE BEHAVIOR OF A TERNARY ALUMINIUM-ZINC-MAGNESIUM ALLOY. INTERIM REPORT. C. A. Stubbington and P. J. E. Forsyth. March 1957. 27p. diagrs., photos., tabs. RAE Tech. Note Met. 258. (Ask for N-57271*)

The present work was carried out to obtain fundamental information on the causes of the low fatigue properties of the high strength aluminum alloys under air and corrosion fatigue conditions. In order to avoid the unnecessary complications of intermetallic particles a simple aluminum alloy containing 7.5 percent zinc, 2.5 percent magnesium, was chosen for the investigation. Earlier work on D. T. D. 683 indicated that heat treatment might influence the subsequent fatigue behavior of this material, and therefore one of the purposes of the investigation was to compare the fatigue behavior of the simple ternary alloy after various carefully controlled and reproducible heat treatments. The work reported in this note is mainly of a metallographic nature, but some quantitative results are also included.

CN-57272*

Royal Aircraft Establishment (Gt. Brit.)
ERRORS CAUSED BY TAPE SPEED VARIATIONS IN ANALOGUE DATA RECORDING ON MAGNETIC TAPE. P. F. Dingwall and E. C. Voss. April 1957. 21p. diagrs. RAE Tech. Note Instn. 159.
(Ask for CN-57272*)

The note discusses the effects of variations in recording and replay tape speed in magnetic recording systems for analog data recording, with particular reference to small periodic speed variations known as flutter. The form of the error signal resulting from these variations in direct recording, and in amplitude modulated and frequency modulated carrier recording, is deduced. The effects resulting from the electrical analysis of the replayed signal are discussed. A method of partial compensation for tape speed variations in frequency modulated carrier recording is considered.

N-57273*

National Gas Turbine Establishment (Gt. Brit.)
A MULTI-HOLE ORIFICE PLATE FOR AIRFLOW MEASUREMENT AND ITS CALIBRATION BY TRAVERSING A NOZZLE. N. A. Dimmock and R. Parker. September 1957. 21p. diagrs. NGTE Memo. M. 306. (Ask for N-57273*)

A multihole orifice plate was constructed for a compressor test rig and calibrated in situ by traversing a nozzle fitted downstream of the orifice plate. The calibration nozzle was designed with a contraction profile based on a cubic equation and gave a satisfactory performance with a constant discharge coefficient of 0.988 and an accuracy better than ±0.5 percent. The multihole orifice plate calibration was consistent within ±1 percent over most of its useful range giving a discharge coefficient very nearly the same as that for a single orifice of the same cross-sectional area.

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CN-57274*

Royal Aircraft Establishment (Gt. Brit.)
THE FLEXURAL STRENGTH OF ASBESTOS-RESIN LAMINATES AT ELEVATED TEMPERATURES. M. M. Cornford. June 1957. 10p. diagr., tabs. RAE Tech. Note Chem. 1308. (Ask for CN-57274*)

The flexural strengths of four experimental asbestos-resin laminates have been determined after aging at elevated temperatures and the values obtained compared with those of the material in current use. Two of the felts showed heat resistance superior to that of the standard material. A silicone-asbestos laminate had very poor flexural strength.

CN-57275*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF TROPICAL EXPOSURE ON "HIGH SOFTENING POINT" PERSPEX. B. A. Blythe, M. M. Cornford, and W. W. Wright. March 1957. 13p. diagrs., tabs. RAE Tech. Note Chem. 1305. (Ask for CN-57275*)

Physical and mechanical tests have been carried out on panels of "high softening point" Perspex before and after exposure to tropical conditions. Considerable degradation took place, as evidenced by molecular weight measurements. There was, however, little effect on physical and mechanical properties after 12 months exposure.

N-57276*

Royal Aircraft Establishment (Gt. Brit.)
THE TENSILE AND FATIGUE PROPERTIES OF NIMONIC 80A (EXTRUDED) AND NIMONIC 95 AT ELEVATED TEMPERATURES. B. F. Billing and M. S. Binning. July 1957. 28p. diagrs. RAE Tech. Note Met. 269. (Ask for N-57276*)

The tensile and fatigue properties are given for extruded Nimonic 80A at 750°, 815°, and 875° C and for Nimonic 95 at 850°, 875°, and 900° C, the latter material in two conditions of heat treatment. The fatigue tests were performed in Haigh type direct stress machines at both zero and various tensile values of mean load.

N-57277*

Aeronautical Research Council (Gt. Brit.)
A SIMPLIFIED FORM OF THE AUXILIARY EQUATION FOR USE IN THE CALCULATION OF TURBULENT BOUNDARY LAYERS. T. J. Black, Cambridge University. February 11, 1957. 19p. diagrs. ARC 19,046; FM 2504. (Ask for N-57277*)

A new type of auxiliary equation is evolved which greatly facilitates the calculation of the form parameter H in turbulent boundary layers with adverse pressure gradients. Comparison with a number of experimental results shows that the accuracy is quite as good as that of existing methods which are more laborious to apply.

N-57278*

Aeronautical Research Council (Gt. Brit.)
SHEAR FLOW THROUGH A CASCADE. W. R. Hawthorne and W. D. Armstrong, Cambridge University. February 21, 1955. 33p. diagrs. ARC 17,390; EA 390; FM 2190. (Ask for N-57278*)

This is a theoretical and experimental study of the flow through a cascade of untwisted airfoils placed in a wind tunnel of rectangular cross section in which the approach velocity was varied artificially in the spanwise direction only. Local pressure differences produce rotational secondary flows which cause overall spanwise accelerations and displacements. These effects are analyzed for frictionless flow by treating the blade row as an actuator plane whose outlet angle is determined by the secondary velocities in the blade passages.

N-57279*

Aeronautical Research Council (Gt. Brit.)
A NOTE ON TURBULENT BOUNDARY-LAYER ALLOWANCES IN SUPERSONIC NOZZLE DESIGN. E. W. E. Rogers and B. M. Davis. 1957. 24p. diagrs. ARC CP 333. (Ask for N-57279*)

Some of the theoretical methods for computing the growth of turbulent boundary layers along both the curved and straight walls of a rectangular supersonic wind tunnel are discussed and the estimated values compared with experiment. Approximate formulas, which may be useful in the initial stages of nozzle design, are suggested for the overall boundary-layer growth along the curved nozzle and flat wall.

N-57280*

Aeronautical Research Council (Gt. Brit.)
THE OPERATION OF THE N.P.L. 18" x 14" WIND TUNNEL IN THE TRANSONIC SPEED RANGE. I. M. Hall. 1957. 21p. diagrs., tab. ARC CP 338. (Ask for N-57280*)

A brief description of the slotted liners used is given together with the power requirements and some flow surveys. Some observations are made on wall interference on a half-model of a swept wing tested in the wind tunnel.

N-57281*

Aeronautical Research Council (Gt. Brit.)
A REVIEW OF THEORETICAL WORK RELEVANT TO THE PROBLEM OF HEAT TRANSFER EFFECTS ON LAMINAR SEPARATION. G. E. Gadd. 1957. 5p. diagrs. ARC CP 331. (Ask for N-57281*)

Results of various theories concerning the effects of heat transfer on laminar separation are briefly discussed. All the theories agree in predicting that wall temperature has an important influence on separation conditions.

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N-57282*

Aeronautical Research Council (Gt. Brit.)
THE MATRIX FORCE METHOD OF STRUCTURAL ANALYSIS AND SOME NEW APPLICATIONS. J. H. Argyris and S. Kelsey, University of London. 1957. 42p. diagrs., tabs. ARC R & M 3034; ARC 18,234. (Ask for N-57282*)

The purpose of this paper is: (a) To summarize the basic principles of the matrix force method of structural analysis and to present also some new applications of the general theory. (b) To establish and illustrate on simple examples the special method of cutouts. In this procedure the stresses in a structure with cutouts are derived from the simpler analysis of the corresponding structure without cutouts under the same loads and/or temperature distribution. (c) To present a method for the determination of the stresses in a structure, some of whose components have been modified subsequent to an initial stress analysis. This procedure is a generalization of the cutout method (b) and gives the stresses in the modified system solely in terms of the stresses of the original system subject to the same loads and temperature distribution.

N-57283*

Aeronautical Research Council (Gt. Brit.)
THE SECONDARY FLOW IN A CASCADE OF TURBINE BLADES. W. D. Armstrong, University of Cambridge. 1957. 14p. diagrs., photo.
ARC R & M 2979; ARC 17,442. (Ask for N-57283*)

It is shown that when the secondary vorticity is sufficiently small perturbation theory may be used to predict accurately the induced velocities downstream of the blades which are due to this distributed vorticity. As the upstream vorticity or the blade deflection is increased then the perturbation theory is no longer applicable and the transport of the Bernoulli surfaces within the blade passages must be considered. In a particular case a crude approximate method has been given for the calculation of the distributed circulation but this itself does not enable the induced velocities to be computed. Experimental eivdence is presented to show that downstream of the cascade there are, for each blade, two adjacent regions of low total head which rotate in opposite directions. One of these regions originates from the blade shed circulation and the other from the distributed secondary circulation within the blade passage.

N-57284*

Ministry of Supply (Gt. Brit.)
DTD. 166 - TYPE AUSTENITIC CHROMIUM-NICKEL STEEL SHEET: A SUMMARY OF PROPERTIES. September 1957. 22p. diagrs., tabs. MOS S&T Memo. 12/57. (Ask for N-57284*)

This report presents the properties of the 18-percent chromium 8-percent nickel stabilized austenitic steel sheet materials. The following topics are discussed: strip rolling and sheet rolling, mechanical properties "as-delivered," mechanical properties after "modulus recovery" heat treatment, forming, weldability, and corrosion resistance.

N-57286*

Ministry of Supply (Gt. Brit.)
CAVITATION EROSION - A REVIEW OF PRESENT KNOWLEDGE (JUNE 1957). D. J. Godfrey. September 1957. 15p. tabs. MOS S&T Memo. 17/57. (Ask for N-57286*)

The present paper contains a discussion of the following: the hydromechanical theory of cavitation erosion; a comparison of cavitation erosion and impingement attack; the effect of cathodic protection; the effect of entrained and dissolved air; environmental factors affecting cavitation erosion resistance; properties of materials affecting cavitation erosion resistance; and resistance of metals to cavitation erosion.

N-57287, pt. 1-5*

Royal Aircraft Establishment (Gt. Brit.)
SOME ASPECTS OF THE CATALYTIC DECOMPOSITION OF HYDROGEN PEROXIDE BY SILVER. PARTS I TO V. F. T. Maggs and D. Sutton. April 1957. 44p. diagrs., tabs. RAE RPD 35.
(Ask for N-57287, pt. 1-5*)

In the use of silver for the catalytic decomposition of hydrogen peroxide many chemical processes are initiated. Investigations of these phenomena and the conclusions drawn therefrom are described in this report, which for clarity in presentation is divided into five parts. The solubility of silver in mixtures of hydrogen peroxide and water; the rate of solution of silver in mixtures of hydrogen peroxide and water; the pH of mixtures of hydrogen peroxide and water containing dissolved silver; the electrical conductivity of mixtures of hydrogen peroxide and water containing dissolved silver; and the effect of chloride ion on the solution of silver in mixtures of hydrogen peroxide and water.

BRITISH REPORTS

N-57287, pt. 6*

Royal Aircraft Establishment (Gt. Brit.)
SOME ASPECTS OF THE CATALYTIC DECOMPOSITION OF HYDROGEN PEROXIDE BY SILVER. PART VI. SOLUTIONS SATURATED WITH SILVER. D. Sutton. May 1957. 9p. diagrs. RAE Tech. Note RPD 135. (Ask for N-57287, pt. 6*)

The enhanced rate of decomposition which follows when a solution of hydrogen peroxide is saturated with silver is shown to be due to the large increase in catalytic surface brought about by the continuous precipitation of particles of silver in the decomposing solution. The changes in electrical conductivity and pH of such solutions have been measured during the course of decomposition. The results show that Ag^+ and HO_2^- ions are removed from solution as the peroxide concentration falls, the amounts remaining in solution being just sufficient to satisfy a limiting ionic product $[Ag^+][HO_2^-]$, which decreases progressively with the fall in peroxide concentration. The measured pH values are in good agreement with those calculated using the values of the ionic product $[H^+][HO_2^-]$ for hydrogen peroxide solutions determined by Wynne-Jones.

N-57288*

Royal Aircraft Establishment (Gt. Brit.)
THE SHAPE OF THE CENTRE PART OF A SWEPTBACK WING WITH A REQUIRED LOAD DISTRIBUTION. J. Weber. May 1957. 51p. diagrs. RAE Aero 2591. (Ask for N-57288*)

A method is developed for designing the center portion of a cambered and twisted sweptback wing to have the same chordwise load distribution at all spanwise stations. For this purpose the downwash field induced by a doublet distribution of constant spanwise strength in the chordal plane of a constant chord wing is determined for incompressible, sonic, and supersonic mainstream flow. Since the downwash has a logarithmic singularity at the center section in the chordal plane itself, an approximate method is suggested to satisfy the boundary condition at the surface of the thick wing. Numerical examples illustrate the influence of the angle of sweep, the wing thickness, and the load distribution. They show in particular that the required shape does not vary much with Mach number. A relatively rapid change of twist and camber with the spanwise distance from the center section is required as shown by calculated results for sonic flow. There is some reason for using the camber and twist designed for the center section of the isolated wing also for wing-fuselage junctions.

CN-57289*

Royal Aircraft Establishment (Gt. Brit.)
CONTROL RESPONSE MEASUREMENTS ON A SINGLE-ROTOR HELICOPTER (WESTLAND "DRAGONFLY"). A. R. S. Bramwell. July 1957. 30p. diagrs., photos. RAE Tech. Note Naval 19. (Ask for CN-57289*)

Flight tests have been made to measure the longitudinal response of a single-rotor helicopter (Westland "Dragonfly") to sudden movements of the cyclic and collective pitch controls. The measured response to the cyclic pitch control agrees quite well with theoretical calculations. It is shown also that the response fails to satisfy the NACA maneuverability criterion, except perhaps at low speeds. It was found possible to obtain the rotor force derivative z_w from the response to cyclic and collective pitch displacements. The values so obtained show fair agreement with theory. Measurements of speed, attitude, and acceleration were made in control-initiated phugoid oscillations and a method is given for using them in conjunction with trim measurements to obtain all the longitudinal stability derivatives.

N-57290*

Royal Aircraft Establishment (Gt. Brit.)
MECHANICAL PROPERTIES OF S.A.P. SHEET HIDUMINIUM 100. D. C. Hayward. April 1957. 16p. diagrs., tabs. RAE Tech. Note Met. 260. (Ask for N-57290*)

Compressive and tensile tests, along and transverse to the rolling direction, were made at room temperature, 200° C, and 400° C. Bend tests at room temperature along and across the grain were also made. At all test temperatures strength was slightly greater transverse to than in the rolling direction for both tension and compression. Elongation was reduced markedly with increase in temperature.

CN-57291*

Royal Aircraft Establishment (Gt. Brit.)
THE BEHAVIOUR OF SOME BAKELITE-BASED STRAIN GAUGES AT TEMPERATURES UP TO 250° C. K. R. Maslen. April 1957. 17p. diagrs., tabs. RAE Tech. Note Instn. 160. (Ask for CN-57291*)

This note describes tests carried out on three types of wire resistance strain gages on a bakelite base, made by H. Tinsley & Co. Ltd. It is shown, by means of gage factor measurements, that the bonding is adequate up to 250° C; and, by repeated loading, that the fatigue strength is adequate at normal temperatures. Variations in resistivity and temperature coefficient have been observed, which appear to depend on the degree of hardness of the gage wire. It is hoped to eliminate these variations by using fully annealed wire in the manufacture of the gages.

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N-57292*

Royal Aircraft Establishment (Gt. Brit.)
EXPERIMENTAL OBSERVATION OF VORTICES IN WING-BODY JUNCTIONS. A. Stanbrook. March 1957. 33p. diagrs., photos. RAE Aero 2589. (Ask for N-57292*)

Tests have been made on various wing-body combinations to investigate the nature of the flow in the junction. It was found that vortices are formed due to separation of the boundary layer on the body in the flow toward the wing. The free edge of the resulting vortex sheet rolls up to form the vortex which then trails downstream around the wing. As incidence is increased the vortex on the suction side of the wing moves toward the wing and the vortex on the pressure side moves away from the wing. The vortices are present with both swept and unswept rounded leading edges at subsonic and supersonic speeds but were not found with sharp leading edges at zero incidence.

CN-57293*

Royal Aircraft Establishment (Gt. Brit.)
PERMEABILITY OF SINTERED ALUMINA TO AIR. J. P. Roberts and C. Wheeler. May 1957. 2p. tab. RAE Tech. Memo. Met. 179. (Ask for CN-57293*)

In the course of other work, it was found necessary to investigate the ability of 12 commercial alumina tubes to exclude the laboratory atmosphere at temperatures up to 1450° C. The tubes had specific gravity 3.7-3.9 (except for one of 3.56), internal diameter generally near 2.5 cm and wall thickness near 0.3 cm. Four of the tubes had one end closed. The results show that the permeability of some sintered alumina tubes of the present usual density can be below one unit up to at least 1450° C, but the important point is that one cannot rely on achieving this with any given tube.

N-57294*

Royal Aircraft Establishment (Gt. Brit.)
SLENDER DELTA WINGS WITH SHARP EDGES AT ZERO LIFT. J. Weber. May 1957. 45p. diagrs. RAE Tech. Note Aero 2508. (Ask for N-57294*)

Several slender wings of delta plan form with sharp edges have been investigated theoretically at zero lift at subsonic and at supersonic speeds. Most of the wings have diamond-shaped cross sections and are intended to lead to a type of flow with leading-edge separation in the lifting condition. The pressure distributions and overall normal-pressure drags resulting from various theoretical methods are compared with one another and some discussion is included concerning the possibility of achieving the results, calculated for an inviscid stream, in a real flow in the presence of a viscous layer around the body.

N-57295*

Aeronautical Research Council (Gt. Brit.)
A GEARED FLYWHEEL BALANCE ARRANGEMENT FOR THE PREVENTION OF CONTROL SURFACE FLUTTER. W. G. Molyneux. 1957. 16p. diagrs., tab. ARC CP 365. (Ask for N-57295*)

Some geared massbalance systems are described that are effective in eliminating inertial couplings between modes of the main surface and the control surface. These arrangements are shown to have an advantage over the conventional arrangement for preventing flutter involving main surface torsion and control rotation, particularly where there is a near frequency coincidence between the modes.

CN-57296*

Aeronautical Research Council (Gt. Brit.)
A NOTE ON SOME INTEGRALS IN AERODYNAMICS. D. E. Williams. 1957. 10p. ARC CP 364. (Ask for CN-57296*)

Some double integrals in aerodynamics are difficult to evaluate because of the singularities in the range of integration. The Dirac delta function has been found useful in evaluating such integrals. Some examples of its use are given.

N-57297*

Ministry of Supply (Gt. Brit.)
TESTS ON COMMERCIALLY PURE TITANIUM SHEET. P. J. James. APPENDIX 1: THE "FREE CONE" BEND TEST. P. J. James. APPENDIX 2: DEVELOPMENT OF WELDING TECHNIQUES FOR COMMERCIALLY PURE TITANIUM SHEET. S. A. V. Swanson. APPENDIX 3: DEVELOPMENT OF DRILLING, DEBURRING, DIMPLING AND RIVETING TECHNIQUES. I. L. G. Baillie and S. A. V. Swanson. September 1957. 68p. diagrs., photos., tabs. MOS S&T Memo. 23/57. (Ask for N-57297*)

Tests have been made on Ti-75A manufactured by the Titanium Metals Corp. of America and I.C.I. 130 manufactured by Messrs. I.C.I. Ltd. Excluding the hydrogen content effects, both materials appeared suitable for appropriate aircraft applications such as bulkheads or other components requiring welding and/or moderate forming.

CN-57298*

Ministry of Supply (Gt. Brit.)
CORROSION OF METALS BY VAPOURS FROM ORGANIC MATERIALS. Vera E. Rance and H. G. Cole. September 1957. 23p. tabs. MOS S&T Memo. 21/57. (Ask for CN-57298*)

The metals most susceptible to this type of corrosion are: cadmium, lead, magnesium, and zinc. The behavior of the following coatings is discussed: zinc, cadmium, tin, tin/zinc alloy, tin/cadmium alloy, nickel, chromium, and aluminum. Aluminum and

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its alloys, preferably anodized and sealed, and stainless steel of the 18/8 type, particularly with an addition of 2 percent to 3 percent Mo, are notably resistant to organic corrosion. Brass and bronze are relatively resistant.

CN-57300*

National Gas Turbine Establishment (Gt. Brit.)
TORQUE AND FLOW CHARACTERISTICS OF A BUTTERFLY VALVE OPERATING AT PRESSURE RATIOS ABOVE THE CRITICAL. A. H. Robinson. July 1957. 22p. diagrs. NGTE Memo. M. 304. (Ask for CN-57300*)

A lenticular butterfly valve of 0.125 thickness/diameter ratio has been tested at pressure ratios up to 4/1. Nondimensional torque and flow characteristics are presented for the valve installed in a straight pipe and in a bulkhead across a large duct. It is shown that the flow characteristics are of the form normally associated with the discharge of air through any orifice, and are only affected by the valve installation insofar as this affects the entry conditions and effective flow area. The torque characteristics, however, are affected by the valve installation to a much greater extent but their general form can be explained by a simplified two-dimensional consideration of the flow conditions.

N-57357*

Aeronautical Research Council (Gt. Brit.)
SECONDARY FLOW IN A STATIONARY CURVED PIPE. S. N. Barua. November 27, 1954. 18p. diagrs., tabs. ARC 17,212; FM 2162. (Ask for N-57357*)

When fluid flows through a stationary curved pipe, a pressure gradient acts across the pipe to balance the centrifugal force arising out of the curvature. A flow is set up in which the fluid near the top and the bottom moves inward and the fluid in the middle moves outward. This flow is known as the secondary flow. This flow is superimposed on the main stream so that the resultant flow is helical in the top and the bottom of the pipe. The works of Dean, White, Hawes, and Adler are discussed and compared with the results of the present calculations.

N-57358*

Aeronautical Research Council (Gt. Brit.)
INVESTIGATIONS INTO THE USE OF AN ELECTRICAL RESISTANCE ANALOGUE FOR THE SOLUTION OF CERTAIN OSCILLATORY FLOW PROBLEMS. P. J. Palmer, Anne R. Copson, and S. C. Redshaw. February 6, 1957. 31p. diagrs., photos. ARC 19,030; Comp.112; 0.1310; FM 2500. (Ask for N-57358*)

The use of an electrical resistance analog, for solving the problem of a thin two-dimensional wing oscillating in an incompressible ideal fluid, is considered; wings with and without flaps are investigated. The particulars of the design and construction of a special graded analog are given. The experimental results are in close agreement with theory.

N-57359*

Aeronautical Research Council (Gt. Brit.)
NUMERICAL ASPECTS OF UNSTEADY LIFTING-SURFACE THEORY AT SUPERSONIC SPEEDS. H. C. Garner. May 15, 1957. 6p. ARC 19,268; Comp.124; 0.1332. (Ask for N-57359*)

Various approaches to numerical solutions for the aerodynamic loading on oscillating wings are briefly discussed. Methods involving iteration, successive approximation, or expansions in powers of frequency do not seem well suited to mechanized computation. However, there is broad scope for developing collocation and "box-grid" methods, which seem more promising from the numerical standpoint.

N-57360*

Aeronautical Research Council (Gt. Brit.)
FREE VIBRATIONS OF A STIFFENED CYLINDRICAL SHELL. P. R. Miller, University of Southampton. May 1957. 39p. diagrs. ARC 19,338; LA 22. (Ask for N-57360*)

This report presents the first stage of an investigation of the response to random noise of a stiffened cylinder, representing an aircraft fuselage, including an analysis of the lower modes of such a cylinder. The energy approach is then extended to give the resonant frequencies and natural modes of a circular cylindrical shell uniformly stiffened with closely spaced longerons and frames, "close spaced" implying that stiffener spacing is much less than the spacing of nodal lines. The effects of rotary inertia have had to be included owing to the lack of symmetry of the section about the skin, but shear deflections are still neglected. Further numerical work is required before much comment can be made on the results, but they seem to be similar in nature to those obtained for the uniform cylinder.

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N-57361*

Aeronautical Research Council (Gt. Brit.)
LOADING ON AN OSCILLATING WING OF INFINITE ASPECT RATIO IN A SUBSONIC STREAM. J. H. Wilkinson. June 17, 1957. 14p. ARC 19,344; Comp. 125. (Ask for N-57361*)

Direct methods of solution of the problem in its original form by orthodox relaxation techniques are not used in practice and this is probably due partly to difficulties arising in the field of numerical analysis and partly to the large volume of computation involved. With the advent of high-speed digital computers it was felt that the possibility of such a direct attack should be reconsidered. The present note describes work that has been done on this problem. It was early apparent that the difficulties involved were very substantial and accordingly the simplest problem, the linearized theory of a vibrating wing of infinite aspect ratio was attempted first.

N-57362*

Aeronautical Research Council (Gt. Brit.)
SOME NOTES ON SHOCK-WAVE BOUNDARY-LAYER INTERACTIONS, AND ON THE EFFECT OF SUCTION ON THE SEPARATION ON LAMINAR BOUNDARY LAYERS. K. N. C. Bray. 1957. 11p. diagrs. ARC CP 332. (Ask for N-57362*)

A brief review is given of a theory, due to Crocco and Lees, which can be used for a wide range of laminar and turbulent boundary-layer problems. The results of applying this theory to the problem of shock wave boundary-layer interactions are described from a reference report. The same method is then applied to the problem of estimating the extent to which critical Mach number effects on a wing can be delayed by boundary-layer suction. In this report, a number of crude approximations have been made to find the order of magnitude of this effect. It is found that a sucked boundary layer may require almost three times as big a disturbance as an unsucked layer, in order to cause separation. As this preliminary result is quite encouraging, some suggestions are made for more accurate calculations.

N-57363*

Aeronautical Research Council (Gt. Brit.)
INSTABILITY IN A SLOTTED WALL TUNNEL. J. L. King, P. Boyle, and J. B. Ogle. 1957. 24p. diagrs., tabs. ARC CP 343. (Ask for N-57363*)

Large pressure fluctuations have been observed in the working section of the Admiralty Research Laboratory's new 30-in. water tunnel. The present report describes investigations carried out in a 7-in. wind tunnel to examine such fluctuations in detail and also theoretical investigations which explain and describe the phenomena. It is shown theoretically that a jet of fluid circular in cross section moving through the same fluid is unstable. The slotted wall is unable to stabilize all frequencies of disturbance. The length of the working section determines preferred wavelengths of disturbance which feed energy back to the upstream end of the jet by compressing the fluid in the reservoir surrounding the working section. In the absence of a reservoir, the instability disappears. The present report is not concerned with the performance of the 30-in. tunnel or with measures now being taken to improve it.

N-57364*

Aeronautical Research Council (Gt. Brit.)
DIRECT STRESS FATIGUE TESTS ON REDUX-BONDED AND RIVETED DOUBLE STRAP JOINTS IN 10 S.W.G. ALUMINIUM ALLOY SHEET. S. Kelsey and J. B. Spooner, Imperial College. 1957. 46p. diagrs., tabs. ARC CP 353. (Ask for N-57364*)

Tensile fatigue tests were carried out on sheet specimens in D.T.D. 610B, 546B, and 687A with double strap Redux and riveted joints. Bonded joints tended to fail by shear of the bond at the higher stress ranges and by tension of the sheet at the lower stress ranges. Riveted joints failed by tension across the first row of rivets in all cases, though tests on three-row riveted joints showed considerable improvement in endurance over those with two rows of rivets. Endurances were greater for bonded joints but with rather more scatter than for riveted joints, particularly where bond shear was the cause of failure.

N-57365*

Aeronautical Research Council (Gt. Brit.)
EXPERIMENTS ON PITOT-TUBES IN SHEAR FLOW. F. A. MacMillan. 1957. 12p. diagrs. ARC R & M 3028; ARC 18,235. (Ask for N-57365*)

When a pitot tube is used in a pipe or boundary layer, the shear and the presence of the wall may cause the pressure in the tube to differ from the true total pressure on the axis of the tube. To investigate these effects measurements were made in a pipe of circular section, with turbulent flow, using pitot tubes of different external diameter. Some supporting experiments were also made in a turbulent boundary layer on a flat plate with zero pressure gradient.

N-57366*

Aeronautical Research Council (Gt. Brit.)
AN INVESTIGATION OF THE VELOCITY DISTRIBUTION AROUND THE NOSE OF THE AEROFOIL WITH A FLAP. Ian H. Rettie. 1957. 15p. diagrs. ARC R & M 3027; ARC 17,633. (Ask for N-57366*)

The velocity distribution around the nose of an NACA 0015-64 airfoil was found by experiment and that around the nose of a Piercy 15/40 airfoil by calculation for various angles of incidence and flap deflection. It was established that at all incidences this velocity distribution is a function of the position of the stagnation point, irrespective of the flap deflection. This result is shown to be true generally, and it is suggested that use might be made of it in the design of a lift-coefficient meter, which could also be used to give warning of a stall.

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N-57396*

Ministry of Supply (Gt. Brit.)
THE CREEP PROPERTIES OF FULLY HEAT TREATED D. T. D. 364A ALLOY AT 100° C, 150° C, 200° C, AND 250° C. August 1957. 6p. diagrs. MOS S & T Memo. 20/57. (Ask for N-57396*)

This report presents the results of creep tests on extruded material carried out at 100° C, 150° C, 200° C, and 250° C, with the object of determining the stress required at each temperature to produce 0.1 percent total plastic strain in 1,000 hours.

N-57398*

Royal Aircraft Establishment (Gt. Brit.)
CALCULATION OF THE FLOW PAST SLENDER DELTA WINGS WITH LEADING EDGE SEPARATION. K. W. Mangler and J. H. B. Smith. May 1957. 49p. diagrs., tabs. RAE Aero 2593. (Ask for N-57398*)

The flow past a slender delta wing with a sharp leading edge, at incidence, usually separates along this edge, that is, a vortex layer extends from the edge and rolls up to form a "core" (a region of high vorticity). A potential flow model of this is constructed in which the layer is replaced by a vortex sheet which is rolled up into a spiral in the region of the "core." This problem is reduced to a two-dimensional one by assuming a conical field and using slender wing theory. The shape and strength of the sheet are determined by the two conditions that it is a stream surface and sustains no pressure difference. Use is made of results previously obtained for the core region and the remaining finite part of the sheet is dealt with by choosing certain functions for its shape and strength.

N-57399*

Royal Aircraft Establishment (Gt. Brit.)
A NEW METHOD OF OBTAINING LOWER LIMITS FOR THE SOLUTIONS OF 'EIGENVALUE' PROBLEMS FOR BEAMS AND PLATES. D. Williams. August 1957. 14p. RAE Structures 225. (Ask for N-57399*)

A new method is described for deriving lower limits for the solutions of eigenvalue problems for beams and plates. It depends on defining the deformation of an elastic system by its displacements at a discrete number of stations, and on expressing curvature in finite-difference form. A physical argument takes the place of a rigorous proof and the method is illustrated by applying it to simple eigenvalue problems of elastic instability and natural vibration frequencies for which well-known standard solutions are available for comparison.

N-57400*

Royal Aircraft Establishment (Gt. Brit.)
LOW SPEED EXPERIMENTS ON THE WAKE CHARACTERISTICS OF FLAT PLATES NORMAL TO AN AIRSTREAM. R. A. Fail, J. A. Lawford, and R. C. W. Eyre. June 1957. 39p. diagrs., tabs. RAE Tech. Note Aero 2516. (Ask for N-57400*)

Experiments on isolated flat plates perpendicular to the wind are described. It is shown that the effects of aspect ratio on drag, base pressure, and flow pattern are small up to A = 10. All of these rectangular plates shed turbulent eddies at particular frequencies; generally there are two shedding frequencies for each plate, one associated with the smaller dimension of the plate, and a lower frequency associated with the larger dimension. Large changes in the shape of low-aspect-ratio plates have very small effects on the aerodynamic characteristics but perforating the plate can eliminate the regular shedding of eddies and reduce the random low-frequency velocity fluctuations.

N-57401*

Royal Aircraft Establishment (Gt. Brit.)
THE CALIBRATION OF A 12 STAGE AXIAL FLOW COMPRESSOR OF 8,000 H.P. A. G. Kurn. April 1957. 18p. diagrs., photo. RAE Tech. Note Aero 2505. (Ask for N-57401*)

The calibration of the Brown-Boveri compressor, which was installed in the R.A.E. transonic wind tunnels circuit in 1955, is described. Volume flows were obtained at two stations of the compressor circuit, using measurements of mean dynamic pressure given by integrating manometers. The results from the two stations agreed generally to within ±2 percent. The usual method of presenting compressor characteristics has been used; the results then form a "family" of curves, instead of collapsing into a single curve as in the simple case. The calibration shows that the design performance of the compressor has been exceeded.

N-57402*

Royal Aircraft Establishment (Gt. Brit.)
THE ROTATING FLAP AS A HIGH-LIFT DEVICE. L. F. Crabtree. APPENDIX II. D. A. Kirby. April 1957. 28p. diagrs. RAE Tech. Note Aero 2492. (Ask for N-57402*)

It is well known that a wing in an airstream can develop extremely high values of lift coefficient if it is rotated about a spanwise axis. A more practical development of this system is a fixed mainplane with a rotating trailing-edge flap. The results of some little-known German research on both systems have been collected together and are presented in compact form together with some further analysis. The emphasis is on the wing-rotating flap combination, and it is shown that this is a very attractive way of generating high lift. Some gaps in our knowledge of the device are pointed out and suggestions are made for some further research.

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CN-57403*

Royal Aircraft Establishment (Gt. Brit.)
NOTES ON A VISIT TO THE FOKKER AIRCRAFT FACTORY SCHIPHOL, AMSTERDAM, 11TH JUNE, 1957. T. Lloyd. July 1957. 7p. RAE Tech.Note Chem.1313. (Ask for CN-57403*)

The visit was arranged to discuss the use of reinforced plastics in the manufacture of the Fokker F.27 Friendship transport aircraft. The weight breakdown of the Friendship shows that over 5 percent of its total unladen weight is made up of glass fiber reinforced plastics, but this is not the only feature which shows a marked departure from conventional orthodox design. Metal to metal bonding by the Redux process is very extensively used and in many ways follows closely the laminating techniques developed in the reinforced plastic and plywood trades. The advantages claimed for these two departures from conventional designs are: reduction in stress concentrations and consequently improved fatigue characteristics, increase in structural rigidity, reduction in sealing problems, smoother outer surfaces, and reduction in cost.

CN-57404*

Royal Aircraft Establishment (Gt. Brit.)
AN EVALUATION OF HEAT RESISTANT LAMINATING RESINS. B. A. Blythe and W. W. Wright. March 1957. 66p. diagrs., tabs. RAE Tech.Note Chem.1303. (Ask for CN-57404*)

The variations with time at various temperatures in the flexural strength, modulus of elasticity, and weight loss of glass fiber laminates using 13 heat-resistant laminating resins were determined. The strength-temperature-time relationship was very complex and differed from resin to resin. On the basis of the results obtained, upper temperature limits have been suggested. The best results were obtained with a polyester triallyl cyanurate resin system, closely followed by a phenolic-epoxy resin mix.

CN-57405*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF CATALYSTS ON THE THERMAL STABILITY OF PHENOLIC RESINS. D. B. V. Parker. March 1957. 14p. diagrs., tabs. RAE Tech.Note Chem.1299. (Ask for CN-57405*)

It has been found that the thermal stability, under oxidative conditions, of phenolic resins is affected by the catalyst used for the condensation. The use of ammonia as catalyst produces resins whose heat resistance is superior to that of resins produced with other common catalysts. The physical behavior of phenolic resin-bonded asbestos laminates when subjected to high temperatures reflects the behavior of the resins. Those prepared with an ammonia-catalyzed resin show superior strength retention.

N-57406*

Royal Aircraft Establishment (Gt. Brit.)
THE MECHANICAL PROPERTIES OF RR58 ALUMINIUM ALLOY SHEET (CLAD) IN TENSION AND COMPRESSION AT ROOM AND ELEVATED TEMPERATURES. D. C. Hayward. April 1957. 33p. diagrs., tabs. RAE Tech.Note Met.261. (Ask for N-57406*)

Mechanical properties of specimens taken longitudinally from clad RR58 sheet at room, 100°, 150°, 200°, 250°, and 300° C after periods of 1, 200, and 1000 hours at temperature are presented. Specimens were also tested at room temperature after being heated for similar periods to investigate for recovery of strength. Results are presented in tabular and graphical form including tensile and compressive stress-strain graphs and tangent moduli for compression. Strength at room temperature was reduced by exposure at the higher temperatures and longer exposure resulted in greater loss. Strength at elevated temperature fell progressively with rise in temperature and above 150° C longer exposure caused greater loss. Stiffness at room temperature fully recovered after even the prolonged heating at all test temperatures.

CN-57407*

Royal Aircraft Establishment (Gt. Brit.)
THE CALIBRATION AT TRANSONIC SPEEDS OF A Mk.9A PITOT STATIC HEAD WITH AND WITHOUT FLOW THROUGH THE STATIC SLOTS. D. G. Mabey. March 1957. 27p. diagrs., tab. RAE Tech.Note Aero 2500. (Ask for CN-57407*)

The static pressure error of a standard Mark 9A pitot static head at transonic speeds has been measured in the R.A.E. (Bedford) 3-foot tunnel. The static error may be reduced slightly by sealing the drain hole. The effects of both flow through the drain hole and rate of altitude change were simulated and for a typical aircraft system the static error corresponding with a high rate of descent was found to be small. Some tunnel interference effects have been observed.

CN-57408*

National Gas Turbine Establishment (Gt. Brit.)
THE MECHANICAL DESIGN OF A PLANT-TYPE GAS TURBINE. L. T. Whitehead. June 1957. 50p. diagrs., photos. NGTE Memo.M.300. (Ask for CN-57408*)

The paper describes the construction of a four-stage, 8,000 b.hp gas turbine designed and manufactured at the National Gas Turbine Establishment, embodying several features intended to deal with problems of thermal expansion and insulation encountered on gas turbine engines.

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CN-57409*

Royal Aircraft Establishment (Gt. Brit.)
AUTOMATIC DATA REDUCTION EQUIPMENT FOR WIND TUNNELS. G. C. Rowley. May 1957. 41p. diagrs., photos., tab. RAE Tech. Note MS 35. (Ask for CN-57409*)

A review is given of the developments since 1947 in the data recording equipment used in R.A.E. wind tunnels. The latest equipment now going into use is described in detail with appendices of operating instructions.

CN-57410*

Royal Aircraft Establishment (Gt. Brit.)
A TRANSISTOR BUFFER STAGE WITH HIGH INPUT IMPEDANCE. D. E. Mullinger. June 1957. 19p. diagrs., photos. RAE Tech. Note GW 459. (Ask for CN-57410*)

A transistor replacement for the thermionic cathode follower intended for use with piezo-electric vibration transducers is described. The input resistance is greater than 20 MΩ and the output resistance is approximately 600 Ω. When used with a barium titanate accelerometer of 200 pF capacitance the gain is about 0.9 and the useful frequency range is 20 c/s to 20 Kc/s. The power supply required is less than 1/2 mV at 6V dc.

N-57411*

Royal Aircraft Establishment (Gt. Brit.)
THE APPLICATION OF 'FRACTOGRAPHY' TO FATIGUE FAILURE INVESTIGATIONS. P. J. E. Forsyth. March 1957. 9p. diagrs., photos. RAE Tech. Note Met. 257. (Ask for N-57411*)

This paper describes a microscopical technique for the examination of fatigue fractures which may supplement the conventional methods of investigation. This technique was originally described by Zapffe and Worden. The present paper considers that on the microscopic scale the only features which can be reliably used for fatigue identification are the fine lamellae which can be revealed at high magnifications.

N-57445*

Aeronautical Research Council (Gt. Brit.)
TURBULENCE MEASUREMENTS IN SUPERSONIC FLOW WITH THE HOT-WIRE ANEMOMETER. B. Wise and D. L. Schultz, Oxford University. 1957. 27p. diagrs., tab. ARC CP 366. (Ask for N-57445*)

Previous measurements of turbulence under compressible flow conditions have shown that fluctuations in stagnation temperature can occur. Determination of the mass flow fluctuation level is thus rendered more difficult since the hot wire is sensitive to both variables, and an improved technique is necessary to distinguish between them. The apparatus developed for this purpose is described and some experimental results presented to illustrate the method used to separate the two variables.

N-57446*

Aeronautical Research Council (Gt. Brit.)
ASSESSMENT OF THE POSSIBILITY OF USING SUCTION TO INHIBIT CAVITATION ON CYLINDRICAL SECTIONS. G. E. Thomas. 1957. 18p. diagrs., tabs. ARC CP 362. (Ask for N-57446*)

This report assesses the possibility of using suction to reduce the suction peak in the pressure distribution on a body moving in a fluid, with a view to delaying the onset of cavitation. Two cases are considered: (1) flow past elliptic cylinders with suction applied over the entire forward half, and (2) flow past circular cylinders with suction applied over limited areas. Results are given of calculations made to determine the effect of varying amounts of suction as well as, in the case of (2), the added effect of changing the location and extent of the suction area. It is shown that while the onset of cavitation can be considerably delayed, the amount of suction required to effect such an improvement proves to be excessive. For this reason, it is unlikely that the method can find application, at least, not on nonlifting two-dimensional forms.

N-57447*

Aeronautical Research Council (Gt. Brit.)
INITIAL LIFT OF FINITE ASPECT-RATIO WINGS DUE TO A SUDDEN CHANGE OF INCIDENCE. Doris E. Lehrian, National Physical Laboratory. 1957. 6p. diagrs., tabs. ARC R & M 3023; ARC 17,603. (Ask for N-57447*)

The initial lift for wings of finite aspect ratio due to a sudden unit change of incidence is considered and, by the use of the method developed in R & M 2117, the ratio of the initial to the final values of the lift is determined for rectangular wings and cropped delta wings of taper ratio 1/7. These values indicate that the initial lift may be greater than the final lift for aspect ratios $A \leq 2$. This result appears to be supported by the values of instantaneous lift which were measured for the delta wing of aspect ratio 1.2 as its incidence was rapidly changed.

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N-57598Y*

Aeronautical Research Council (Gt. Brit.)
INVESTIGATIONS ON AN EXPERIMENTAL AIR-COOLED TURBINE. PART I - GENERAL DESCRIPTION OF TURBINE AND EXPERIMENTAL TECHNIQUE. D. G. Ainley and N. E. Waldren.
PART II - COOLING CHARACTERISTICS OF BLADES HAVING A MULTIPLICITY OF SMALL DIAMETER COOLANT PASSAGES. D. G. Ainley, N. E. Waldren, and K. Hughes. 1957. 64p. diagrs., photos., tabs. ARC R & M 2975; ARC 16,957; ARC 16,958. Supersedes NGTE R. 153 and NGTE R. 154.
(Ask for N-57598Y*)

Part I gives a general description of an experimental single-stage air-cooled turbine which has been erected and operated at NGTE to facilitate the development of high-temperature air-cooled turbine engines. Part II continues with a description of some internally air-cooled nozzle and rotor blades together with an account of some experimental investigations concerning their performance.

N-57599Y*

Aeronautical Research Council (Gt. Brit.)
MEASUREMENTS OF THE AERODYNAMIC DERIVATIVES FOR SWEPT WINGS OF LOW ASPECT RATIO DESCRIBING PITCHING AND PLUNGING OSCILLATIONS IN INCOMPRESSIBLE FLOW. C. Scruton, L. Woodgate, and A. J. Alexander, National Physical Laboratory. 1957. 35p. diagrs., photos., tabs. ARC R & M 2925. Supersedes ARC 15,499; 0.1035; S & C 2719 and ARC 16,210; 0.1076; S & C 2810.
(Ask for N-57599Y*)

The aerodynamic lift and moment derivatives for pitching oscillations in incompressible flow have been measured for two axis positions on a clipped delta wing of AR = 1.2, a complete delta wing of AR = 1.6, and an arrowhead wing of AR = 1.32. The results for the arrowhead wing and the clipped delta wing are compared with values predicted by the vortex-lattice and the Multhopp-Garner methods of calculation. The results for the complete delta wing are compared with values calculated by Garner and by Lawrence and Gerber. In each of the comparisons a satisfactory measure of agreement was found between the theoretical and experimental values of the derivatives.

N-57600Y*

Aeronautical Research Council (Gt. Brit.)
AN APPROXIMATE METHOD OF ESTIMATING THE EFFECT OF ELASTIC DEFORMABILITY OF THE AIRCRAFT STRUCTURE ON THE MANOEUVRE POINT. PART I AND II. H. Fingado and A. S. Taylor. 1957. 111p. diagrs., tabs. ARC R & M 3019; ARC 12,501; ARC 18,053. Supersedes RAE Aero 2320 and RAE Aero 2362.
(Ask for N-57600Y*)

An approximate method of estimating the effect of structural deformability on the maneuver point of an aircraft is developed. The introduction outlines the scope of the work in relation to the work of Lyon & Ripley. Part I opens with a detailed discussion of the structural deformability of wings, swept and unswept, and proceeds on the basis of certain aerodynamic and structural approximations to derive relatively simple formulas for the calculation of the shift of maneuver point due to elastic camber, elastic washout, and the direct effect of wing bending on pitching moment. Part II examines the effects of fuselage and tail plane deformability, and at the same time investigates the effect of wing deformability on the fuselage and tail-plane contributions to maneuvering stability.

N-57632*

Royal Aircraft Establishment (Gt. Brit.)
SOME SIMPLE CONICAL CAMBER SHAPES TO PRODUCE LOW LIFT-DEPENDENT DRAG ON A SLENDER DELTA WING. G. G. Brebner. September 1957. 27p. diagrs. RAE Tech. Note Aero 2529. (Ask for N-57632*)

This note presents some of the theoretical aerodynamic characteristics of narrow delta wings having flat center portions and two types of simple conical camber designed to produce zero load at the leading edge at the design C_L. Slender wing theory is used in the calculations. It is shown that the drag due to lift is comparable with the low values found by Smith and Mangler for wings with more "wavy" camber lines.

CN-57633*

Royal Aircraft Establishment (Gt. Brit.)
THE TROPICAL DURABILITY OF METAL ADHESIVES (INTERIM NOTE). A. Baker and M. G. D. Hockney. March 1957. 11p. diagr., tabs. RAE Tech. Note Chem. 1304. (Ask for CN-57633*)

A tropical trial of metal adhesives by the boxed test-piece technique has been proceeding for 3 years. Specimens have been withdrawn at suitable intervals for strength testing, in comparison with controls kept at R. A. E. Araldite type 1 joints have been appreciably weakened by the tropical climate, but Redux joints have shown no deterioration.

N-57634*

Royal Aircraft Establishment (Gt. Brit.)
SUPERSONIC FLOW PAST NARROW WINGS WITH "SIMILAR" CROSS-SECTIONS AT ZERO-LIFT. W. T. Lord and G. G. Brebner. August 1957. 55p. diagrs., tab. RAE Tech. Note Aero 2509. Supersedes RAE Tech. Memo. Aero 525.
(Ask for N-57634*)

A coordination and extension of some recent theoretical work on narrow wings at zero lift is given. The wings have arbitrary plan forms, subject to the restrictions that the trailing edges are straight and unswept, and thickness distributions which have arbitrary root profiles and cross sections, provided that each wing has "similar" cross sections at all chordwise positions. Formulas are given for the overall pressure distributions, and in particular the root pressure distributions, and the wave drags of such wings. The formulas for the root pressure

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distributions and wave drags are very simple and enlightening. A selection of some wings of especial interest is made; results for this selection are given in detail. A primary aim is to aid the discovery of wings which possess the properties of simple geometry, of lowish wave drag, and of having inviscid pressure distributions which are unlikely to be seriously changed by viscous effects. Although in this note the emphasis is placed on narrow wings with straight unswept trailing edges, many of the formulas presented here apply unchanged to wings with swept-forward trailing edges, provided the plan forms are smooth curves.

N-57635*

Royal Aircraft Establishment (Gt. Brit.)
DRAG REDUCTION OF THIN WINGS AT SUPERSONIC SPEEDS, BY THE USE OF CAMBER AND TWIST. G. M. Roper. July 1957. 105p. diagrs., tabs. RAE Aero 2585. (Ask for N-57635*)

Camber and twist are applied to the problem of reducing the drag, due to incidence, of thin triangular or sweptback wings, at supersonic speeds, with subsonic leading edges, and supersonic or sonic trailing edges. Two cases are considered: (1) with leading-edge suction ignored, and (2) with leading suction forces included. It is found that twist, especially towards the wing tips, is more effective in reducing drag, for given lift, for the larger values of $\tan\gamma/\tan\mu$, where γ is the semiapex angle and μ is the Mach angle, and that camber is more effective for the smaller values, though, in general, the best results are obtained by a suitable combination of camber and twist.

N-57636*

National Gas Turbine Establishment (Gt. Brit.)
PILOT COMBUSTION CANS EMPLOYING A LARGE SCALE RECIRCULATION FLOW PATTERN. H. G. Lyall. September 1957. 31p. diagrs. NGTE Memo. M.305. (Ask for N-57636*)

A pilot combustion can is described, suitable for use as the first stage of a ram-jet primary zone, in which the flame is stabilized by a large-scale recirculation flow pattern. The recirculation is established behind the shrouded cone which forms the front of the can, and is carefully fed from several injection stations. This system is a distinct improvement on the much used earlier first stage, the "single-row can," in that despite a reduced stability range the combustion efficiency, and thus heat release, are higher. When compared with the "pepper-pot" system in which the combustion zone is fed by many small jets, with no major flow reversal, the performance of the shrouded cone system is shown to be slightly inferior with premixed vaporized combustibles but less sensitive to the presence of liquid fuel at low inlet air temperature. Results from geometrically similar cans tested at fixed inlet temperature over a range of pressures and scales are adequately correlated by the second-order reaction rate loading parameter, Q/VP^2.

N-57637X*

Aeronautical Research Council (Gt. Brit.)
FLOW IN THE LAMINAR BOUNDARY LAYER NEAR SEPARATION. B. S. Stratford. APPENDIX I - THE SOLUTION IN THE NEIGHBOURHOOD OF THE SINGULARITY AT $x = x_0$, WITH FINITE PRESSURE GRADIENTS. G. E. Gadd, National Physical Laboratory. 1957. 27p. diagrs., tabs. ARC R & M 3002. Supersedes ARC 17,230; FM 2166. (Ask for N-57637X*)

A simple formula is derived for the separation of the laminar boundary layer. The method of derivation and a key test suggest that it should be reasonably accurate and of general application, including particularly the range of sharp pressure gradients and small pressure rises to separation. In addition, a partially new exact solution is found for the boundary-layer equations of motion; also the pressure distribution is obtained for continuously zero skin friction, this pressure distribution being expected to attain any given pressure rise in the shortest distance possible for a given laminar boundary layer provided that there is neither transition nor boundary-layer control.

N-57639*

Aeronautical Research Council (Gt. Brit.)
THE INFLUENCE OF SOLID BOUNDARIES UPON AERODYNAMIC SOUND. N. Curle, National Physical Laboratory. February 5, 1955. 10p. ARC 17,373; FM 2188. (Ask for N-57639*)

An extension is made to Lighthill's general theory of aerodynamic sound, so as to incorporate the influence of solid boundaries upon the sound field. This influence is twofold; namely, reflection and diffraction of the sound waves at the solid boundaries, and a resultant dipole field at the solid boundaries which are the limits of Lighthill's quadrupole distribution. It is shown that these effects are exactly equivalent to a distribution of dipoles, each representing the force with which unit area of solid boundary acts upon the fluid.

N-57640, pt.2*

Aeronautical Research Council (Gt. Brit.)
A MODIFIED POHLHAUSEN METHOD FOR SOLUTION OF LAMINAR BOUNDARY LAYERS. PART II - COMPRESSIBLE FLOW WITH ZERO HEAT TRANSFER. N. Curle, National Physical Laboratory. June 17, 1957. 14p. tabs. ARC 19,342; FM 2554. (Ask for N-57640, pt.2*)

The effects of compressibility are shown, following Howarth, to be equivalent to a modification of the effective pressure gradient and a stretching of the coordinate normal to the wall. The momentum integral equation is developed in terms of this new coordinate and a quintic velocity profile substituted. Solution of the resulting equation indicates in all cases a forward movement of separation as the Mach number increases. For a linearly retarded velocity the results agree well with those of Stewartson.

BRITISH REPORTS

N-57642*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE CONDITIONS AT A SEPARATION POINT. G. Temple. September 10, 1957. 3p. ARC 19,520; FM 2583. (Ask for N-57642*)

It is commonly asserted in discussions of boundary-layer theory that the viscous stress vanishes at the point on the flat plate where laminar separation takes place. The author has not found any formal proof of this in the literature and therefore puts forward this elementary investigation in order to open a further discussion of this matter.

N-57643*

Aeronautical Research Council (Gt. Brit.)
THE CALCULATION OF THE PATHS OF VORTICES FROM A SYSTEM OF VORTEX GENERATORS, AND A COMPARISON WITH EXPERIMENT. J. P. Jones, Southampton University. 1957. 16p. diagrs., photos., tabs. ARC CP 361. (Ask for N-57643*)

A method is described for the calculation of the paths of the trailing vortices from a system of counter-rotating vortex generators, and a comparison is made with some experimental results obtained in a water tunnel. The method can be adapted to other configurations of generators arranged to produce rows of vortices close to a plane surface.

N-57644*

Aeronautical Research Council (Gt. Brit.)
A SUBSONIC LIFTING-SURFACE THEORY FOR LOW ASPECT-RATIO WINGS. C. R. Taylor, Imperial College. 1957. 20p. diagrs., tabs. ARC R & M 3051; ARC 18,142. (Ask for N-57644*)

A method is developed for determining the loading on low-aspect-ratio wings. By allowing for downstream effects on the flow at a station on the wing and for the trailing-edge condition, the method improves on R. T. Jones' theory for wings of very small aspect ratio. Calculations have been made for 13 different wings and a comparison with other methods of solution is given for some cases.

N-57645*

Aeronautical Research Council (Gt. Brit.)
EXPERIMENTS AT M = 1.41 ON ELLIPTIC CONES WITH SUBSONIC LEADING EDGES. E. E. E. Rogers and C. J. Berry, National Physical Laboratory. 1957. 41p. diagrs., photos., tabs. ARC R & M 3042; ARC 17,929. (Ask for N-57645*)

Tests have been made on six elliptic cones forming two families of models. In the first, the vertex angle in the plane of the major axes of the elliptic cross sections was maintained constant at 60° and the ratio between the minor and major axes varied; in the second family, the minor axis was constant and the vertex angle had values of 30°, 60°, and 90°. Two cones from the first family were pressure plotted at incidences up to 15°, the resulting pressure distributions being integrated to give the lift and pressure drag arising from the curved surfaces of the cones. Lift, drag, and center-of-pressure position were measured on all but one model on a strain-gage balance. Where comparison was possible, good agreement was obtained for the lift and drag derived from the two methods.

N-57647*

Royal Aircraft Establishment (Gt. Brit.)
THE TENSILE STRENGTH AT ROOM TEMPERATURE AND 300° C OF FUSION AND RESISTANCE WELDED TITANIUM Ti6Al4V ALLOY SHEET. N. J. F. Gunn and G. I. Lewis. January 1957. 13p. diagrs., photos., tabs. RAE Tech. Note Met. 255. (Ask for N-57647*)

Tests have been made on a small number of fusion and resistance welds in Ti6Al4V alloy sheet at room temperature and 300° C. At both temperatures all specimens except one showed a joint efficiency of 97 percent or greater. The strength at 300° C was found to be about 75 percent of that at room temperature irrespective of straining rate.

CN-57648*

Royal Aircraft Establishment (Gt. Brit.)
ELEMENTARY ESTIMATES OF PARACHUTE OPENING FORCES. M. H. L. Waters. May 1957. 37p. diagrs. RAE Tech. Note Mech. Eng. 238. (Ask for CN-57648*)

Simple assumptions of the rate of parachute inflation are used to construct data sheets for parachute maximum loads and other quantities. The aim is to present an elementary analysis in detail as a basis for future comparison with experiment. Appendices treat nonhorizontal motion of the parachute and store, and estimate the effect on the opening load, of the virtual airmass associated with the canopy. The "shock factor" as measured in wind-tunnel tests is also discussed, and the last appendix extends the method of calculation to reefed parachutes.

CN-57650*

Royal Aircraft Establishment (Gt. Brit.)
SECTIONING AND ETCHING TECHNIQUES FOR TRANSISTORS AND DIODES. W. G. Townsend. May 1957. 21p. diagrs., photos. RAE Tech. Note EL 142. (Ask for CN-57650*)

A simple technique for sectioning and etching germanium and silicon transistors and diodes to reveal the p-n junctions is described and the results illustrated photographically. Some defects occurring in the junctions are also shown and their causes discussed. Experiments with various chemical and electrolytic etches to reveal dislocations on single crystal germanium and silicon are described and the results of the different types of etches used are discussed. Illustrations showing arrays of dislocation etch pits formed on crystals with (111) growth axes are included. Materials used for preparing specimens and etching solutions are listed in appendices.

* AVAILABLE ON LOAN ONLY.

BRITISH REPORTS

N-57663*

Aeronautical Research Council (Gt. Brit.)
CURVES SUITABLE FOR FAMILIES OF AEROFOILS WITH VARIABLE MAXIMUM THICKNESS POSITION, NOSE RADIUS, CAMBER, AND NOSE DROOP. L. H. Tanner, National Physical Laboratory. 1957. 26p. diagrs. ARC CP 358. (Ask for N-57663*)

The paper shows that it is possible to design geometric curves, given by single explicit equations, and having shapes suitable for use as airfoil sections. A family of sharp-nosed sections with variable maximum thickness position is described. A method of rounding the leading edge of any sharp-nosed section is then suggested. Finally a family of curves with camber and nose droop is given. The methods used could be adapted to produce other section variations if required.

N-57723*

Royal Aircraft Establishment (Gt. Brit.)
TEMPERATURE CONTROL AND STRAIN MEASUREMENT IN TENSILE TESTS AT HIGH RATES OF HEATING AND LOADING. B. F. Billing and M. S. Binning. May 1957. 16p. diagrs., photos. RAE Tech.Note Met. 263. (Ask for N-57723*)

Equipment is described both for manual and automatic control of the temperature of a specimen heated by the passage of a heavy alternating current to temperatures up to 1200° C in under 30 seconds and maintained at temperature for up to 30 minutes. An extensometer suitable for use up to 1100° C is described together with a procedure for strain measurement and recording which enabled the 0.2-percent proof stress to be reached in about 10 seconds.

N-57724*

Aeronautical Research Council (Gt. Brit.)
APPROXIMATE CALCULATIONS OF THE LAMINAR BOUNDARY LAYER WITH SUCTION, WITH PARTICULAR REFERENCE TO THE SUCTION REQUIREMENTS FOR BOUNDARY LAYER STABILITY ON AEROFOILS OF DIFFERENT THICKNESS/CHORD RATIOS. M. R. Head. September 10, 1957. 31p. diagrs. ARC 19,519; FM 2582. (Ask for N-57724*)

An approximate method of calculation, based on the use of the momentum and energy integral equations, has been used to obtain solutions to several two-dimensional laminar boundary-layer problems involving suction or blowing through the surface. Curves have been obtained showing how the suction quantities required to maintain neutral stability of the boundary layer on an airfoil vary with thickness/chord ratio and Reynolds number.

N-57725*

Aeronautical Research Council (Gt. Brit.)
SUPERSONIC BANGS. P. Sambasiva Rao, Manchester University. March 2, 1955. 27p. diagrs. ARC 17,427; FM 2194. (Ask for N-57725*)

In this paper a nonlinear theory of the supersonic bangs from an accelerating body is worked out, using an extension of Whitham's method. The strength of the bow shock is determined, and it is shown that the effect of acceleration on the pressure rise is appreciable at large distances from the nose for Mach numbers near unity. The results are compared with those of linear theory; the estimate for the pressure rise is found to be about a half of the linear value. The results also include an expression for the curvature of an attached shock at the nose, and a formula for the decay of a shock after it is detached from a decelerating body.

CN-57726*

Royal Aircraft Establishment (Gt. Brit.)
A DETAILED CODING PROGRAMME FOR DEUCE. P. A. Samet. August 1957. 19p. RAE Tech.Note MS 37. (Ask for CN-57726*)

This note describes a program, RAE 415, which performs the detailed coding of DEUCE programs.

N-57727*

Aeronautical Research Council (Gt. Brit.)
CONTRIBUTIONS TO THE THEORY OF THE PITOT-TUBE DISPLACEMENT EFFECT. M. J. Lighthill. April 10, 1957. 21p. tabs. ARC 19,182; FM 2529; TP 524. (Ask for N-57727*)

The author analyzes the secondary flow due to the presence of a solid sphere in a uniformly sheared oncoming stream, with viscosity neglected, and computes the upstream displacement of the stagnation streamline. He then discusses in some detail the relevance of this and of various other recent theoretical results to the problem of the pitot-tube displacement effect.

N-57728*

Aeronautical Research Council (Gt. Brit.)
ENTHALPY CHARTS: FOR DISSOCIATING GAS MIXTURES IN THE TEMPERATURE RANGE 600 DEG TO 4000 DEG K. H. Reichert. 1957. 25p. diagrs., charts, tabs. ARC R & M 3015; ARC 16,506. Supersedes RAE Tech.Note RPD 35. (Ask for N-57728*)

By means of a quantity called "reaction enthalpy," it is possible without previous knowledge of the composition of the mixture of gases to work out dissociation processes occurring at equilibrium. Also,

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composition of the mixture can be obtained from the charts. The charts are confined to the C,H,O-system, but their extension to include N in the system is simple. Charts with the total pressure p and the molar ratio n_C/n_H as parameters have been constructed in the first place for the four pressures p = 0.1, 1.0, 10.0, and 100.0 kg/sq cm, and for the seven molar ratios n_C/n_H = 0, 0.2, 0.4, 0.6, 0.8, 1.0, and ∞. The four charts (reduced in scale) for the molar ratio n_C/n_H = 0.4 are attached as examples.

N-57730X*

Aeronautical Research Council (Gt. Brit.)
SOME FURTHER JET FLAP EXPERIMENTS.
N. A. Dimmock. 1957. 70p. diagrs., photos., tabs.
ARC CP 345. (Ask for N-57730X*)

This paper. which may be considered as an addendum to the NGTE Report R.175, records the results of tests on the same two-dimensional airfoil which was used for the earlier work and which had a 12.5-percent-thick elliptical cross section with a narrow full span jet slot. This time, however, the jet deflection is 58.1° from the chord line. In addition to the measurement of the forces and moments acting on the model, the flow pattern in the vicinity of the airfoil was revealed with smoke filaments and was recorded photographically. A comparison with the theory of reference 2 is drawn where appropriate and additional support is given to the thrust hypothesis. A check on the effects of Reynolds number variation and of the addition of transition wires to the model confirmed the results of the previous experiments, while the influence of ground proximity on the lift, center of lift position, and the thrust was investigated and found to be substantial, although a reason is suggested why these results might be pessimistic.

N-57773*

Royal Aircraft Establishment (Gt. Brit.)
A SIMPLE METHOD OF IMPROVING THE SUPERSONIC VELOCITY DISTRIBUTION IN A TRANSONIC TUNNEL HAVING SLOTTED WALLS. C. N. Hall. July 1957. 13p. diagrs., photo. RAE Tech. Note Aero 2517. (Ask for N-57773*)

This note describes how the center-line distribution of Mach number in the R. A. E. 8 ft x 6 ft transonic tunnel has been modified at supersonic speeds by means of curved lengths of perforated steel plate set behind a proportion of the suction slots in the walls of the working section. It was found that the slope and curvature of the perforated strips and the distance from the suction slots determined their effect on the distribution of Mach number. A form of plate was evolved which reduced the variation of Mach number about the mean from ±0.010 to ±0.006 at the maximum Mach number.

N-57774*

Royal Aircraft Establishment (Gt. Brit.)
BOUNDARY LAYER MEASUREMENTS ON 15° AND 24.5° CONES AT SMALL ANGLES OF INCIDENCE AT M = 3.17 AND 3.82 AND ZERO HEAT TRANSFER. F. V. Davies and R. J. Monaghan. June 1957. 40p. diagrs., photos. RAE Aero 2577. (Ask for N-57774*)

The transition front was extremely sensitive to α, a fourfold variation occurring between transition RN on the leeward and windward sides of the 15° cone at $\alpha = 2°$. At zero α the transition RN was between 2.5 and 3.0 x 10^6 and no significant variation was observed over the test range of stagnation pressures from 2 to 5 atmospheres. Pitot traverses on the top generator of the 15° cone at $M_\infty = 3.17$ showed that the effects of small α on the characteristics of the laminar boundary layer were nearly linear. Small α altered the thicknesses of both laminar and turbulent boundary layers, but did not affect the shapes of the velocity profiles. The alteration with α of the displacement thickness of the laminar boundary layer was large (agreeing with Moore's theory) and in amount was more than twice that found with a turbulent boundary layer.

MISCELLANEOUS

Errata on NACA Rept. 1313, by Bertram. 1957.

N-41875X

Advisory Group for Aeronautical Research and Development. AERODYNAMIC THEORY AND ITS APPLICATION TO FLUTTER. I. E. Garrick, NACA. (Presented at 3rd meeting of AGARD Structures and Materials Panel, April 10-17, 1956, Washington, D.C.) April 1956. vii, 32p. diagrs. AGARD Report 34. (Ask for N-41875X)

A survey is given of the present status of aerodynamic theory in relation to flutter analysis with a discussion of concepts implied in the structural and aerodynamical background. Applications of some recent developments in the theory of oscillating wings, offering promise for the flutter analysis of low-aspect-ratio wings, are indicated. Problems of the subsonic and supersonic speed ranges are included.

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MISCELLANEOUS

N-41948X

Advisory Group for Aeronautical Research and Development. DIVERGENCE OF DELTA AND SWEPT SURFACES IN THE TRANSONIC AND SUPERSONIC SPEED RANGES. Franklin W. Diederich, NACA. (Presented at 3rd meeting of AGARD Structures and Materials Panel, April 10-17, 1956, Washington, D.C.) April 1956. viii, 43p. diagrs. AGARD Report 42. (Ask for N-41948X)

Discusses various divergence phenomena in a qualitative manner, and concludes that sweptback wings cannot diverge, but that thin delta wings may be capable of divergence at transonic speeds in a predominantly chordwise mode. Methods of analyzing divergence as well as subcritical static aeroelastic phenomena are discussed in some detail, with particular reference to approaches suitable for problems where simple-beam theory is inadequate. A simple approximate method of analyzing static aeroelastic phenomena is presented and used to make some calculations for a delta wing at supersonic speeds.

N-45852X

Advisory Group for Aeronautical Research and Development. SOME UNIQUE ASPECTS OF FLIGHT TEST INSTRUMENTATION FOR VERTICAL TAKE-OFF AIRCRAFT. E. R. Hinz and R. A. Fuhrman, Ryan Aeronautical Co. (Presented at 9th meeting of AGARD Flight Test Techniques Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. vii, 24p. diagrs., photo. AGARD Report 85. (Ask for N-45852X)

Describes those aspects of flight test instrumentation which are unique to VTO aircraft, as distinct from conventional aircraft. These aspects are discussed under three headings: hovering flight, transitional flight, and conventional flight. The idea of establishing a common space-axes system applicable to all flight regimes is discussed also and a suggestion put forward for the establishment of a new stable platform attitude reference.

N-46302X

Advisory Group for Aeronautical Research and Development. A SUPERSONIC WIND TUNNEL FOR MACH NUMBERS UP TO 3.5. L. E. Leavy. (Presented at 9th meeting of AGARD Wind Tunnel and Model Testing Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. iv, 31p. diagrs., photo. AGARD Report 70. (Ask for N-46302X)

A description is given of the requirements, design, and construction of the new AVRO 27-in. by 36-in. intermittent "blowdown" supersonic wind tunnel. The relative advantages and disadvantages of the "blowdown" and "suck-down" tunnels are compared, and it is concluded that the "blowdown" is the most suitable for the purpose. An outline of the factors governing the size of a tunnel designed to work at M = 3.5 is given and the reasons for the choice of low pressure storage are set out. The main parts of the tunnel (working section, control valve, etc.,) and its associated equipment such as driers, etc., are described briefly and an estimate of the tunnel utilization and cost is given.

N-47069X*

Advisory Group for Aeronautical Research and Development. HISTORY OF GERMAN GUIDED MISSILES DEVELOPMENT. Edited by Th. Benecke and A. W. Quick. (AGARD first Guided Missiles Seminar, Munich, Germany, April 1956.) 1957. viii, 420p. diagrs., photos., tabs. AGARDograph 20.

Contents: SUMMARY OF GERMAN DEVELOPMENTS IN GUIDED MISSILES. Theodor Benecke. GUIDANCE AND CONTROL OF THE HENSCHEL MISSILES. Herbert A. Wagner. CONTRIBUTIONS TO THE GUIDANCE OF MISSILES. Eduard Fischel, Kearfott Co., Inc. SPOILER CONTROL OF MISSILES. Günter Ernst. THE AERODYNAMIC DEVELOPMENT OF THE V-2. Hermann H. Kurzweg, Naval Ordnance Lab. DEVELOPMENT AND TESTING OF THE V-1 AUTO-PILOT. Heinrich Temme, Siemens & Halske AG. THE CONTROL SYSTEM OF THE V-2. Otto Müller. Attache au service technique de l'armee francaise. DEVELOPMENT AND FIELD-TESTS OF A RADIO-CONTROLLED AEROPLANE MODEL AS TARGET SIMULATOR FOR ANTI-AIRCRAFT BATTERIES. Walter Kloepfer. GUIDED MISSILES RADIO REMOTE CONTROL. Josef Dantscher. FURTHER DEVELOPMENT OF REMOTE CONTROL SYSTEMS AND THE REMOTE CONTROL OF AIR-TO-AIR MISSILES. Josef Dantscher. A GUIDING SYSTEM USING TELEVISION. Fritz Münster. Deutsche Versuchsanstalt für Luftfahrt. SUMMARY OF THE DEVELOPMENT OF HIGH-FREQUENCY HOMING DEVICES. Georg Güllner, Askania-Werke AG. THE GUIDANCE SYSTEMS HV AND HAWAII II. Richard Schäfer, Instituto Nacional de Electronica. GUIDANCE OF SURFACE-TO-AIR MISSILES BY MEANS OF RADAR. Karl H. Schirrmacher, Royal Aircraft Establishment. THE PHYSICAL AND TECHNICAL DEVELOPMENT OF INFRARED HOMING DEVICES. Edgar W. Kutzscher, Lockheed Aircraft Corp. REVIEW OF THE DEVELOPMENT OF PROXIMITY FUSES. Friedrich von Rautenfeld, Institut für Rundfunktechnik. SOME SPECIAL PROBLEMS OF POWER PLANTS. Otto Lutz, Technical University Brunswick. THE DESIGN AND DEVELOPMENT OF THE SOLID-FUEL ROCKET AND ITS PERFORMANCE. Hermann Vüllers. DEVELOPMENT OF HYDROGEN PEROXIDE ROCKETS IN GERMANY. Hellmuth Walter, R. & D. Worthington Corp. THE DEVELOPMENT OF THE V-2 ROCKET ENGINE. Martin Schilling, Redstone Arsenal. BMW-DEVELOPMENTS. Helmut Ph. G. A. R. von Zborowski. HISTORY OF THE AIR-BORNE TOWING EXPERIMENTS WITH LARGE SIZE RAM-JET DUCTS IN GERMANY DURING 1941-1945. Irene Sänger-Bredt, Forschungsinstitut für Physik der Strahlantriebe. HIGH-VELOCITY FREE-FLYING RAM-JET UNITS (TR-MISSILES. Wolf Trommsdorff, Deutsche Versuchsanstalt für Luftfahrt. ON THE HISTORY OF THE DEVELOPMENT OF THE SCHMIDTROHR. Paul Schmidt, Maschinen- und Apparatebau. DEVELOPMENT OF THE V-1 PULSE JET. Fritz Gosslau, Ernst Heinkel Fahrzeugbau AG. RESEARCH AND DEVELOPMENT OF THE GUIDED MISSILE "FEUERLILIE." Walter Wernitz, Technical University Brunswick.

(May be purchased from Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, New York, at $7.50)

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MISCELLANEOUS

N-47742X

Advisory Group for Aeronautical Research and Development. AIR SUPPLY FOR BLOW-DOWN WIND TUNNELS. E. J. Stollenwerk. (Presented at 9th meeting of AGARD Wind Tunnel and Model Testing Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. iv, 19p. diagrs., photos. AGARD Report 88. (Ask for N-47742X)

An air-supply system for a blowdown wind tunnel is described with particular emphasis on the problem of air storage and pressure control, flow equalization downstream of the control valve, and temperature control. The basis of the description is operational experience with tunnel E-1 during the past 3 years. Tunnel E-1 is a 12-inch by 12-inch supersonic wind tunnel of the Gas Dynamics Facility, Arnold Engineering Development Center, Tullahoma, Tennessee, U.S.A.

N-47899X

Advisory Group for Aeronautical Research and Development. THE BLOW-DOWN WIND TUNNEL AT AACHEN. A. Naumann, A. Heyser, and W. Trommsdorff, Deutsche Versuchsanstalt für Luftfahrt. (Presented at 9th meeting of AGARD Wind Tunnel and Model Testing Panel, August 27-31, 1956, Brussels.) August 1956. vi, 20p. diagrs. AGARD Report 69. (Ask for N-47899X)

The construction, installation, and operation of the first stage of the blowdown wind tunnel at Aachen are described. The general layout of the complete tunnel, as finally intended, is also described, and a simple analytical estimation is given of the aerodynamic performance of such a tunnel.

N-48957

Advisory Group for Aeronautical Research and Development. LOADS ON A MODEL DURING STARTING AND STOPPING OF AN INTERMITTENT SUPERSONIC WIND TUNNEL. K. G. Winter and C. S. Brown. (Presented at 9th meeting of AGARD Wind Tunnel and Model Testing Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. v, 16p. diagrs., photos. AGARD Report 65. (Ask for N-48957)

Measurements are given of the loads on a model during starting and stopping of an intermittent supersonic wind tunnel at Mach numbers of 2.00 and 2.48. Qualitative agreement is obtained with a simple theory but a need is evident for further measurements at higher Mach numbers. The use of a model loading coefficient in terms of tunnel stagnation pressure is proposed.

N-50038X

Advisory Group for Aeronautical Research and Development. DYNAMICS OF A DISSOCIATING GAS. III. NON-EQUILIBRIUM THEORY. N. C. Freeman, National Physical Laboratory. (Presented at 11th meeting of AGARD Wind Tunnel and Model Testing Panel, July 8-12, 1957, Scheveningen, Holland.) July 1957. vii, 21p. diagrs., tab. AGARD Report 133. (Ask for N-50038X)

The equilibrium theory of an "ideal dissociating" gas discussed by Lighthill (1956) is extended to nonequilibrium thermodynamic conditions by postulating a rate equation for the dissociation process (including the effects of recombination). The behavior of the gas in flow through strong normal shock waves and past bluff bodies is studied under nonequilibrium conditions.

N-50048X

Advisory Group for Aeronautical Research and Development. HYPERSONIC SHOCK TUBE EQUIPMENT AT THE NATIONAL PHYSICAL LABORATORY, U. K. D. L. Schultz and B. D. Henshall. (Presented at 11th meeting of AGARD Wind Tunnel and Model Testing Panel, July 8-12, 1957, Scheveningen, Holland.) July 1957. v, 23p. diagrs., photos., tabs. AGARD Report 147. (Ask for N-50048X)

Descriptions are given of an existing shock tube fitted with a flow expansion nozzle giving a Mach number of approximately 9, and of a proposed larger tube. Performance charts illustrate the conditions for which full-scale flight might be simulated. A unified electronic timing and recording system is also described.

N-50053X

Advisory Group for Aeronautical Research and Development. THE LIGHT GAS HYPERSONIC GUN TUNNEL AT A.R.D.E., FORT HALSTEAD, KENT. R. N. Cox and D. F. T. Winter. (Presented at 11th meeting of AGARD Wind Tunnel and Model Testing Panel, July 8-12, 1957, Scheveningen, Holland.) July 1957. vi, 24p. diagrs., photos. AGARD Report 139. (Ask for N-50053X)

A description is given of an intermittent hypersonic tunnel having a running time of hundreds of milliseconds. The tunnel employs a gun as a compressor. A light piston is driven at supersonic velocity in a closed barrel, and the miltiple shock reflections between the piston and the closed end of the barrel provide a high temperature, high pressure stagnation region of gas, which is allowed to expand through a convergent-divergent nozzle when the piston has come to rest. A theoretical study is given of the piston motion and of the shock-reflection process. It is shown that perfect gas stagnation temperatures up to 10,000° K are possible if a light gas such as hydrogen is used to drive the tunnel. Tunnel instrumentation is discussed, and some measurements of flow quantities in the tunnel are presented.

MISCELLANEOUS

CN-51495X

Advisory Group for Aeronautical Research and Development. AMERICAN DEVELOPMENT IN STOL AND VTOL AIRCRAFT. C. W. Meshier, Bureau of Aeronautics, Navy Dept. (Presented at 9th meeting of AGARD Flight Test Techniques Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. vi, 15p. diagrs., photos. AGARD Report 86. (Ask for CN-51495X)

To date most research activity on short take-off and vertical take-off aircraft has been directed toward the development of basic configurations to achieve the required performance. This paper discusses the low-speed control problems of such aircraft, to which little effort has been applied until recently.

N-52867X

Advisory Group for Aeronautical Research and Development. A FLIGHT TECHNIQUE FOR THE MEASUREMENT OF THRUST BOUNDARIES AND OF DRAG DUE TO LIFT. H. D. Rylands. (Presented at 10th meeting of AGARD Flight Test Panel, May 20-24, 1957, London.) May 1957. v, 14p. diagrs. AGARD Report 123. (Ask for N-52867X)

None of the existing methods of measuring thrust boundaries is suitable for use with the new high-performance aircraft. A new technique is therefore proposed which is acceptable for supersonic aircraft and which will also have many advantages over existing methods for use with subsonic types. Some data on drag due to lift can also be obtained without the need for thrust measurement. Preliminary flight trials on a subsonic aircraft proved very satisfactory. No major difficulties are anticipated when the technique is applied to supersonic aircraft.

N-52875X

Advisory Group for Aeronautical Research and Development. SOME REMARKS UPON THE PROBLEM OF TEMPERATURE SHOCK IN AIRCRAFT. F. Bollenrath. (Presented at 4th meeting of AGARD Structures and Materials Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. vi, 12p. diagrs., tabs. AGARD Report 90. (Ask for N-52875X)

An account is given of the structural problems associated with heating and large temperature gradients. The thermal stresses due to a nonstationary distribution of temperature are calculated for a plate cooled on one surface and heated on the other by a gas moving at high speed. The cases where the plate is completely free or completely restrained in one direction are discussed. Formulas are obtained which, under these conditions of restraint, make a quick comparison of different materials possible. Possible lines for the extension of theoretical and experimental work are suggested.

N-53173Y

Advisory Group for Aeronautical Research and Development. NACA HYPERSONIC ROCKET AND HIGH-TEMPERATURE JET FACILITIES. Paul E. Purser and Aleck C. Bond. (Presented at 11th meeting of AGARD Wind Tunnel and Model Testing Panel, July 8-12, 1957, Scheveningen, Holland.) July 1957. iv, 13p. diagrs., photos. AGARD Report 140. (Ask for N-53173Y)

This paper discusses the extension of the rocket-model research of the National Advisory Committee for Aeronautics (NACA) to hypersonic speeds and describes briefly several high-temperature jet facilities assembled by the NACA for research on structures and materials. Of the jets described, one is essentially the exhaust of a ram-jet engine and provides stagnation temperatures up to 3000° F, one is a rocket engine and provides stagnation temperatures up to 4200° F, one is a 4000° F air jet using a ceramic heat exchanger, and one is an electric-arc-heated jet with stagnation temperatures of over 15,000° F.

CN-53351X

Advisory Group for Aeronautical Research and Development. THE FUNCTION OF MAGNETIC TAPE IN FLIGHT TEST DATA RECORDING AND PROCESSING SYSTEMS. Arthur T. Snyder, Boeing Airplane Co. (Presented at 9th meeting of AGARD Flight Test Techniques Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. iv, 12p. diagrs. AGARD Report 83. (Ask for CN-53351X)

The advantages of magnetic tape for recording flight test data are discussed in detail. A brief description of several systems which are in common use is given, and one of the Boeing data recording and processing systems is fully described.

N-53686X

Advisory Group for Aeronautical Research and Development. A CONTACT EXTENSOMETER FOR THE RECORDING OF FLIGHT-LOAD SPECTRA. O. Svenson, Laboratory for Performance Testing, Darmstadt, Germany. (Presented at 10th meeting of AGARD Flight Test Techniques Panel, May 20-24, 1957, London, England.) May 1957. iv, 10p. diagrs., photo. AGARD Report 121. (Ask for N-53686X)

This report describes a contact extensometer, developed in the Performance Testing Laboratory at Darmstadt, Germany, for the recording of flight-load spectra. The varying stress cycles are registered on a film which is run at low speed, and the subsequent analysis can be made by any method desired. The instrument is to be installed in aircraft operated by the German Lufthansa.

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N-53979X

Advisory Group for Aeronautical Research and Development. THE USE OF GUN-LAUNCHED MODELS FOR EXPERIMENTAL RESEARCH AT HYPERSONIC SPEEDS. Alvin Seiff, NACA. (Presented at 11th meeting of AGARD Wind Tunnel and Model Testing Panel, July 8-12, 1957, Scheveningen, Holland.) July 1957. v, 19p. diagrs., photos. AGARD Report 138. (Ask for N-53979X)

The difficulty in obtaining hypersonic air flows with Mach numbers in excess of 10 has led to a concerted effort at the Ames Laboratory of the NACA for the development of gun-launched model flight tests for this speed range. As ordinary guns are normally limited to launching speeds of about 6,000 ft/sec, two ways of extending gun-launched model tests farther into the hypersonic Mach number range have been exploited. One is to use a counter-current supersonic airstream flowing opposite to the free-flying model, by means of which a Mach number of 13 can be attained. The second approach is to replace powder gas as a propellant in guns by compression-heated helium. In this way, short, lightweight projectiles have been propelled at speeds in excess of 17,000 ft/sec. In combination, the high-performance gun and the counter-current airstream give still higher Mach numbers, of the order of 25.

N-54976X

Advisory Group for Aeronautical Research and Development. THE HYPERSONIC FACILITY OF THE POLYTECHNIC INSTITUTE OF BROOKLYN AND ITS APPLICATION TO PROBLEMS OF HYPERSONIC FLIGHT. Antonio Ferri and Paul A. Libby. (Presented at 11th meeting of AGARD Wind Tunnel and Model Testing Panel, July 8-12, 1957, Scheveningen, Holland.) July 1957. vii, 39p. diagrs. AGARD Report 136. (Ask for N-54976X)

The engineering problems connected with hypersonic flight are reviewed. The utilization of a hypersonic wind tunnel with stagnation temperatures of 3000° to 5000° R for the solution of these problems is discussed. It is shown that for most problems presently considered important, such a wind tunnel can provide the means for investigation. The hypersonic facility of the Polytechnic Institute of Brooklyn is described; the design considerations of the heating system and the demonstrated and expected performance are presented. Finally, some of the testing techniques developed in connection with conventional testing at a Mach number of 6 and with shrouded model testing are reviewed.

CN-55019X

Advisory Group for Aeronautical Research and Development. TITANIUM FABRICATION. L. P. Spalding, North American Aviation, Inc. (Presented at 5th meeting of AGARD Structures and Materials Panel, April 24-27, 1957, Oslo, Norway.) April 1957. v, 33p. diagrs., photos. AGARD Report 96. (Ask for CN-55019X)

A description is given of the problems encountered and the techniques evolved for their solution during the manufacture of some 2,000 airplanes incorporating about a million pounds of titanium in their designs. Primary emphasis is given to titanium-alloy sheet applications.

CN-55022X

Advisory Group for Aeronautical Research and Development. PRODUCTION PROBLEMS OF TITANIUM AND ITS ALLOYS. E. Swainson and R. L. P. Berry, Imperial Chemical Industries Ltd. (Presented at 5th meeting of AGARD Structures and Materials Panel, April 29-May 3, 1957, Copenhagen, Denmark.) April-May 1957. v, 29p. diagr., photos. AGARD Report 95. (Ask for CN-55022X)

Discusses the present state of knowledge in certain aspects of titanium technology and gives some indication of the possible pattern of future developments. The aspects discussed include the problems of reducing the ore to a metal of sufficiently low oxygen content to have adequate ductility and alloying capabilities, melting in the absence of air and without contamination from furnace refractories and other sources, realization of the full alloying potential of the metal, fabrication of ingots of high strength alloy compositions into the various semifinished forms required, and reclamation of titanium scrap.

N-55023X

Advisory Group for Aeronautical Research and Development. ALUMINIUM ALLOYS IN AIRCRAFT STRUCTURES. G. Meikle, United Kingdom. (Presented at 5th meeting of AGARD Structures and Materials Panel, April 24-27, 1957, Oslo, Norway.) April 1957. iv, 11p. diagrs., photos. AGARD Report 102. (Ask for N-55023X)

Details of compositions of three groups of aluminum alloys used in the United Kingdom are discussed in relation to alloys used in the U. S. A. The properties of these alloys at elevated temperatures are mentioned particularly with regard to the effect of time and temperature, this being of great importance where kinetic heating is involved. The different

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nominal compositions of the high strength aluminum-zinc-magnesium alloys used in the United Kingdom are dealt with and some of the difficulties experienced with stress-corrosion in this type of alloy are mentioned. Research at the Royal Aircraft Establishment on this problem is briefly mentioned with particular reference to the effect of chemical composition and heat treatment. Brief reference is made to a possible aluminum alloy for use at temperatures up to 200° C.

N-55117X

Advisory Group for Aeronautical Research and Development. RESEARCH IN THE U.S. NAVAL ORDNANCE LABORATORY BALLISTICS RANGES. Paul A. Thurston. (Presented at 11th meeting of AGARD Wind Tunnel and Model Testing Panel, July 8-12, 1957, Scheveningen, Holland.) July 1957. v, 28p. diagrs., photos., tab. AGARD Report 137. (Ask for N-55117X)

The object of this paper is to inform aerodynamics workers of the possibilities of ballistics ranges. It gives a brief account of the complementarism of wind tunnels and ballistics ranges as tools for aerodynamics research. This is followed by a general description of the ballistics ranges in use at the U. S. Naval Ordnance Laboratory and a variety of examples to illustrate the research program in these ranges.

N-55131X

Advisory Group for Aeronautical Research and Development. DESIGN AND OPERATION OF HYPERSONIC WIND TUNNELS. R. Smelt and James C. Sivells. (Presented at 11th meeting of AGARD Wind Tunnel and Model Testing Panel, July 8-12, 1957, Scheveningen, Holland.) July 1957. v, 37p. diagrs., photos., tab. AGARD Report 135. (Ask for N-55131X)

Discusses problems of the operation of hypersonic wind tunnels, including air supply, diffuser efficiency, heater design and operation, nozzle design and calibration, and instrumentation. Real (imperfect) gas effects and the application of hypersonic-wind-tunnel results to flight problems are also discussed. Some solutions are given, based on experience of the design and operation of the Gas Dynamics Facility at the Arnold Engineering Development Center.

N-57062

Advisory Group for Aeronautical Research and Development. A REVIEW OF THE PRESENT POSITION ON FLUTTER. Haydn Templeton. (Presented at 3rd meeting of AGARD Structures and Materials Panel, April 10, 1956, Washington, D.C.) April 1956. iii, 16p. AGARD Report 57. (Ask for N-57062)

An edited version of the author's verbal contribution to the discussions on flutter at the third meeting of the Advisory Group for Aeronautical Research and Development (AGARD, NATO) held in Washington in April 1956. A summary of the present position on the flutter problem is given and recommendations made for further action.

N-57063

Advisory Group for Aeronautical Research and Development. SHORT NOTES ON MODEL-MAKING AND FORCE MEASURING TECHNIQUES. E. Dobbinga, Technical University of Delft and G. Prast, National Aeronautical Research Institute, Netherlands. (Presented at 8th meeting of AGARD Wind Tunnel and Model Testing Panel, February 20-25, 1956, Rome, Italy.) February 1956. vii, 26p. diagrs., photos. AGARD Report 18. (Ask for N-57063)

Contains seven short notes on techniques used in the Netherlands. Three, on special methods of model making, are concerned respectively with propeller blades, the concave walls of curved slots, and wing-fuselage fairings. Two other notes describe model-making machines and the remaining two deal with results of tests with pressure bearings in a sting holder and with an apparatus for calibrating a strain-gage balance.

CN-57064

Advisory Group for Aeronautical Research and Development. THE FRENCH TELEMETRY. (Les telemesures Francaises.) J. Idrac. (Presented at 8th meeting of AGARD Flight Test Group, Rome, Italy, February 20-25, 1956.) February 1956. v, 18p. diagrs., tab. (French text.) AGARD Report 33. (Ask for CN-57064)

This paper is a review of French telemetering equipment in current use. The four main types are those of O.N.E.R.A., S.F.E.N.A., Turck, and D.E.F.A. and, after a brief description of each of these, the paper ends with a discussion of their use in aircraft flight testing, in comparison with equipment used previously.

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N-57164

Advisory Group for Aeronautical Research and Development. FLIGHT TECHNIQUES FOR DETERMINING AIRPLANE DRAG AT HIGH MACH NUMBERS. De E. Beeler, Donald R. Bellman, and Edwin J. Saltzman, NACA. (Presented at AGARD Flight Test Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. viii, 34p. diagrs., photos. AGARD Report 84. (Ask for N-57164)

Discusses techniques investigated and developed by the NACA High-Speed Flight Station for measuring the drag of high-speed research and fighter airplanes, for comparison with wind-tunnel data. The accelerometer method, which was found to be the most successful, requires the accurate measurement of longitudinal and normal accelerations, angle of attack, and engine thrust; in addition, the static pressure, airspeed, airplane weight, and longitudinal control positions must be measured. Satisfactory methods of determining these factors are explained and discussed.

CN-57183

Advisory Group for Aeronautical Research and Development. NOTES ON THE FIFTH MEETING OF THE PANEL. (AGARD Structures and Materials Panel meeting, April-May 1957, Oslo, Norway and Copenhagen, Denmark.) 41p. AGARD. (Ask for CN-57183)

This note describes the proceedings at the fifth meeting of the Structures and Materials Panel. It does not contain a copy of all papers and discussions but is intended to outline the main subjects discussed and the decisions which were reached.

CN-57184

Advisory Group for Aeronautical Research and Development. THERMODYNAMIC EFFECTS IN THE CALCULATION OF THE RESISTANCE OF AIRCRAFT STRUCTURES AND ENGINES. (Effets thermiques dans le calcul de la resistance des structures d'avions et d'engins.) N. J. Hoff, Polytechnic Institute of Brooklyn. (Four conferences presented in Rome, Paris, and Liege, January 1956.) January 1956. v, 111p. (French text). AGARD Report 52. (Ask for CN-57184)

After reviewing the laws controlling the aerodynamic heating of supersonic aircraft and missiles, the author of this paper discusses heat transmission inside the wings by conduction and radiation. Thermal stresses and their effect on the buckling of rods and thin plates are examined, as well as the problem of creep and its effect on stress distribution. The last part deals with buckling caused by creep.

N-57185

Advisory Group for Aeronautical Research and Development. CASCADE FLOW PROBLEMS. H. Schlichting. (Presented at 10th meeting of AGARD Wind Tunnel and Model Testing Panel, February 18-21, 1957, Paris.) February 1957. vii, 14p. diagrs. AGARD Report 93. (Ask for N-57185)

Reports very briefly on some of the research work on cascades done in recent years in the Institute of Fluid Mechanics of the Engineering University of Braunschweig. Includes results of theoretical calculations of loss coefficients of two-dimensional cascades in incompressible flow, leading to the characteristic curves of an axial-flow compressor, and results of pressure-distribution measurements on cascades at high subsonic Mach numbers carried out in the new Variable Density High-Speed Cascade Wind Tunnel, which allows independent variation of Reynolds number and Mach number.

N-57732

Advisory Group for Aeronautical Research and Development. THE MECHANICAL AND ENGINEERING PROPERTIES OF COMMERCIALLY AVAILABLE TITANIUM ALLOYS. H. V. Kinsey, Department of Mines and Technical Surveys, Canada. (Presented at 5th meeting of AGARD Structures and Materials Panel, April 24-27, 1957, Oslo, Norway.) April 1957. iv, 15p. tabs. AGARD Report 100. (Ask for N-57732)

The titanium alloys being produced on a commercial basis up to early 1957 are listed. Nominal chemical compositions and manufacturer's designations for these alloys are given. An attempt has been made to collect all the published data on physical, mechanical, and engineering properties of these alloys and to indicate those properties required by the aeronautical design engineer that are not available.

UNPUBLISHED PAPERS

N-57659*

FORCED OSCILLATIONS OF A SIMPLE NONLINEAR SYSTEM. I. THE DIFFERENTIAL EQUATIONS AND THEIR STEADY-STATE SOLUTIONS. (Erzwungene Schwingungen eines einfachen nichtlinearen Systems. I. Die Differentialgleichungen und ihre stationären Lösungen.) Werner Braunbek. October 1957. 15p. diagrs. Translation from Zeitschrift für Physik, v. 147, 1957, p. 297-306. (Ask for N-57659*)

Based on the methods of the slowly variable modulation functions of Van der Pol and of Kryloff and Bogoljuboff, the nonlinear equation of motion with

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UNPUBLISHED PAPERS

force term ($Kx + x^3$) and with external harmonic periodic excitation is treated. The differential equations of the first order for the modulation functions (amplitude u and phase φ) are obtained according to two different methods. They are used, first of all, for determining the steady oscillations without and with damping. The resonance curve is discussed and the critical damping, below which instable steady oscillations become possible, is defined.

CN-57721, pt. 1*

Virginia Agricultural Experiment Station. ESTIMATION PROBLEMS CONNECTED WITH STOCHASTIC PROCESSES. PART I. SOME RESULTS ON THE DISCRETE ESTIMATION OF CROSS-SPECTRA. A. E. Garratt and John E. Freund. (Final report.) August 1957. 63p. Virginia Agricultural Experiment Station. (Ask for CN-57721, pt. 1*)

Chapter 1 is devoted to a brief introduction to the theory of this type of spectral analysis followed by a review of the standard methods of cross-spectral estimation for discrete time-history data. In Chapter 2 cospectral and quadrature-spectral estimators are presented which are characterized by nonnegative spectral windows. Other properties of these estimators are also examined. In Chapter 3 randomized cospectral and quadrature-spectral estimators are developed which substantially reduce the number of required arithmetic operations.

CN-57721, pt. 2*

Virginia Agricultural Experiment Station. ESTIMATION PROBLEMS CONNECTED WITH STOCHASTIC PROCESSES. PART II. CROSS-SPECTRAL ESTIMATION FOR THE ANALOG CASE. A. E. Garratt and John E. Freund. (Final report.) August 1957. 24p. Virginia Agricultural Experiment Station. (Ask for CN-57721, pt. 2*)

This paper treats the continuous case where it is possible to determine, by means of suitable analog equipment, the coefficients of the Fourier series expansions of realizations of the basic processes over a finite time interval. For such a case estimators, which provide extremely simple point estimates of the spectral densities, are presented. The expectations, variances, and covariances of these estimators are derived and the properties of their spectral windows discussed.

N-57722*

Polytechnic Institute of Brooklyn. VIBRATIONS OF A HELICOPTER ROTOR-FUSELAGE SYSTEM INDUCED BY THE MAIN ROTOR BLADES IN FLIGHT: A THREE-DIMENSIONAL MODEL INCLUDING DAMPING. M. Morduchow and A. Muzyka. May 1957. 70p. diagrs., tabs. Polytechnic Inst. of Brooklyn. PIBAL Report 401. (Ask for N-57722*)

The response of the hub and fuselage of a helicopter to harmonic forces transmitted by the rotor blades to the hub is derived on the basis of a simplified three-dimensional dynamical model of the hub-fuselage structure in flight. Hub and fuselage displacements and external exciting forces both in and normal to the rotor plane of rotation are considered. Explicit expressions for these displacements in terms of appropriate hub and fuselage natural frequency and mass parameters are obtained, and explicit conditions of resonance are determined. The effect of internal damping is analyzed and comparatively simple expressions are derived for the maximum displacements of the hub-fuselage structure with damping. Numerical examples are given throughout to illustrate the results.

N-57802*

ENGINE NACELLE - WING INTERFERENCE AT HIGH SPEEDS (THE AREA RULE). (Motorgondel-Flügel-Interferenz bei hohen Geschwindigkeiten (Die Flächenregel).) Otto Frenzl. 6p. diagrs. Translation from Zeitschrift für Flugwissenschaften, v. 5, no. 6, 1957, p. 181-183. (Ask for N-57802*)

German work in the 1940's is described that bears a resemblance to the "area-rule" concept of Whitcomb. This work led to a patent in 1944 whose claims are similar to the area-rule statements. Data are presented from some wing-nacelle studies that serve to verify the concept.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification January 20, 1958.

NACA RM A52A31

WING LOAD DISTRIBUTION ON A SWEPT-WING AIRPLANE IN FLIGHT AT MACH NUMBERS UP TO 1.11 AND COMPARISON WITH THEORY. L. Stewart Rolls and Frederick H. Matteson. April 1952. 73p. diagrs., photos., tabs. (NACA RM A52A31)

Flight tests were made to determine the pressure distribution on the wing of an F-86 airplane over the flight range of lift coefficients for Mach numbers up to 1.11. Comparisons are made between the results and subsonic and supersonic theories for the spanwise distribution of loading. Tuft studies are used in conjunction with the buffeting and aileron floating characteristics to explain variations in the measured loading.

NACA RM A53A30

LIFT, DRAG, AND PITCHING MOMENT OF LOW-ASPECT-RATIO WINGS AT SUBSONIC AND SUPERSONIC SPEEDS. Charles F. Hall. April 1953. 132p. diagrs., tabs. (NACA RM A53A30)

Results are presented, in graphical and tabular form, from a wind-tunnel investigation of the lift, drag, and pitching-moment characteristics of thin, low-aspect-ratio wings in combination with a body at Mach numbers from 0.25 to as high as 1.9. The following are analyzed and compared with existing theoretical results: (1) effects of aspect ratio on 3-percent-thick triangular wings; (2) effects of plan form on 3-percent-thick triangular, sweptback, and unswept wings of aspect ratios 2 and 3; (3) effects of wing thickness on triangular wings of aspect ratio 2; (4) effects of profile shape on triangular, sweptback, and unswept wings; and (5) effects of camber and twist on triangular wings of aspect ratios 2 and 4.

NACA RM A54A04

EFFECT OF NOSE SHAPE AND TRAILING-EDGE BLUNTNESS ON THE AERODYNAMIC CHARACTERISTICS OF AN UNSWEPT WING OF ASPECT RATIO 3.1, TAPER RATIO 0.4, AND 3-PERCENT THICKNESS. John C. Heitmeyer. March 1954. 36p. diagrs., tabs. (NACA RM A54A04)

The effects of blunting the trailing edge and/or rounding the leading edge upon the lift, drag, and pitching-moment characteristics of a wing-body combination, employing a plane tapered wing of aspect ratio 3.1 with 3-percent-thick biconvex sections, have been experimentally determined at Mach numbers from 0.61 to 0.91 and 1.20 to 1.90. Trailing-edge thicknesses from 0.3 to full maximum section thickness are considered.

NACA RM A54L27

A FLIGHT INVESTIGATION AT TRANSONIC SPEEDS OF A MODEL HAVING A TRIANGULAR WING OF ASPECT RATIO 4. Loren G. Bright. March 1955. 40p. diagrs., photos., tabs. (NACA RM A54L27)

The longitudinal aerodynamic characteristics of a model having an aspect-ratio-4 triangular wing and a 45° sweptback horizontal tail mounted in the extended wing chord plane were investigated at transonic speeds by the free-falling recoverable model technique. Static- and dynamic-stability data, and load-distribution data are presented for Mach numbers from 0.88 to 1.14 and angles of attack from -1° to about $+8^{\circ}$ to $+21^{\circ}$, depending on the Mach number.

NACA RM A55A03

EFFECTS OF SWEEP AND TAPER RATIO ON THE LONGITUDINAL CHARACTERISTICS OF AN ASPECT RATIO 3 WING-BODY COMBINATION AT MACH NUMBERS FROM 0.6 TO 1.4. Earl D. Knechtel and James L. Summers. March 1955. 36p. diagrs., photo. (NACA RM A55A03)

An experimental investigation has been made to determine the effects of sweep and taper ratio on the longitudinal characteristics of a wing-body combination at Mach numbers from 0.6 to 1.4 at 1.5×10^{6} Reynolds number. The wings were 3 percent thick and of aspect ratio 3. Leading-edge sweep angle was varied from 19.1° to 53.1° for a constant taper ratio of 0.4, and taper ratio was varied from 0 to 0.4 for a constant sweep angle of 53.1°.

NACA RM E9I16

ALTITUDE-WIND-TUNNEL INVESTIGATION OF TAIL-PIPE BURNER WITH CONVERGING CONICAL BURNER SECTION ON J35-A-5 TURBOJET ENGINE. H. Carl Thorman and Carl E. Campbell. February 10, 1950. 60p. diagrs., photos., tab. (NACA RM E9I16)

Investigation of tailpipe burning was conducted in Lewis altitude wind tunnel using full-scale turbojet engine and tailpipe burner designed for specific airplane. Three fuel patterns and three flame holders were investigated using fixed-area exhaust nozzle. Tailpipe shell cooling was accomplished by means of inner liner. Burner performance, overall performance, and combustion blowout limits are presented and discussed. Most efficient burner performance and widest range of operable fuel-air ratios were obtained with configurations in which fuel injectors that gave relatively uniform distribution of tailpipe fuel-air mixture were used with annular-V-gutter type flame holders blocking about 30 percent of burner cross-sectional area.

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NACA RM E50A19

ALTITUDE PERFORMANCE AND OPERATIONAL CHARACTERISTICS OF 29-INCH-DIAMETER TAILPIPE BURNER WITH SEVERAL FUEL SYSTEMS AND FUEL-COOLED STAGE-TYPE FLAME HOLDERS ON J35-A-5 TURBOJET ENGINE. Richard L. Golladay and Harry E. Bloomer. April 28, 1950. 57p. diagrs., photos., tab. (NACA RM E50A19)

An investigation of tailpipe burning was conducted in the NACA Lewis altitude wind tunnel with a full-scale turbojet engine and a 29-inch-diameter tailpipe burner. Effects of fuel distribution and number and arrangement of stages on performance and operational characteristics of several fuel-cooled flame holders are presented and discussed. Operation with a three-stage flame holder having the large stage upstream was the most efficient. Combustion efficiency was slightly increased at high altitudes by injecting fuel upstream of the flame holder.

#NACA RM SE50L29, by Vasu, Schwent, and Ketchum

NACA RM E52I25

TURBOJET COMBUSTOR EFFICIENCY WITH CERAMIC-COATED LINERS AND WITH MECHANICAL CONTROL OF FUEL WASH ON WALLS. Helmut F. Butze and Edmund R. Jonash. November 1952. 43p. photos., diagrs., tabs. (NACA RM E52I25)

Two methods of decreasing losses of unevaporated fuel from the combustion zone of turbojet-engine combustors were investigated: installing fuel dams on the inner surface of a J33 combustor liner to divert liquid-fuel films on the walls into penetrating air jets and coating the liner wall of a J33 and a J47 single combustor with ceramic to increase surface temperature and hence rate of evaporation of fuel. Installation of fuel dams brought about a substantial increase in combustion efficiency at low fuel flows; no increase was observed at high fuel-flow rates. Similar results were obtained in another J33 combustor, the liner of which was coated with a dual ceramic coating. No further improvements in combustion efficiency resulted from a combination of fuel dams and ceramic coating. Only small effects on combustion efficiency were noted when two other types of ceramic coating were applied to the J33 combustor or when the dual ceramic coating was applied to the J47 combustor.

NACA RM E52J07

ALTITUDE PERFORMANCE INVESTIGATION OF TWO SINGLE-ANNULAR TYPE COMBUSTORS AND THE PROTOTYPE J40-WE-8 TURBOJET ENGINE COMBUSTOR WITH VARIOUS COMBUSTOR INLET-AIR PRESSURE PROFILES. Adam E. Sobolewski, Robert R. Miller, and John E. McAulay. May 1953. 46p. diagrs., photos., tab. (NACA RM E52J07)

Data obtained for three single-annular type combustors over a range of engine speeds at an altitude of 30,000 feet and flight Mach number of 0.62 indicated that changes in combustor hole geometry and combustor-inlet air-pressure profiles affected the combustor-outlet temperature profile and the combustor pressure-loss coefficient but had no discernible effect on combustion efficiency. Performance data for the prototype J40-WE-8 turbojet-engine combustor were obtained over a range of altitudes from 15,000 to 55,000 feet and flight Mach numbers from 0.17 to 0.99. A good correlation was obtained when combustion efficiency was presented as a function of a combustion parameter and engine fuel-air ratio.

NACA RM E52K21

PRELIMINARY INVESTIGATION OF A CHEMICAL STARTING TECHNIQUE FOR THE ACID GASOLINE ROCKET PROPELLANT SYSTEM. Glen Hennings and Gerald Morrell. January 1953. 23p. photo., diagrs., tab. (NACA RM E52K21)

A preliminary investigation of chemical starting of the acid - gasoline system in a 200-pound-thrust rocket engine indicated that transition to gasoline could be obtained at -40° F provided a small quantity of gasoline was suspended in the hydrazine hydrate igniter fluid. Blends of triethylamine and aromatic amines were found to ignite at -85° F with specially blended red fuming nitric acid, but at this temperature, transition was obtained only when the running fuel was triethylamine.

NACA RM E52L22a

DESIGN AND TEST OF MIXED-FLOW IMPELLERS. III - DESIGN AND EXPERIMENTAL RESULTS FOR IMPELLER MODEL MFI-2A AND COMPARISON WITH IMPELLER MODEL MFI-1A. Joseph T. Hamrick, Walter M. Osborn, and William L. Beede. March 1953. 34p. diagrs., photo., tab. (NACA RM E52L22a)

A mixed-flow impeller was designed to give a prescribed blade-surface velocity distribution at mean blade height for a given hub-shroud profile. The blade shape at mean blade height, which was produced by the prescribed velocity distribution, was extended by means of radial lines to form the composite blade shape from hub to shroud. The resulting blade was relatively thick; therefore, it was necessary to retain the inverse blade taper which resulted from extension of the radial lines in order to prevent merging or near merging of the separate blades near the hub. For the first test version of the impeller, designated the MFI-2A, the blade

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height was arbitrarily made greater than that for the basic impeller (the MFI-2) to allow for viscous effects. At design equivalent speed of 1400 feet per second the peak pressure ratio and maximum adiabatic efficiency were 3.95 and 79 percent, respectively. The adiabatic efficiency of the MFI-2A is four points lower than that for impeller model MFI-1A, but because of the higher slip factor for the MFI-2A, the pressure ratios are approximately equal. The procedures followed in the design of the MFI-1A and MFI-2A were, in general, the same; and, although the prescribed initial condition resulted in geometrical configurations that were quite dissimilar, the resulting performance characteristics compare favorably with designs for which considerable development work has been necessary.

NACA RM E53A12

INVESTIGATION OF PRESSURE RECOVERY OF A SINGLE-CONICAL-SHOCK NOSE INLET AT MACH NUMBER 5.4. Harry Bernstein and Rudolph C. Haefeli. April 1953. 22p. diagrs., photos. (NACA RM E53A12)

An experimental investigation of the performance of a single-conical-shock diffuser was conducted at a Mach number of 5.4 and a Reynolds number based on model diameter of 375,000. Total-pressure recoveries of 13.7 and 13.1 percent were obtained at angles of attack of 0° and 3°, respectively. The corresponding kinetic energy efficiencies were 86.4 percent at an angle of attack of 0° and 86.0 percent at an angle of attack of 3°.

NACA RM E53A30

EFFECT OF DIFFUSER DESIGN, DIFFUSER-EXIT VELOCITY PROFILE, AND FUEL DISTRIBUTION ON ALTITUDE PERFORMANCE OF SEVERAL AFTERBURNER CONFIGURATIONS. E. William Conrad, Frederick W. Schulze, and Karl H. Usow. July 1953. 63p. diagrs., photos., tab. (NACA RM E53A30)

An investigation was conducted in the NACA Lewis altitude wind tunnel to improve the altitude performance and operational characteristics of an afterburner primarily by modifying the diffuser-exit velocity profile by changes in diffuser design and by changing the fuel distribution and the flame holder. Twenty configurations, consisting of combinations of six diffuser geometries, six flame-holder types, and twelve fuel systems, were investigated. Data were obtained over a range of afterburner fuel-air ratios at diffuser-inlet total pressures from 2750 to 620 pounds per square foot. Variations of the velocity profile produced the greatest effect on afterburner combustion efficiency at the pressure level of 620 pounds per square foot. Changes in fuel distribution affected the fuel-air ratio at which peak combustion efficiency occurred as well as the efficiency level. Screeching combustion, which was most prevalent at low altitudes and medium-to-high fuel-air ratios, imposed a restriction on the operable range of a number of configurations.

NACA RM E53F23

INVESTIGATION OF A SUPERSONIC-COMPRESSOR ROTOR WITH TURNING TO AXIAL DIRECTION. I - ROTOR DESIGN AND PERFORMANCE. Edward R. Tysl, John F. Klapproth, and Melvin J. Hartmann. August 1953. 36p. diagrs., photos. (NACA RM E53F23)

An approximate, quasi-three-dimensional design method was adapted to the design of impulse-type supersonic compressors. The method was applied to the design of a compressor rotor having a tip speed of 1600 feet per second, an inlet hub-tip radius ratio of 0.75, and an axial discharge relative to the rotor. Tests of the rotor as a separate component at 97.5 percent of the equivalent design condition in Freon-12 produced a total-pressure ratio of 5.7 at an adiabatic efficiency of 0.89. The absolute mean-radius discharge Mach number was 1.93.

NACA RM E53L02

DESIGN AND TEST OF MIXED-FLOW IMPELLERS. IV - EXPERIMENTAL RESULTS FOR IMPELLER MODELS MFI-1 AND MFI-2 WITH CHANGES IN BLADE HEIGHT. Joseph T. Hamrick, William L. Beede, and Joseph R. Withee, Jr. February 1954. 32p. diagrs., photos. (NACA RM E53L02)

Modifications A and B of impeller model MFI-1 and A, B, and C of impeller model MFI-2 were investigated experimentally in an attempt to determine what allowance in blade height should be made for boundary layer and viscous losses in an impeller designed for isentropic compressible flow. A gradual increase in blade height was arbitrarily made from inlet to outlet in anticipation of a gradual buildup of boundary layer. Apparently there was a rapid buildup of boundary layer near the inlet in the experimental case rather than a gradual one. Therefore, the proper allowance for boundary layer cannot be prescribed from the data obtained. Decreasing the pressure gradient along the shroud by reducing the blade height allowance apparently did little to increase the overall efficiency. At the design speed of 1400 feet per second, the overall adiabatic efficiency was increased from 0.83 for the MFI-1A to 0.85 for the MFI-1B with reduction in height; however, it is indicated from the theoretical velocity distribution and outlet surveys that the increase was due to a change from decelerating to accelerating flow along the hub rather than from any change along the shroud. It is further indicated that the consequences of a thickened or separated boundary layer depend not only on the design velocity gradients but also on the shape of the passage.

NACA RM E53L24

INVESTIGATION OF A SUPERSONIC-COMPRESSOR ROTOR WITH TURNING TO AXIAL DIRECTION. II - ROTOR COMPONENT OFF-DESIGN AND STAGE PERFORMANCE. Melvin J. Hartmann and Edward R. Tysl. March 1954. 31p. diagrs., photos. (NACA RM E53L24)

Analysis of the complete performance of an impulse-type supersonic-compressor rotor with turning to the axial direction indicated that the best stage performance would probably be obtained at an intermediate

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rotor-discharge Mach number rather than at the design impulse condition. The matching of the operational points of the rotor and stators is rather critical. The stators designed for this investigation caused the rotor to operate at a discharge Mach number that is too low for good stage performance. It was indicated that the rotor and stator matching could be improved at part speed by decreasing the stator angles below the design setting. Decreasing the stator angle 6° resulted in a stage total-pressure ratio of 2.7 and a stage adiabatic efficiency of 0.77.

NACA RM E54A18

PRELIMINARY INVESTIGATION OF PUMPING AND THRUST CHARACTERISTICS OF FULL-SIZE COOLING-AIR EJECTORS AT SEVERAL EXHAUST-GAS TEMPERATURES. W. K. Greathouse. April 1954. 130p. diagrs., photos., tab. (NACA RM E54A18)

An experimental investigation was made to determine the performance of seven full-size ejector configurations operating over a range of secondary to primary air-flow ratio from zero to about 0.30 at primary total- to ambient-pressure ratios up to 5.0 with various primary gas temperatures from 1120° to 3700° R. Diameter ratios of 1.048, 1.095, 1.195, and 1.60 were tested with cylindrical-type ejector shrouds, and a diameter ratio of 1.10 was tested with a conical-type shroud. Spacing ratio varied from 0.213 to 0.810. Pumping characteristics of cylindrical-type ejectors having a short spacing ratio relative to the diameter ratio were generalized by the corrected weight-flow ratio parameter $(W_s/W_p)\sqrt{T_s/T_p}$. The total variation in gross ejector thrust ratio with primary gas temperature did not exceed 5 percent for any one ejector investigated when compared over a range of corrected weight-flow ratio at the primary pressure ratio of 5.0.

NACA RM E54A20

APPLICATION OF RADIAL-EQUILIBRIUM CONDITION TO AXIAL-FLOW TURBOMACHINE DESIGN INCLUDING CONSIDERATION OF CHANGE OF ENTROPY WITH RADIUS DOWNSTREAM OF BLADE ROW. James E. Hatch, Charles C. Giamati, and Robert J. Jackson. April 1954. 52p. diagrs. (NACA RM E54A20)

An investigation was made of the validity of application of the simplified-radial-equilibrium equation to axial-flow turbomachines. Data from axial-flow compressors were compared with two types of calculations of radial variations of axial velocity, one type including the measured radial variation of stagnation-pressure losses by means of a radial-entropy gradient term in the radial-equlibrium equation and the other type excluding this term. In order to compute accurately the radial variation of velocities at an axial station following several stages of a multistage compressor, or in the boundary-layer regions of a compressor, it was necessary to include the entropy term in the simplified-radial-equilibrium equation. A velocity-diagram design method including the effect of estimated stagnation pressures on the design axial-velocity profile is presented.

NACA RM E54G13

PERFORMANCE OF A 16-INCH RAM-JET ENGINE WITH A CAN-TYPE COMBUSTOR AT MACH NUMBERS OF 1.50 TO 2.16. Donald P. Hearth and Eugene Perchonok. August 1954. 30p. diagrs. (NACA RM E54G13)

Combustor, engine, and inlet data were obtained over a fuel-air-ratio range of from 0.018 to 0.070. Angle-of-attack data to 10° are presented at Mach numbers of 1.50, 1.79, and 1.98. Results indicated that the combustion efficiencies were generally unaffected by free-stream Mach number and varied between 60 and 90 percent with JP-4 fuel. Combustor operation at 10° angle of attack was satisfactory except under subcritical diffuser operation at Mach number 1.98.

NACA RM E55A04

EFFECTS OF INLET-AIR-FLOW DISTORTION ON STEADY-STATE ALTITUDE PERFORMANCE OF AN AXIAL-FLOW TURBOJET ENGINE. William Conrad, Morgan P. Hanson, and John E. McAulay. September 1955. 47p. diagrs., photo. (NACA RM E55A04)

An investigation was conducted in an NACA altitude test chamber to determine the effects of radial and circumferential distortions of the inlet air on the steady-state performance of an axial-flow engine and its components. Radial distortions up to 17 percent of the average inlet total pressure and circumferential distortions up to 26 percent were imposed. Data were obtained at altitudes from 15,000 to 50,000 feet at a flight Mach number of 0.8. Compared on the basis of equal average values of compressor-inlet total pressure, the maximum loss in net thrust was 14 percent.

#NACA RM E55A25, by Gibbons

NACA RM E55E13

DESIGN AND TEST OF MIXED-FLOW IMPELLERS. V - DESIGN PROCEDURE AND PERFORMANCE RESULTS FOR TWO VANED DIFFUSERS TESTED WITH IMPELLER MODEL MFI-1B. Joseph T. Hamrick and Walter M. Osborn. July 1955. 32p. diagrs., photos. (NACA RM E55E13)

The design procedure and experimental test results for a range of impeller speeds are presented for two vaned diffusers of 24 and 40 vanes. Both were designed to give approximately the same velocity distribution on the vane surfaces. A maximum efficiency of 0.78 for a pressure ratio of 3.25 at a mean outlet speed of 1300 ft/sec was obtained for both diffusers. The maximum efficiency at the design speed of 1400 ft/sec was 0.77 at a pressure ratio of 3.73 for both diffusers.

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NACA RM E55E16

EFFECTIVENESS OF A TURBOJET TUBULAR COMBUSTOR IN SCREENING THE TURBINE FROM FOREIGN OBJECTS. Patrick T. Chiarito. July 1955. 20p. diagrs., photos. (NACA RM E55E16)

The effectiveness of a tubular combustor in screening the turbine from foreign objects used in these tests was measured to be 36 percent (that is, on the average, 64 percent of the objects used in the tests penetrated the production combustor). The screening effectiveness of this type combustor may be improved by moving the bellows housing aft and radially outward. Wire screens mounted over the air-intake holes reduced the penetration of objects that were even smaller than the screen openings. A fine-mesh screen wrapped around the liner prevented penetration. The maximum pressure loss due to the screens was about 1/2 percent of the total pressure at the combustor inlet.

NACA RM E55F23

DESIGN AND TEST OF MIXED-FLOW IMPELLERS. VI - PERFORMANCE OF PARABOLIC-BLADED IMPELLER WITH SHROUD REDESIGNED BY RAPID APPROXIMATE METHOD. Kenneth J. Smith and Walter M. Osborn. September 1955. 22p. diagrs., photo., tab. (NACA RM E55F23)

A centrifugal impeller was modified by a newly developed design procedure that reduced the velocity gradients from inlet to outlet along the hub contour. The experimental test results for the modified impeller are compared with those of the original impeller. At a speed of 1500 feet per second, the peak pressure ratio and maximum efficiency were 4.03 and 0.800, respectively. The maximum efficiency points for the speed range 900 to 1500 feet per second were between 0.854 and 0.800. The modified impeller had higher efficiencies than the original impeller at all speeds tested, with a gain in efficiency of 0.195 (0.605 to 0.800) at 1500-feet-per-second equivalent speed.

NACA RM E55L13

EVALUATION OF AN AUTOMATIC INLET-PRESSURE CONTROL VALVE FOR STUDY OF TRANSIENT ENGINE PERFORMANCE CHARACTERISTICS. Lewis E. Wallner, Robert J. Lubick, and Harry E. Bloomer. April 1956. 25p. diagrs., photo. (NACA RM E55L13)

An evaluation of data obtained with an automatic constant-inlet-pressure control valve designed to facilitate the study of transient engine performance characteristics was made in the Lewis altitude wind tunnel. During acceleration, inlet total-pressure deviations of about 5 percent from the desired level were obtained with the proportional-type control. When integrating action was added to the control, this pressure deviation was reduced to 1-1/2 percent. The engine transient and surge characteristics obtained with the automatic inlet-pressure valve were about the same as those obtained with the bellmouth-inlet installation.

NACA RM E55L15

DESIGN AND TEST OF MIXED-FLOW IMPELLERS. VII - EXPERIMENTAL RESULTS FOR PARABOLIC-BLADED IMPELLER WITH ALTERNATE BLADES CUT BACK TO FORM SPLITTER VANES. Walter M. Osborn. March 1956. 13p. diagrs., photo. (NACA RM E55L15)

A centrifugal impeller was altered by cutting back every other blade to form a splitter-vaned impeller. The experimental test results for the splitter-vaned impeller are compared with those of the fully bladed impeller. At a speed of 1500 ft/sec, the peak pressure ratio and maximum efficiency were 4.03 and 0.780, respectively. The maximum-efficiency points for the speed range of 900 to 1500 ft/sec were between 0.780 and 0.825. The splitter-vaned impeller had a higher weight-flow range but lower peak pressure ratios and maximum efficiencies than the fully bladed impeller.

NACA RM E56A16

INTERACTION OF AN EXHAUST JET AND ELEMENTARY CONTOURED SURFACES LOCATED IN A SUPERSONIC AIR STREAM. Joseph F. Wasserbauer and Gerald W. Englert. April 1956. 20p. diagrs., photo. (NACA RM E56A16)

A study of the forces on simple contoured surfaces near an exhaust jet was made at a free-stream Mach number of 1.6 over a range of nozzle pressure ratios. The surfaces were located at two fixed positions from the nozzle center line. Also investigated was the influence on the forces of the fairings between these surfaces and the boattail housing the exhaust nozzle. Varying the wedge angle, radius of curvature, and arc length of the various surfaces affected the normal-force coefficient. Addition of fairings changed normal forces and center-of-pressure locations.

NACA RM E56A23

METHODS FOR CALCULATING THRUST AUGMENTATION AND LIQUID CONSUMPTION FOR VARIOUS TURBOJET-AFTERBURNER FUELS. James F. Morris. October 1956. 73p. diagrs. (NACA RM E56A23)

Methods are presented for making turbojet-afterburner thrust calculations using air specific-impulse data for various fuels. Nomographic solutions for these calculation methods and thermodynamic data for several fuels are given.

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NACA RM E56L07

DESIGN AND TEST OF MIXED-FLOW IMPELLERS. VIII - COMPARISON OF EXPERIMENTAL RESULTS FOR THREE IMPELLERS WITH SHROUD REDESIGNED BY RAPID APPROXIMATE METHOD. Walter M. Osborn, Kenneth J. Smith, and Joseph T. Hamrick. February 1957. 32p. diagrs., photos. (NACA RM E56L07)

Three centrifugal impellers with parabolic, circular, and skewed-parabolic blading were modified by a newly developed design procedure to reduce the velocity gradients from inlet to outlet along the hub contour. The experimental test results for the modified impellers are compared with those of the original impellers. The modified impellers had higher efficiencies than the original impellers at all speeds tested, with the largest gains in efficiency at 1300 feet per second and higher. Of the three modified impellers, the parabolic-bladed had the highest maximum efficiencies (0.854 to 0.800) over the speed range tested.

NACA RM H55A17

LATERAL STABILITY AND CONTROL CHARACTERISTICS OF THE CONVAIR XF-92A DELTA-WING AIRPLANE AS MEASURED IN FLIGHT. Thomas R. Sisk and Duane O. Muhleman. May 1955. 55p. diagrs., photos., tabs. (NACA RM H55A17)

The lateral stability and control characteristics of the Convair XF-92A delta-wing airplane are determined from sideslips, aileron rolls, and rudder pulses. A limited amount of data with wing fences installed at 60 percent of the wing semispan is presented for comparison with the basic airplane configuration.

NACA RM H56A06

AN ANALOG STUDY OF THE RELATIVE IMPORTANCE OF VARIOUS FACTORS AFFECTING ROLL COUPLING. Joseph Weil and Richard E. Day. April 1956. 81p. diagrs., photo., tabs. (NACA RM H56A06)

An analog study of the roll coupling problem has been made for a representative swept-wing and a tailless delta-wing configuration. The investigation, conducted primarily for subsonic flight conditions, included determination of the effects of wide variations in many of the pertinent aerodynamic derivatives on the motions developed in rolling maneuvers. The influence of large changes in principal axis inclination and mass distribution was also considered.

NACA RM L9I07a

FLIGHT TESTS OF A MODEL HAVING SELF-SUPPORTING FUEL-CARRYING PANELS HINGED TO THE WING TIPS. Robert E. Shanks and David C. Grana. November 2, 1949. 10p. diagrs., tab. (NACA RM L9I07a)

This paper presents the results of an experimental investigation conducted in the Langley free-flight tunnel to determine the effect of various configurations of self-supporting fuel-carrying panels hinged to the wing tips on the flight behavior and controllability characteristics of a general research model.

#NACA RM SL50A07, by Mitchell and Peck

#NACA RM SL50H18, by Gillespie and Arbic

NACA RM L50K28a

LARGE-SCALE FLIGHT MEASUREMENTS OF ZERO-LIFT DRAG AT MACH NUMBERS FROM 0.90 TO 1.95 OF AN ARROW WING IN COMBINATION WITH A SMALL BODY. Warren Gillespie, Jr., and Richard G. Arbic. January 12, 1951. 17p. diagrs., photos., tab. (NACA RM L50K28a)

A flight investigation was made at high subsonic, transonic, and supersonic speeds and at high Reynolds numbers to determine the zero-lift drag of an arrow wing in combination with a small body. The drag was found to be very low throughout the Mach number range of the test.

NACA RM SL51K07, by Gillespie and Arbic

NACA RM L52A02

AN INVESTIGATION AT MACH NUMBERS OF 1.62 AND 1.93 OF THE LIFT EFFECTIVENESS AND INTEGRATED DOWNWASH CHARACTERISTICS OF SEVERAL IN-LINE MISSILE CONFIGURATIONS HAVING EQUAL-SPAN WINGS AND TAILS. Carl E. Grigsby. April 1952. 75p. diagrs., tabs. (NACA RM L52A02)

An investigation has been made at Mach numbers of 1.62 and 1.93 to determine the lift effectiveness and average downwash characteristics of several in-line missile configurations having rectangular and triangular tail plan forms. Breakdown tests were made for combinations of a body and four wing plan forms and two tail plan forms. For two locations of the wing relative to the tail, tests were made for two values of tail incidence angle so that average effective downwash angles at the tail might be calculated.

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NACA RM L53A14

WIND-TUNNEL INVESTIGATION OF A RAM-JET MISSILE MODEL HAVING A WING AND CANARD SURFACES OF DELTA PLAN FORM WITH 70° SWEPT LEADING EDGES. FORCE AND MOMENT CHARACTERISTICS OF VARIOUS COMBINATIONS OF COMPONENTS AT A MACH NUMBER OF 1.6. Clyde V. Hamilton, Cornelius Driver, and John R. Sevier, Jr. March 1953. 48p. diagrs., photo., tabs. (NACA RM L53A14)

A force investigation of a canard missile configuration having a wing and canard surfaces of delta plan form with 70° swept leading edges and various combinations of its components has been conducted in the Langley 4- by 4-foot supersonic pressure tunnel at a Mach number of 1.61 and a Reynolds number of 3.83×10^6 based on wing mean aerodynamic chord. Longitudinal- and lateral-force characteristics are presented for an angle-of-attack range from -4° to 14° and an angle-of-sideslip range from -4° to 10°.

NACA RM L54A20

AERODYNAMIC CHARACTERISTICS AT TRANSONIC AND SUPERSONIC SPEEDS OF A ROCKET-PROPELLED AIRPLANE CONFIGURATION HAVING A 52.5° DELTA WING AND A LOW, SWEPT HORIZONTAL TAIL. Alan B. Kehlet. March 1954. 31p. diagrs., photos. (NACA RM L54A20)

A flight investigation was conducted on a rocket-propelled airplane configuration having a 52.5° delta wing with an aspect ratio of 3.08 and NACA 65A003 airfoil sections in the streamwise direction. The configuration had a swept empennage with a horizontal tail of 45° quarter-chord-line sweep mounted in a low position. Characteristics of trim, drag, damping, and longitudinal and directional stability at low lift were presented over a Mach number range from 0.79 to 1.83.

NACA RM L54A21

WIND-TUNNEL INVESTIGATION AT HIGH SUBSONIC SPEEDS OF THE EFFECTS OF WING-MOUNTED EXTERNAL STORES ON THE LOADING AND AERODYNAMIC CHARACTERISTICS IN PITCH OF A 45° SWEPTBACK WING COMBINED WITH A FUSELAGE. H. Norman Silvers, Thomas J. King, Jr., and William J. Alford, Jr. March 1954. 36p. diagrs., tabs. (NACA RM L54A21)

Ogive-cylinder external stores of fineness ratio 9.34 were tested in the Langley high-speed 7- by 10-foot tunnel to determine the effect of tip-mounted, inboard, and combined inboard and tip-mounted arrangements on the loading characteristics of a 45° sweptback wing of aspect ratio 4.0 and taper ratio 0.60 that was combined with a fuselage. Overall force and moment characteristics of the model with the various store arrangements are also presented.

NACA RM L54L01

THE ROLLING MOMENT DUE TO SIDESLIP OF SWEPT WINGS AT SUBSONIC AND TRANSONIC SPEEDS. Edward C. Polhamus and William C. Sleeman, Jr. March 1955. 81p. diagrs., photos., tabs. (NACA RM L54L01)

A summary and analysis have been made of results obtained in a systematic research program concerned with the effects of wing sweep, aspect ratio, taper ratio, and dihedral on the rolling moment due to sideslip characteristics of wing-fuselage configurations up to Mach numbers of about 0.95. New methods have been derived and design charts are presented for estimating the effects of compressibility and wing geometry on the rolling moment due to sideslip.

NACA RM SL54L01a, by Klinar and Lee

NACA RM L54L31b

TRANSONIC WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF SWEEPBACK AND THICKNESS RATIO ON THE WING LOADS OF A WING-BODY COMBINATION OF ASPECT RATIO 4 AND TAPER RATIO 0.6. Robert J. Platt, Jr., and Joseph D. Brooks. April 1955. 44p. diagrs., photos., tab. (NACA RM L54L31b)

Sweepback angles of 0°, 35°, and 45° were investigated in the Langley 8-foot transonic pressure tunnel for a wing with an aspect ratio of 4, taper ratio of 0.6, and NACA 65A006 airfoil sections. An additional unswept wing with NACA 65A004 airfoil sections was tested to provide information on thickness effects. The tests covered a Mach number range from 0.6 to 1.2 at a Reynolds number of about 2×10^6.

NACA RM L55A05a

INVESTIGATION AT TRANSONIC SPEEDS OF AERODYNAMIC CHARACTERISTICS OF A SEMICIRCULAR AIR INLET IN THE ROOT OF A 45° SWEPTBACK WING. Charles D. Trescot, Jr., and Arvid L. Keith, Jr. March 1955. 30p. diagrs., photos., tab. (NACA RM L55A05a)

An investigation has been made in the Langley transonic blowdown tunnel at Mach numbers from 0.63 to 1.41 to study internal and external aerodynamic characteristics of a sweptback semicircular air inlet installed in the root of a 45° sweptback wing-body combination through a range of mass-flow ratio and angle of attack from 0.36 to 0.91 and 0.4° to 8.5°, respectively. Total-pressure ratio at the assumed engine-face station varied from 0.97 at subsonic speeds to 0.84 at the maximum test speed for a mass-flow ratio of 0.80. Addition of the inlet increased the transonic drag rise of the basic wing-body combination by 0.004 at low angles of attack.

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NACA RM L55A07a

A TRANSONIC WIND-TUNNEL INVESTIGATION OF THE LONGITUDINAL FORCE AND MOMENT CHARACTERISTICS OF TWO DELTA WINGS AND ONE CLIPPED-TIP DELTA WING OF 4 PERCENT THICKNESS ON A SLENDER BODY. William E. Palmer and Dale L. Burrows. April 1955. 31p. diagrs., photo. (NACA RM L55A07a)

A transonic wind-tunnel investigation has been made at angles of attack as high as 20° and a Reynolds number of about 5 x 10^6 of an aspect-ratio-4 delta wing, an aspect-ratio-3 delta wing, and an aspect-ratio-3 clipped delta wing, all with NACA 65A004 airfoil sections streamwise. Results showed that reduction of the aspect ratio by clipping the tips had less adverse effect on the aerodynamic characteristics than reduction of the aspect ratio by increasing the leading-edge sweep angle; so, in general, the aspect-ratio-3 clipped delta wing had better characteristics than the aspect-ratio-3 delta wing.

#NACA RM SL55A10a, by Lee and Wilkes

NACA RM L55A14

FLUTTER EXPERIENCES WITH THIN POINTED-TIP WINGS DURING FLIGHT TESTS OF ROCKET-PROPELLED MODELS AT MACH NUMBERS FROM 0.8 TO 1.95. Harvey A. Wallskog. April 1955. 32p. diagrs., photos., tabs. (NACA RM L55A14)

Flutter data were obtained from five thin delta, diamond, and arrow wings when tested in free flight over the Mach number range from 0.8 to 1.95 as part of a general zero-lift drag investigation. The results show that pointed-tip wings of high overall static strength may possess poor flutter characteristics depending to some extent on the distribution of material (in laminated wood-metal structures). Although insufficient data were available to establish a flutter boundary for all pointed-tip wings, it is believed that these data may be useful to a designer in comparing his design to others which did or did not experience flutter.

NACA RM L55J28

ANALYSIS OF A FLIGHT INVESTIGATION AT SUPERSONIC SPEEDS OF A SIMPLE HOMING SYSTEM. Robert A. Gardiner, Clarence L. Gillis, and G. B. Graves, Jr. January 1956. 55p. diagrs., photos. (NACA RM L55J28)

A flight investigation of a simple homing device utilizing unique guidance principles has been conducted. From the telemetered data and the photographic records of the trajectory of a supersonic test missile homing on a parachute flare, it is concluded that the principle of guidance and control exemplified by the simple homing system is fundamentally sound. As a result of analog studies concerned primarily with the ratio of rolling frequency to airframe frequency, it is concluded that considerable system improvement may be obtained from further research.

(This report was improperly announced through NACA Research Abstracts and Reclassification Notice No. 121 as being unavailable.)

NACA RM SL55L15, by Coffee

NACA RM L56A04

ANALYSIS OF AN AUTOMATIC CONTROL TO PREVENT ROLLING DIVERGENCE. William H. Phillips. April 1956. 31p. diagrs., tab. (NACA RM L56A04)

Results are presented of an analog computer investigation of an automatic control intended to prevent rolling divergence by offsetting the roll coupling terms in the equations of motion. The control is shown to be effective in the cases studied. A gyroscopic instrument for sensing the product of two angular velocities about perpendicular axes, a necessary input to the proposed control, is described.

NACA RM L56A06a

AN EXPERIMENTAL STUDY AT HIGH SUBSONIC SPEEDS OF SEVERAL TAIL CONFIGURATIONS ON A MODEL WITH AN UNSWEPT WING. William C. Sleeman, Jr. April 1956. 67p. diagrs., photos. (NACA RM L56A06a)

An investigation was conducted in the Langley high-speed 7- by 10-foot tunnel of the static longitudinal and lateral stability characteristics of a model having several different tail arrangements. A systematic series of Y-tails, including a V-tail, was tested and comparative results obtained for a +-tail and X-tail arrangement. The test results were compared with a more conventional T-tail. All of the tails were unswept and of rectangular plan form. The model wing was of aspect ratio 3, taper ratio 0.5, and had an unswept half-chord line. The test Mach number range extended from 0.60 to 0.94 and the angle-of-attack range extended from -4° to 22° at the lowest test Mach number.

NACA RM L56A09a

EFFECT OF AIRPLANE CONFIGURATION ON STATIC STABILITY AT SUBSONIC AND TRANSONIC SPEEDS. Edward C. Polhamus and Joseph M. Hallissy, Jr. May 1956. 17p. diagrs. (NACA RM L56A09a)

This paper summarizes some of the most recent subsonic and transonic wind-tunnel investigations related to some of the current static stability problems of aircraft configurations. Of the numerous problems, those discussed in the present paper are pitch-up and other pitching-moment nonlinearities, the variation of directional stability with angle of

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attack, and the effect of sideslip on the pitching moment. The effects on these parameters of such variables as wing plan form, wing height, horizontal-tail position, and fuselage shape, are discussed.

NACA RM L56A12

A FLIGHT INVESTIGATION OF THE HANDLING CHARACTERISTICS OF A FIGHTER AIRPLANE CONTROLLED THROUGH AN ATTITUDE TYPE OF AUTOMATIC PILOT. S. A. Sjoberg, Walter R. Russell, and William L. Alford. April 1956. 60p. diagrs., photos., tabs. (NACA RM L56A12)

The paper presents results obtained in a flight investigation made to obtain experimental information on the handling qualities of a fighter airplane which a human pilot controlled by supplying signals to an attitude type of automatic pilot. In the flight program the response characteristics of the airplane - automatic-pilot system were determined and, in addition, the system was evaluated by performing various flight operations such as air-to-air tracking, strafing runs, and rough-air flying. Pilots' opinions of the handling characteristics are included.

#NACA RM SL56A13, by Crabill

NACA RM L56A17

LATERAL STABILITY CHARACTERISTICS BETWEEN MACH NUMBERS OF 0.80 AND 1.57 AND SIMULATION OF COUPLED MOTION AT MACH NUMBER 1.30 OF A ROCKET-PROPELLED MODEL OF AN AIRPLANE CONFIGURATION HAVING THIN HIGHLY TAPERED 45° SWEPTBACK SURFACES. Charles T. D'Aiutolo and Allen B. Henning. April 1956. 41p. diagrs., photos., tabs. (NACA RM L56A17)

A rocket-propelled model of an airplane configuration having thin, highly tapered, 45° sweptback surfaces was tested in the Mach number range of 0.80 to 1.57 to obtain the lateral stability characteristics of the configuration. The model experienced a violent lateral-longitudinal motion at a Mach number of 1.3, and an approximate simulation of this motion on an analog computer indicated possible values of the stability derivatives of the model while undergoing this maneuver. An analysis of the Dutch roll oscillation was performed by the time-vector method and the single-degree-of-freedom method to determine the lateral stability derivatives C_{Y_β}, C_{n_β}, C_{l_β}, C_{l_p}, and $\left(C_{n_r} - C_{n_\beta}\right)$.

NACA RM L56A24

INVESTIGATION AT HIGH SUBSONIC SPEEDS OF SOME EFFECTS OF SIDESLIP ON THE AERODYNAMIC LOADS ON FINNED AND UNFINNED BODIES MOUNTED FROM THE WING OF A SWEPT-WING—FUSELAGE MODEL. Thomas J. King, Jr. April 1956. 50p. diagrs., tabs. (NACA RM L56A24)

Finned and unfinned ogive-cylinder bodies of fineness ratio 9.34 were tested on a swept-wing—fuselage model in sideslip in the Langley high-speed 7- by 10-foot tunnel. For one arrangement, one instrumented body was mounted directly to the left wing tip; for a second arrangement, two bodies (one instrumented), symmetrically located about the plane of symmetry, were mounted to pylons in an inboard location. Five-component force and moment measurements (no axial force) were made of the left-wing bodies in the presence of the model over a Mach number range of 0.50 to 0.94.

NACA RM L56A25a

EFFECT OF FUSELAGE AIR BRAKES ON THE LONGITUDINAL STABILITY CHARACTERISTICS OF A SWEPT-WING FIGHTER MODEL AT TRANSONIC SPEEDS. Donald D. Arabian. April 1956. 22p. diagrs., photos. (NACA RM L56A25a)

An investigation was conducted on a 40° swept-wing fighter model at transonic speeds to determine the effect of extending a fuselage-type air brake located near the wing. Force and moment data and wing pressures were measured and are presented for a range of Mach numbers and angles of attack.

NACA RM L56A26a

AERODYNAMIC DAMPING AT MACH NUMBERS OF 1.3 AND 1.6 OF A CONTROL SURFACE ON A TWO-DIMENSIONAL WING BY THE FREE-OSCILLATION METHOD. W. J. Tuovila and Robert W. Hess. May 1956. 21p. diagrs., tabs. (NACA RM L56A26a)

Tests have been made at two supersonic speeds to obtain experimentally the aerodynamic damping characteristics of a control surface on a two-dimensional wing. The test results are compared with results calculated by two- and three-dimensional oscillating air-force theories. At a Mach number of 1.6, both theories are in fairly good agreement with the experimental results. At a Mach number of 1.3, both theories predict negative (unstable) damping, whereas the tests indicate that the damping is slightly positive (stable). The in-phase or aerodynamic stiffness coefficients predicted by both theories are slightly higher than the experimentally determined coefficients.

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DECLASSIFIED NACA RESEARCH REPORTS

NACA RM L56A27

TRANSONIC WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF A HEATED PROPULSIVE JET ON THE PRESSURE DISTRIBUTION ALONG A FUSELAGE OVERHANG. Elden S. Cornette and Donald H. Ward. April 1956. 42p. diagrs., photos., tab. (NACA RM L56A27)

Pressure-distribution data were obtained on fuselage surfaces which extended downstream of a jet exit and were subject to the influence of a heated propulsive jet. Three fuselage-overhang configurations were investigated at free-stream Mach numbers from 0.80 to 1.10 while jet pressure ratio was varied from 1 to 11 at jet-exit temperatures of cold, 800° F, and 1200° F.

NACA RM L56A31

AN EVALUATION OF AN AEROMECHANICAL METHOD OF MINIMIZING SERVO-MISSILE TRANSFER-FUNCTION VARIATIONS WITH FLIGHT CONDITION. Martin L. Nason. April 1956. 41p. diagrs., tabs. (NACA RM L56A31)

An investigation has been conducted to evaluate the properties of a control-surface actuator and missile combination considered from the standpoint of the minimization of the effects of Mach number and altitude. A torque servo, employing judicious amounts of control-surface-position feedback, was found to have exceptionally favorable static and dynamic operating characteristics as compared with a conventional position servo-actuated missile. The control-surface-position feedback loop exhibited a strong stabilizing influence on the damping of the airframe mode and careful adjustment of the torque servo and position feedback gain constants considerably reduced the percentage Mach number and altitude variation of the available missile turning rate.

NACA RM L56B21

WIND-TUNNEL INVESTIGATION OF A RAM-JET MISSILE MODEL HAVING A WING AND CANARD SURFACES OF DELTA PLAN FORM WITH 70° SWEPT LEADING EDGES. FORCE AND MOMENT CHARACTERISTICS AT COMBINED ANGLES OF PITCH AND SIDESLIP FOR MACH NUMBER 2.01. Cornelius Driver and Clyde V. Hamilton. April 1956. 67p. diagrs., photo., tabs. (NACA RM L56B21)

An investigation has been conducted in the Langley 4- by 4-foot supersonic pressure tunnel to determine the static stability and control characteristics of a ram-jet canard missile at a Mach number of 2.01. The complete model and various combinations of its components were tested through an incidence angle range from -2° to about 26° at various roll angles from 0° to -90°. A resolution of these results provides the aerodynamic characteristics for the missile at angles of attack up to about 26° at zero sideslip or at combinations of angle of attack and angle of sideslip up to a maximum of about 16° for each.

This is authority for those possessing copies of the following research report to declassify it from Secret. Effective date of declassification January 20, 1958.

#NACA RM SA51C16, by Cleary and Coe

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SPECIAL NOTICE

1. If there is enough sales potential, AGARD will reprint the Flight Test Manual in a commercial edition. Please write NACA if you want to be counted as a prospective purchaser. If reprinted, the Manual will probably be available next fall; we don't know the price.

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1301

LINEARIZED LIFTING-SURFACE AND LIFTING-LINE EVALUATIONS OF SIDEWASH BEHIND ROLLING TRIANGULAR WINGS AT SUPERSONIC SPEEDS. Percy J. Bobbitt. 1957. ii, 19p. diagrs., photo. (NACA Rept. 1301. Supersedes TN 3609)

The sidewash in the vertical plane of symmetry behind steady-rolling triangular wings traveling at supersonic speeds has been derived by use of both linearized lifting-surface and lifting-line methods. The lifting-surface results are limited by the condition that the wing leading edges must be subsonic. Variations of the sidewash with vertical and longitudinal distances are presented in graphical form for a number of combinations of Mach number and leading-edge sweep. Sidewash computed by the lifting-line method showed good agreement with lifting-surface results except close behind the trailing edge when the leading edge approached the sonic condition. An illustrative calculation has been made of the force induced by the sidewash behind a triangular wing on a vertical tail located in various longitudinal positions. The approximate lifting-line expression may be used to compute the sidewash behind rolling wings of arbitrary plan form and span loading.

NACA Rept. 1308

INVESTIGATION OF THE COMPRESSIVE STRENGTH AND CREEP LIFETIME OF 2024-T3 ALUMINUM-ALLOY PLATES AT ELEVATED TEMPERATURES. Eldon E. Mathauser and William D. Deveikis. 1957. ii, 14p. diagrs., photos., tabs. (NACA Rept. 1308. Supersedes TN 3552)

The results of elevated-temperature compressive-strength and creep tests of 2024-T3 (formerly 24S-T3) aluminum-alloy plates supported in V-grooves are presented. The strength-test results indicate that a relation previously developed for predicting plate compressive strength at room temperature is satisfactory for determining elevated-temperature strength. Creep-lifetime results are presented for the plates in the form of master creep-lifetime curves by using a time-temperature parameter that is convenient for summarizing tensile creep-rupture data. The use of isochronous stress-strain curves obtained from plate-creep curves for predicting plate-creep failure stresses is investigated.

NACA Rept. 1320

AN EVALUATION OF FOUR EXPERIMENTAL METHODS FOR MEASURING MEAN PROPERTIES OF A SUPERSONIC TURBULENT BOUNDARY LAYER. George J. Nothwang. 1957. ii, 11p. diagrs., photos. (NACA Rept. 1320. Supersedes TN 3721)

Surveys were made through the flat plate turbulent boundary layer at a Mach number of 3 using a pitot probe, an X-ray densitometer, and cold-wire and

CURRENT NACA RESEARCH REPORTS

hot-wire probes. The first three methods indicated consistent mean values of pitot pressure, density, and total temperature; the hot-wire probe, however, indicated larger values of mean mass flow. The assumption of constant total temperature through the boundary layer yielded negligible errors in velocity distribution, and displacement and momentum thicknesses.

NACA RM E57K19a

CORRELATION OF TURBULENT HEAT TRANSFER IN A TUBE FOR THE DISSOCIATING SYSTEM $N_2O_4 \rightleftarrows 2NO_2$. Richard S. Brokaw. March 1958. 17p. diagrs., tabs. (NACA RM E57K19a)

Experimental data are in accord with the usual Nusselt-Prandtl-Reynolds number correlation for this type of convective heat transfer. Calculated equilibrium thermal conductivities and kinematic viscosities were used. An approximate method using frozen gas properties gave somewhat poorer results, but should be useful for complex systems or systems in which chemical equilibrium is not attained. In nonequilibrium systems, the enthalpy of the gas in the free stream and at the wall must be known.

NACA RM E57K22

THEORETICAL ROCKET PERFORMANCE OF JP-4 FUEL WITH SEVERAL FLUORINE-OXYGEN MIXTURES ASSUMING EQUILIBRIUM COMPOSITION. Sanford Gordon. February 1958. 69p. diagrs., tabs. (NACA RM E57K22)

Data were calculated for a chamber pressure of 600 pounds per square inch absolute, fluorine in oxidant from 0 to 100 percent, pressure ratios of 1 to 1500, and a range of equivalence ratios. Parameters included are specific impulse, combustion and exit temperatures, molecular weight, characteristic velocity, coefficient of thrust, area ratio, specific heat, isentropic exponent, viscosity, thermal conductivity, and equilibrium gas compositions. Maximum specific impulse for expansion to 1 atmosphere is 325.7 pound-seconds per pound at 70.37 percent fluorine in oxidant.

NACA RM E57K22a

ELEVATED-TEMPERATURE COMBINED STRESS-RUPTURE PLUS FATIGUE STRENGTH OF WASPALOY HAVING DIFFERENT AGING TREATMENTS AND/OR MOLYBDENUM CONTENTS. C. A. Hoffman and M. B. Hornak. February 1958. 21p. diagrs., photos., tabs. (NACA RM E57K22a)

Waspaloy was studied (at 1500° F) to determine if stress-rupture ductilities and notch sensitivities associated with given aging treatments and/or molybdenum contents could be correlated with respective combined stress-rupture plus fatigue strengths. A possible relation between stress-rupture ductility and combined stress-rupture plus fatigue strength was indicated. No clear relation was found between notch-rupture strength and combined stress-rupture plus fatigue strength. If heat treatment and/or composition alone are considered, results indicate that double aging could improve combined stress strength and that double aging plus increased molybdenum content could cause a further increase in combined stress strength of Waspaloy.

NACA RM L57L05

LIMITED INVESTIGATION OF NOISE SUPPRESSION BY INJECTION OF WATER INTO EXHAUST OF AFTERBURNING JET ENGINE. Max C. Kurbjun. February 1958. 15p. diagrs., photo. (NACA RM L57L05)

A preliminary investigation of the effect of injection of up to 880 gallons of water per minute on the noise production of an afterburning jet engine producing 8,000 pounds of thrust showed a reduction of 2 to 6 decibels in overall sound-pressure level in the direction of maximum noise radiation. It was further noted that the reduction in overall sound pressure was achieved by significant reductions (up to 10 decibels) in the range of frequencies below 800 cps, a region where the attenuation due to atmospheric losses is negligible.

NACA RM L57L12

SUMMARY OF LOCATIONS, EXTENTS, AND INTENSITIES OF TURBULENT AREAS ENCOUNTERED DURING FLIGHT INVESTIGATIONS OF THE JET STREAM FROM JANUARY 7, 1957 TO APRIL 28, 1957. Martin R. Copp. March 1958. 8p. tab. (NACA RM L57L12)

A summary of the locations, extents, and intensities of turbulent areas encountered during a flight investigation of the jet stream is presented. The data were obtained from NACA time-history records.

NACA RM L58A17

EFFECT OF DISTRIBUTED GRANULAR-TYPE ROUGHNESS ON BOUNDARY-LAYER TRANSITION AT SUPERSONIC SPEEDS WITH AND WITHOUT SURFACE COOLING. Albert L. Braslow. March 1958. 22p. diagrs., photos. (NACA RM L58A17)

An investigation at a Mach number of 2.01 and 1.61 in the Langley 4- by 4-foot supersonic pressure tunnel showed that for a distributed granular-type surface roughness, transition could be correlated at supersonic speeds on the basis of a critical local roughness Reynolds number similar to that previously developed for use at subsonic speeds. Surface cooling did not increase the value of the critical roughness Reynolds number to any important extent, and, therefore, promoted transition due to existing three-dimensional surface roughness because of the adverse effect of cooling on the actual roughness Reynolds number.

CURRENT NACA RESEARCH REPORTS

NACA TM 1404

INVESTIGATION OF APERIODIC TIME PROCESSES WITH AUTOCORRELATION AND FOURIER ANALYSIS. (Untersuchung unperiodischer Zeitvorgänge mit der Autokorrelations und der Fourieranalyse.) Marie Luise Exner. March 1958. 44p. diagrs., photos., tabs. (NACA TM 1404. Translation from Acustica, v. 4, no. 3, 1954, p. 365-379)

Autocorrelation and frequency analyses of a series of aperiodic time events, in particular, filtered noises and sibilant sounds, were made. The position and band width of the frequency ranges are best obtained from the frequency analysis, but the energies contained in the several bands are most easily obtained from the autocorrelation function. The mean number of zero crossings of the time function was determined from the curvature of the latter function in the vicinity of the zero crossing, and also with the aid of a decimal counter. The second method was found to be more exact.

NACA TM 1413

IMPACT ON A COMPRESSIBLE FLUID. (Udar o szhimaemuiu zhidkost.) I. T. Egorov. February 1958. 12p. diagrs. (NACA TM 1413. Translation from Prikladnaia Matematika i Mekhanika, v. 20, no. 1, 1956, p. 67-72)

Theoretical solution is made of vertical hydrodynamic impact of a flat rigid body on the surface of a nonviscous compressible fluid. The solution is based on potential motion of the fluid. Rise of the fluid near the body is considered to be negligible. The equations permit calculation of histories of impact force and motion. Histories of kinetic energy and momentum for impacts at 5 m sec^{-1} on water, alcohol, and pentane are calculated.

NACA TM 1432

EVAPORATION, HEAT TRANSFER, AND VELOCITY DISTRIBUTION IN TWO-DIMENSIONAL AND ROTATIONALLY SYMMETRICAL LAMINAR BOUNDARY-LAYER FLOW. (Verdunstung, Wärmeübergang und Geschwindigkeitsverteilung bei zweidimensionaler und rotationssymmetrischer laminarer Grenzschichtströmung.) Nils Frössling. February 1958. 37p. tabs. (NACA TM 1432. Translation from Lunds Universitets Arsskrift, v. 36, no. 4. Kungl. Fysiografiska Sallskapets Handlingar, v. 51, no. 4, 1940)

A theoretical investigation is made of the boundary-layer flow over two-dimensional bodies and over bodies of revolution. The evaporation, the heat transfer, and the boundary-layer velocity profiles are calculated by power-series developments with respect to the distance along the surface. The coefficient functions that occur in the series developments were chosen so that they are valid for all pressure distributions; some of these coefficient functions were calculated numerically. Methods for the determination of the errors caused by breaking off the series are briefly treated. Methods of proceeding further along the surface are discussed. It is shown, for large Prandtl numbers, that the Nusselt number is exactly proportional to the cube root of the Prandtl number. Finally, approximate methods of calculation are discussed.

NACA TN 4036

CREEP OF ALUMINUM-COPPER ALLOYS DURING AGE HARDENING. E. E. Underwood, L. L. Marsh, and G. K. Manning, Battelle Memorial Institute. February 1958. 73p. diagrs., photos., tabs. (NACA TN 4036)

The interrelation of aging during creep and of creep during aging has been studied in polycrystalline aluminum alloys containing 1 to 4 percent copper. Experimental procedures included interrupted creep tests, tensile tests of crept specimens, quantitative metallographic determination of the percent precipitation during creep, hardness measurements on unstressed and stressed aged alloys, X-ray studies of deformation in the crystalline lattice, and microscopic examination of the surface-deformation markings.

NACA TN 4133

BOUNDARY-LAYER DISPLACEMENT EFFECTS IN AIR AT MACH NUMBERS OF 6.8 AND 9.6. Mitchel H. Bertram. February 1958. 61p. diagrs., photos. (NACA TN 4133)

Measurements are presented for boundary-layer-induced pressure gradients on a flat plate in air at a Mach number of 9.6 and for the drag of thin wings at a Mach number of 6.8 and zero angle of attack. The investigation was conducted in the Langley 11-inch hypersonic tunnel, and the pressure measurements at a Mach number of 9.6 were made in the presence of substantial heat transfer from the boundary layer to the wall.

NACA TN 4136

THEORETICAL INVESTIGATION OF SUBSONIC OSCILLATORY BLADE-ROW AERODYNAMICS. Frank Lane and Manfred Friedman, New York University. February 1958. 64p. diagrs., tabs. (NACA TN 4136)

A method is presented for calculating the aerodynamic lifts and moments experienced by a cascade or two-dimensional approximation to a compressor or turbine blade row in subsonic flow under harmonic oscillation. Arbitrary stagger and interblade phase-lag angles are permitted. The most significant features of the method stem from the utilization of Fourier transforms of blade pressure-jump functions.

CURRENT NACA RESEARCH REPORTS

NACA TN 4139

WALL PRESSURE FLUCTUATIONS IN A TURBULENT BOUNDARY LAYER. William W. Willmarth, California Institute of Technology. March 1958. 39p. diagrs., photo. (NACA TN 4139)

A low-noise- and low-turbulence-level wind tunnel and a flush-mounted barium titanate transducer have been used to measure the wall pressure fluctuations in a turbulent boundary layer. It was found that the spectrum of the wall pressure fluctuations extended to 50 kilocycles and that the root-mean-square wall pressure was a constant part of the free-stream dynamic pressure for $0.2 < M < 0.8$ and $1.5 < Re < 20 \times 10^6$. A few typical spectra are given for different values of Reynolds number and Mach number.

NACA TN 4145

AN ANALYSIS OF THE OPTIMIZATION OF A BEAM RIDER MISSILE SYSTEM. Marvin Shinbrot and Grace C. Carpenter. March 1958. 34p. diagrs. (NACA TN 4145)

A transfer function is derived for a beam rider missile guidance system which is optimum when the target moves in a nonstationary way. The effects of acceleration limiting are considered and a discussion of the miss as a function of the various parameters which determine it is included. A form of design chart is presented which allows the immediate determination of the optimum under any set of target-missile conditions.

NACA TN 4147

MEASURED AND PREDICTED DYNAMIC RESPONSE CHARACTERISTICS OF A FLEXIBLE AIRPLANE TO ELEVATOR CONTROL OVER A FREQUENCY RANGE INCLUDING THREE STRUCTURAL MODES. Henry A. Cole, Jr., and Euclid C. Holleman. February 1958. 81p. diagrs., photo., tabs. (NACA TN 4147)

The dynamic response of selected points on a flexible airplane to elevator motions is presented over the operating Mach number range at altitudes from 15,000 to 35,000 feet. Comparisons are made between measured responses over various frequency bands and predicted responses based on equations with three structural degrees of freedom.

NACA TN 4149

AN ANALYSIS OF THE TURBULENT BOUNDARY-LAYER CHARACTERISTICS ON A FLAT PLATE WITH DISTRIBUTED LIGHT-GAS INJECTION. Morris W. Rubesin and Constantine C. Pappas. February 1958. 43p. diagrs. (NACA TN 4149)

An exploratory analysis has been developed for the case of distributed injection of a foreign gas into a turbulent boundary layer in air on a flat plate. The work is divided into three parts: a derivation of the basic turbulent boundary-layer equations for a binary gas system; a derivation of modified Reynolds analogies between momentum, mass, and heat transfer for a binary gas system; and an evaluation of the effect of foreign gas injection on the skin friction and heat transfer of a nearly isothermal boundary layer using mixing length theory. Numerical results are given for the injection of the light gases, hydrogen, and helium.

NACA TN 4151

CORRELATIONS AMONG ICE MEASUREMENTS, IMPINGEMENT RATES, ICING CONDITIONS, AND DRAG COEFFICIENTS FOR UNSWEPT NACA 65A004 AIRFOIL. Vernon H. Gray. February 1958. 45p. diagrs., photos., tabs. (NACA TN 4151)

An empirical relation is derived by which changes in section drag coefficients due to ice on an NACA 65A004 airfoil are calculable from known icing and operating conditions. The correlation is obtained by use of measured ice heights and ice angles. Initial ice weights are in agreement with droplet impingement data; in glaze conditions, ice weights increase at progressively greater rates with time.

NACA TN 4153

EFFECT OF WALL COOLING ON INLET PARAMETERS OF A SCOOP OPERATING IN A TURBULENT BOUNDARY LAYER ON A FLAT OR CONICAL SURFACE FOR MACH NUMBERS 2 TO 10. Andrew Beke. March 1958. 21p. diagrs., tabs. (NACA TN 4153)

Mass-flow, momentum, total-temperature, and total-pressure recovery ratios were calculated for a scoop inlet having a height equal to the boundary-layer thickness. Wall cooling on a flat or conical surface increases the inlet mass-flow and momentum ratios up to 50 percent, and reduces the total-temperature ratio of the boundary-layer mass flow by about 6 percent with small increases in total-pressure recovery.

CURRENT NACA RESEARCH REPORTS

NACA TN 4155

AERODYNAMIC EFFECTS CAUSED BY ICING OF AN UNSWEPT NACA 65A004 AIRFOIL. Vernon H. Gray and Uwe H. von Glahn. February 1958. 47p. diagrs., photos., tabs. (NACA TN 4155)

At angles of attack less than 4° both rime and glaze-ice formations increased drag, reduced lift, and reduced diving moments. At angles of attack greater than 4°, drag coefficients increased with glaze-ice formations and decreased with rime ice; lift coefficients generally increased with glaze ice and were variably affected by rime ice; pitching-moment changes were rather erratic and depended on the ice shape. When the airfoil was iced at high angles of attack and rotated to lower angles, large negative pitching moments were obtained. Ice formations on the airfoil had no significant effects on control-surface hinge moments.

NACA TN 4158

ACCELERATIONS IN TRANSPORT-AIRPLANE CRASHES. G. Merritt Preston and Gerard J. Pesman. February 1958. 76p. diagrs., photos., tab. (NACA TN 4158)

Full-scale aircraft crashes were made with low-wing pressurized and high- and low-wing unpressurized transport airplanes to determine the crash loads that result from a variety of crash events. The effects of the crash circumstances and the airplane configuration on the magnitude of the crash loads are indicated.

NACA TN 4161

EFFECT OF LUBRICANT BASE STOCK ON ROLLING-CONTACT FATIGUE LIFE. Thomas L. Carter. February 1958. 28p. diagrs., tab. (NACA TN 4161)

Five different base-stock fluids, a methyl silicone, a mineral oil, a glycol, a sebacate, and an adipate, were tested as lubricants in the rolling-contact fatigue spin rig using groups of air-melt M-1 tool-steel balls at 100° F. Other test conditions such as lubricant viscosity, at test temperature, and ball loading were held constant. Differences were observed in the ball fatigue lives produced with these lubricants. Lubricants whose viscosities were increased the most by pressure produced the longest fatigue lives. No differences were observed in chemical or metallurgical effects or in failure type.

NACA TN 4180

INVESTIGATION OF SPOILERS AT A MACH NUMBER OF 1.93 TO DETERMINE THE EFFECTS OF HEIGHT AND CHORDWISE LOCATION ON THE SECTION AERODYNAMIC CHARACTERISTICS OF A TWO-DIMENSIONAL WING. James N. Mueller. February 1958. 52p. diagrs., photos. (NACA TN 4180. Supersedes RM L52L31)

The results of a pressure-distribution investigation of a 6-percent-thick symmetrical wing with spoilers are presented for a Reynolds number of approximately 1×10^6. The values of section normal force and pitching moment are presented as a function of angle of attack, spoiler height, and spoiler chordwise location. Some effects of spoiler height on spoiler pressure drag are shown for several angles of attack and two chordwise spoiler locations.

NACA TN 4183

INVESTIGATION OF EFFECTS OF DISTRIBUTED SURFACE ROUGHNESS ON A TURBULENT BOUNDARY LAYER OVER A BODY OF REVOLUTION AT A MACH NUMBER OF 2.01. John R. Sevier, Jr., and K. R. Czarnecki. February 1958. 31p. diagrs., photos. (NACA TN 4183)

An investigation of three ogive-cylinders over a surface-roughness range from 23 to 480 microinches root mean square was made at zero angle of attack for a Reynolds number range based on body length from 4×10^6 to 30×10^6. The drag and base pressure were measured for conditions of natural and fixed transition. The results are compared with those of tests of the same models at a Mach number of 1.61, and the comparison indicates that increasing the Mach number from 1.61 to 2.01 results in a 40-percent increase in allowable roughness height for the turbulent boundary layer. This increase is in good agreement with that predicted on the basis of a constant ratio of allowable roughness height to laminar-sublayer thickness or to a constant value of the Reynolds number based on allowable roughness height, shearing-stress velocity, and local conditions at the surface.

NACA TN 4188

CHARTS RELATING THE COMPRESSIVE AND SHEAR BUCKLING STRESSES OF LONGITUDINALLY SUPPORTED PLATES TO THE EFFECTIVE DEFLECTIONAL STIFFNESS OF THE SUPPORTS. Aldie E. Johnson, Jr. February 1958. 42p. diagrs., tab. (NACA TN 4188)

A stability analysis is made of long flat rectangular plates subjected to both shear and compressive loads. The edges of the plates are taken to be simply supported and the plates are supported along one or two intermediate longitudinal lines by lines of deflectional springs (elastic line supports). The results of the analysis are presented in the form of charts that are useful in the determination of the buckling load of plates stiffened by stringers or webs.

CURRENT NACA RESEARCH REPORTS

NACA TN 4194

COMPARISON OF HYDRODYNAMIC-IMPACT ACCELERATION AND RESPONSE FOR SYSTEMS WITH SINGLE AND WITH MULTIPLE ELASTIC MODES. Robert W. Miller. February 1958. 30p. diagrs., photos., tabs. (NACA TN 4194)

Hydrodynamic-impact tests were made on a multimode elastic model consisting of a rigid prismatic float and a flexible wing. Comparisons of multimode results with theoretical and experimental results for a single-mode system having the same mass ratio indicate that the applied accelerations are in agreement with those obtained by the method of NACA Report 1074 and that the higher modes present had no significant effect on the applied accelerations.

NACA TN 4196

A METHOD FOR THE CALCULATION OF THE LATERAL RESPONSE OF AIRPLANES TO RANDOM TURBULENCE. John M. Eggleston and William H. Phillips. February 1958. 34p. diagrs., tab. (NACA TN 4196)

In this method, the gust velocities are represented as rolling gusts, yawing gusts, and side gusts. Random distributions of gust velocities across the span are taken into account in defining the rolling and yawing gusts. Complex stability derivatives are used to account for the random distribution of side gusts along the fuselage and vertical tail and the lag effects in gust penetration. A sample calculation procedure is presented for obtaining the response of the airplane in each degree of freedom.

NACA TN 4197

SUMMARY OF FLUTTER EXPERIENCES AS A GUIDE TO THE PRELIMINARY DESIGN OF LIFTING SURFACES ON MISSILES. Dennis J. Martin. February 1958. 21p. diagrs. (NACA TN 4197. Supersedes RM L51J30)

Presented is a limited review of some experiences in flight testing of missiles and of wing flutter investigations that may be of interest in missile design. Several types of flutter of concern in missile studies are briefly described. Crude criteria are presented for two of the most common types of flutter to permit a rapid estimate to be made of the probability of the occurrence of flutter. Many of the details of the flutter problem have been omitted, and only the broader elements have been retained so as to give the designer an overall view of the subject.

NACA TN 4200

EFFECTIVENESS OF BOUNDARY-LAYER CONTROL, OBTAINED BY BLOWING OVER A PLAIN REAR FLAP IN COMBINATION WITH A FORWARD SLOTTED FLAP, IN DEFLECTING A SLIPSTREAM DOWNWARD FOR VERTICAL TAKE-OFF. Kenneth P. Spreemann. February 1958. 32p. diagrs., photo. (NACA TN 4200)

The wing employed in this investigation had a 67-percent-chord slotted flap in combination with a 33-percent-chord plain rear flap equipped with a full-span blowing nozzle. The tests were conducted in a static-thrust facility at the Langley Aeronautical Laboratory. The investigation indicated that the plain rear flap alone with a low momentum coefficient for boundary-layer control provided larger turning angles than the combined slotted and plain flaps without boundary-layer control.

NACA TN 4202

QUALITATIVE SIMULATOR STUDY OF LONGITUDINAL STICK FORCES AND DISPLACEMENTS DESIRABLE DURING TRACKING. Stanley Faber. February 1958. 23p. diagrs., photo. (NACA TN 4202)

In this study in which an airplane simulator with one degree of freedom (pitch) was used, results were determined for three conditions of airplane dynamics. For an undamped natural frequency of 1/2 cps with a damping ratio of 0.8, low stick-force gradients and stick-displacement gearings were desired. For an undamped natural frequency of 1/2 cps with a damping ratio of 0.18 and for an undamped natural frequency of 1 cps with a damping ratio of 0.11, moderate longitudinal stick forces and displacements were desired.

NACA TN 4203

FLIGHT INVESTIGATION OF EFFECTS OF ATMOSPHERIC TURBULENCE AND MODERATE MANEUVERS ON BENDING AND TORSIONAL MOMENTS ENCOUNTERED BY A HELICOPTER ROTOR BLADE. LeRoy H. Ludi. February 1958. 34p. diagrs., photo., tab. (NACA TN 4203)

Experimental studies of the effects of atmospheric turbulence and moderate maneuvers on the steady and periodic rotor blade moments encountered by a single-rotor helicopter show that atmospheric turbulence and control motions do not produce additional periodic blade moments, except when accompanied by center-of-gravity accelerations, significant to fatigue calculations during the principal part of the flying time. This information permits the use of time spent, as determined by an NACA helicopter VGHN recorder, in conjunction with prototype strain measurements as a basis for that portion of the cumulative fatigue analysis that covers the principal part of the flying time.

CURRENT NACA RESEARCH REPORTS

NACA TN 4204

COMPILATION OF INFORMATION ON THE TRANSONIC ATTACHMENT OF FLOWS AT THE LEADING EDGES OF AIRFOILS. Walter F. Lindsey and Emma Jean Landrum. February 1958. 63p. diagrs., photos., tabs. (NACA TN 4204)

Schlieren photographs have been compiled of the two-dimensional flow at transonic speeds past 37 airfoils. These airfoils have variously shaped profiles, and some are related in thickness and camber. The data for these airfoils were analyzed to provide basic information on the flow changes involved and to determine factors affecting transonic-flow attachment, which is a transition from separated to unseparated flow at the leading edges of two-dimensional airfoils at fixed angles as the subsonic Mach number is increased.

NACA TN 4205

TRANSIENT HEATING EFFECTS ON THE BENDING STRENGTH OF INTEGRAL ALUMINUM-ALLOY BOX BEAMS. Richard A. Pride and John B. Hall, Jr. March 1958. 38p. diagrs., photo., tab. (NACA TN 4205)

Twenty-five square-tube beams were tested to failure under combinations of bending load and symmetrical heating. The results of tests for skin buckling and maximum strength are compared with theoretical calculations. Results for local buckling are calculated from theories combining the effects of appropriate material properties and thermal stress in both elastic- and plastic-stress ranges. A marked reduction in buckling strength was observed as a result of thermal stress. At failure, the results of all tests correlated well with those calculated by a compression maximum-strength theory based solely on appropriate material properties; this correlation indicates that thermal-stress effects which influence local buckling appear alleviated at maximum load.

NACA TN 4209

EXPERIMENTAL THERMAL CONDUCTIVITIES OF THE $N_2O_4 \rightleftarrows 2NO_2$ SYSTEM. Kenneth P. Coffin and Cleveland O'Neal, Jr. February 1958. 22p. diagrs., photo., tab. (NACA TN 4209)

Thermal conductivity was measured by a hot-wire technique at temperatures between 20° and 215° C and pressures from 1/3 to 1 atmosphere; approximate values were obtained at pressures as low as 0.02 atmosphere from 20° to 80° C. Experimental values are in good agreement with values calculated so as to include the effects of dissociation; dissociation produces an order-of-magnitude increase in conductivity.

NACA TN 4210

STABILITY OF PROPANE-AIR FLAMES IN VORTEX FLOW. A. E. Potter, Jr., E. L. Wong, and A. L. Berlad. February 1958. 27p. diagrs., tab. (NACA TN 4210)

The stability limits of propane-air flames in vortex flow were measured. The blowoff velocity was proportional to the 0.73 power of vortex strength, and increased slightly with fuel concentration. The flames were stabilized by a stagnation or near-stagnation region induced by a pressure defect existing at the vortex center. When the vortex strength was made large, the pressure defect at the vortex center drew ambient air into the flame. This caused partial quenching of lean flames. H_2O_2, HCHO, higher aldehydes, CH_3OH, H_2, and CO were found in the combustion products of lean flames in strong vortices.

NACA TN 4211

FRICTION STUDIES OF VARIOUS MATERIALS IN LIQUID NITROGEN. D. W. Wisander, W. F. Hady, and R. L. Johnson. February 1958. 35p. diagrs., photos., tab. (NACA TN 4211)

Friction data were obtained under conditions applicable to positive-displacement pumps (2300 ft/min sliding velocity and 1000-gram load) with a 3/16-inch-radius hemisphere sliding on the flat surface of a rotating disk. Graphite-filled Teflon gave lower friction coefficient (0.15) and wear than other materials, including rolling-contact-bearing metals, mechanical-seal-type carbons, phenolic laminates, and a cermet. Other filled Teflon compositions also gave good results. Phenolic laminates gave relatively high friction (>0.5).

NACA TN 4213

RECOVERY TEMPERATURES AND HEAT TRANSFER NEAR TWO-DIMENSIONAL ROUGHNESS ELEMENTS AT MACH 3.1. Paul F. Brinich. February 1958. 20p. diagrs. (NACA TN 4213)

The effects of single and multiple two-dimensional roughness elements on the temperature distribution, the pressure distribution, and the heat transfer on a hollow cylinder and a cone-cylinder model were determined at Mach 3.1. Abrupt perturbations in surface temperature occurred in the neighborhood of the elements when the boundary layer was turbulent, but were absent when it was laminar. The type of perturbation depended on the element shape, forward-facing wedges giving the lowest temperatures immediately behind the element, and forward-facing steps the highest. For a turbulent boundary layer the heat-transfer rate behind the wedge element was less than that immediately ahead of the element.

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NACA TN 4214

BOUNDARY-LAYER TRANSITION ON AN OPEN-NOSE CONE AT MACH 3.1. Paul F. Brinich. February 1958. 11p. diagrs. (NACA TN 4214)

Transition locations on an open-nose cone are compared with those on a conventional cone and a hollow cylinder. The transition locations on the sharp open-nose cone are exactly the same as those on the sharp open-nose cylinder. The effects on transition location of blunting the leading edge of the open-nose cone are also quite similar to those observed for the hollow cylinder.

NACA TN 4216

EFFECT OF FIBER ORIENTATION IN RACES AND BALLS UNDER ROLLING-CONTACT FATIGUE CONDITIONS. Thomas L. Carter. February 1958. 37p. diagrs., photos., tabs. (NACA TN 4216)

The rolling-contact fatigue spin rig was used to study the interrelations of fiber orientation and fatigue. In both balls and races, a concentration of fatigue failures was observed in regions with the highest angle of intersection of fiber flow lines with the surface. Also, in races, poorer fatigue life was observed with increasing fiber orientation angle. Each of the ten ball materials studied showed a greater than normal tendency to fail in the polar or end grain areas.

NACA TN 4221

TURBULENT FLOW THROUGH POROUS RESISTANCES SLIGHTLY INCLINED TO THE FLOW DIRECTION. Albert L. Loeffler, Jr., and Morris Perlmutter. February 1958. 30p. diagrs., photos. (NACA TN 4221)

Analytical and experimental studies have been made of the channel flow of air through porous resistances inclined at an angle of $3\text{-}1/2^{\circ}$ to the axis of the channel with the air discharging to the atmosphere. These studies determine the channel wall shape that would yield a uniform discharge through the porous resistance.

NACA TN 4227

DRAG MINIMIZATION FOR WINGS IN SUPERSONIC FLOW, WITH VARIOUS CONSTRAINTS. Max. A. Heaslet and Franklyn B. Fuller. February 1958. 30p. (NACA TN 4227)

Minimization of inviscid fluid drag is studied for wings subject to constraints on lift, pitching moment, base area, or volume. An approximate solution for given lift is obtained. For certain wing classes, analogies between lifting and nonlifting cases are found. Results are given for a family of wings with curved leading edges when lift and a center of pressure at 60-percent chord are specified. Integrals of loading along oblique lines are given. Minimum drag for other plan forms is determined, and, for nonlifting wings, occurrence of unreal shapes is discussed.

NACA TN 4259

TEMPERATURE-PRESSURE-TIME RELATIONS IN A CLOSED CRYOGENIC CONTAINER. Sidney C. Huntley. February 1958. 21p. diagrs. (NACA TN 4259)

An experimental study with liquid nitrogen in a closed container showed that surface temperature controlled the tank pressure and verified the existence of temperature gradients that accounted for the increase in pressure above that calculated from the average liquid temperature. Stirring the liquid to equalize liquid temperatures caused a pressure reduction to the calculated value. Mixing the vapor increased the direct heat flow to the stable liquid layer at the surface, which resulted in an increase in pressure.

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N-21261X*

Aeronautical Research Council (Gt. Brit.)
DETERMINATION OF THE STRESS DISTRIBUTION IN REINFORCED MONOCOQUE STRUCTURES. PART II - A THEORY OF SWEPT WINGS WHERE THE RIBS ARE IN THE LINE OF FLIGHT. L. S. D. Morley. 1957. 51p. diagrs., photos. ARC R & M 2967; ARC 15,676. Supersedes RAE Structures 138. (Ask for N-21261X*)

In this paper an analysis has been developed to estimate the stresses due to root constraint in a two-spar swept wing of reinforced monocoque construction where the ribs are in the line of flight. The analysis yields also the distorted shape of the wing. A detailed numerical example has been given. Tests on a cellulose-nitrate model have provided good qualitative confirmation of the theory.

N-27846Y*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF A WIND GRADIENT ON THE RATE OF CLIMB OF AN AIRCRAFT. W. A. Mair, Cambridge University. 1957. 9p. ARC R & M 2953. Supersedes ARC 15,862; Perf.1086(rev.). (Ask for N-27846Y*)

The behavior of an aircraft climbing in the presence of a wind gradient is analyzed by a method similar to that used in R & M 379, but with fewer simplifying assumptions. It is shown that the result obtained in the earlier paper is only correct if the angle of climb is small and if the true airspeed is constant during the climb. With the climb techniques that are now usual, however, the true airspeed is not constant during the climb; with typical subsonic aircraft the effect of this is to change the correction due to a wind gradient by about 10 percent. For aircraft

*AVAILABLE ON LOAN ONLY.

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climbing at supersonic speeds the effect of acceleration may be much greater than this. Since the percentage change of rate of climb due to a given wind gradient is approximately proportional to the flight speed, the effect does not become less important as aircraft speeds increase. Moreover, wind gradients having a significant effect on the rate of climb are not confined to low altitudes. For a modern high-speed aircraft it is shown that the wind gradient may change the rate of climb by 20 percent or more.

N-30610X*

Aeronautical Research Council (Gt. Brit.)
INTERFERENCE CORRECTIONS FOR ASYMMETRICALLY LOADED WINGS IN CLOSED RECTANGULAR WIND TUNNELS: H. C. Garner and W. E. A. Acum, National Physical Laboratory. 1957. 38p. diagrs., tabs. ARC R & M 2948. Supersedes ARC 16,153; FM 1951; S & C 2805. (Ask for N-30610X*)

The problem of tunnel interference on a complete lifting wing fitted with ailerons is considered in relation to aerodynamic measurements on a six-component balance. Asymmetric loading introduces corrections to the incidence of the wing, the drag, and the rolling, pitching, and yawing moments. The basic theory of wall interference in closed rectangular tunnels is outlined. The tunnel-induced upwash is expressed in terms of the loading on the wing and four quantities dependent on the shape of tunnel. One section describes how the evaluation of tunnel interference is conveniently linked with Multhopp's lifting-surface theory to determine corrections to incidence, pitching moment, and rolling moment. The corrections are applied to an arrowhead wing with various ailerons in a duplex tunnel.

N-38759X*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF THE GROUND ON A HELICOPTER ROTOR IN FORWARD FLIGHT. I. C. Cheeseman and W. E. Bennett. 1957. 10p. diagrs. ARC R & M 3021; 17,772; 17,937. Supersedes AAEE/Res/288 and AAEE Airborne Experimental Div. Note 18. (Ask for N-38759X*)

An approximate method of estimating the effect of the ground on the lift of a rotor at any forward speed is described. Flight tests on several different helicopters show reasonable agreement with the theory. Curves are given showing the relation between thrust, height, speed, and power. The theory has been extended to include the effect of a variation in blade loading coefficient and shows that, within the range that this parameter takes on present single-rotor helicopters, the effect is small. The effect of fitting flat surfaces beneath the rotor is also considered.

N-40307X*

Aeronautical Research Council (Gt. Brit.)
THE CALCULATION OF THE PRESSURE DISTRIBUTION ON THE SURFACE OF THICK CAMBERED WINGS AND THE DESIGN OF WINGS WITH GIVEN PRESSURE DISTRIBUTION. J. Weber. 1957. 59p. diagrs., tabs. ARC R & M 3026; ARC 17,972. Supersedes RAE Aero 2548. (Ask for N-40307X*)

This report deals with thick cambered wings of any section shape and with the inverse problem of designing airfoils which have prescribed velocity distributions. As the general method is so organized that particular solutions are built up of a few basic solutions, so also in the present case, only the basic cases of the two-dimensional airfoil and the center section of swept wings need be treated in detail. A simple calculation method, suitable for practical application, is derived by approximating to the integral expressions for the unknown quantities (velocity increment or section ordinate or the slope of the section) by finite sums over the given section ordinates or velocity increments and tabulating the required coefficients. For the two-dimensional airfoil, a comparison is made with exact results which shows that the accuracy is sufficient for practical purposes.

N-40342X*

Aeronautical Research Council (Gt. Brit.)
CURRENT TESTS ON LAMINAR-BOUNDARY-LAYER CONTROL BY SUCTION THROUGH PERFORATIONS. S. F. J. Butler. 1957. 21p. diagrs., tab. ARC R & M 3040; 17,902. Supersedes RAE Tech.Note Aero 2375. (Ask for N-40342X*)

No attempt was made to obtain full-chord laminar flow, as this had been shown previously to be a natural consequence of applying a suitable suction distribution, providing turbulent wedges did not result from oversuction. In the present tests, the main aim therefore was to determine the flow rates at which such wedges appeared for different arrangements of perforations. In order to simplify the test procedure, most of the results were obtained using one or more closely spaced rows of perforations at a single chordwise station on an otherwise plain wing. A method is given, supported by some experimental evidence, for predicting the perforation spacing which would be required in a full-chord application from the results thus obtained at a single chordwise station.

N-41381X*

Aeronautical Research Council (Gt. Brit.)
FORMULAE AND APPROXIMATIONS FOR AERODYNAMIC HEATING RATES IN HIGH SPEED FLIGHT. R. J. Monaghan. 1957. 53p. diagrs. ARC CP 360. (Ask for N-41381X*)

The formulas are based on the "intermediate enthalpy" approximation which has given good agreement with theoretical and experimental evidence. In the general flight case they could be used in conjunction with

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an analog computer or a step-by-step method of integration to predict the variations of heat flow and skin temperature with time. In the restricted case of flight at constant altitude and Mach number, simple analytical methods and results are given which include the effects of radiation and can be applied to "thick" as well as "thin" skins.

N-44352X*

Aeronautical Research Council (Gt. Brit.)
AN EXTENSION OF THE HYDRODYNAMIC SOURCE-SINK METHOD FOR AXISYMMETRIC BODIES.
A. H. Armstrong. 1957. 18p. diagrs., tab.
ARC R & M 3020; ARC 17,787. Supersedes ARE Rept. 59/54. (Ask for N-44352X*)

Real flow patterns are produced by formally placing a pair of conjugate complex sources at conjugate complex points on the axis of symmetry. These complex singularities are shown to be equivalent to a nonuniform distribution of real doublets on a real disk. Reciprocal relationships are formulated between these new singularities and the well-known simple source ring and vortex ring. While the latter are simpler physically, the new type of singularity is easier to handle in mathematical analysis, involving only square roots instead of elliptic integrals. Sufficient conditions are determined under which an axisymmetric body may be generated by a real distribution of sources and sinks along the axis of symmetry, and the formula for the source intensity is given when these conditions are satisfied.

N-44953, pt. 2*

National Gas Turbine Establishment (Gt. Brit.)
A THEORETICAL ANALYSIS OF REACTION RATE CONTROLLED SYSTEMS - PART II. M. V. Herbert. October 1957. 128p. diagrs., tabs.
NGTE R. 213. (Ask for N-44953, pt. 2*)

Certain of the general equations given in part I are revised, leading in particular to a corrected vitiation factor in the airloading group. Theoretical predictions of loading are also made for the cases of water vapor dilution of the combustion mixture, and nonuniform fuel distribution. Further analysis of data on "can" and baffle stabilizers has clarified the balance between reaction and aerodynamic factors. It is tentatively concluded that this balance is similar for "cans," with a satisfactory internal flow pattern, and both three- and properly two-dimensional baffles, with fully turbulent conditions in the wake. An explanation is given of the effect of baffle drag on stability for small blockages.

N-48942X*

Aeronautical Research Council (Gt. Brit.)
NOZZLE AND CONTRACTION SHAPES OF THE R.A.E. 3 FT X 3 FT SUPERSONIC WIND TUNNEL.
A. Stanbrook. 1957. 9p. diagr., tabs. ARC CP 375. (Ask for N-48942X*)

Ordinates of the contraction and of each of the solid liners of the 3-ft by 3-ft supersonic wind tunnel are tabulated.

CN-57863*

Royal Aircraft Establishment (Gt. Brit.)
MEASUREMENT OF THE ATTEMPT ON THE WORLD ALTITUDE RECORD FOR AEROPLANES AT LUTON ON 28th AUGUST, 1957. N. E. G. Hill and W. Goldsmith. September 1957. 21p. diagrs., photos., tabs. RAE Instn. 10. (Ask for CN-57863*)

On 28 August 1957, Mr. M. Randrup and Mr. W. Shirley flew in a Canberra B.2 airplane powered by Avon jet engines and a Double Scorpion rocket motor, and attempted to establish a new world altitude record for airplanes of unrestricted weight. The altitude of the airplane was measured during the attempt by R.A.E. staff using radio altimeter equipment, and the results show that the maximum altitude reached was 21,430 meters (70,310 feet). The global margin of error of the estimate of height was less than 0.2 percent at the 99-percent confidence level.

N-57864*

Royal Aircraft Establishment (Gt. Brit.)
THE AERODYNAMIC EFFECTS OF ASPECT RATIO ON CONTROL SURFACE FLUTTER. H. Hall and E. W. Chapple. September 1957. 16p. diagrs.
RAE Tech. Note Structures 227. (Ask for N-57864*)

The report describes a series of low-speed flutter tests to obtain a direct measurement of the aerodynamic effects of aspect ratio on wing-aileron flutter. The tests were made on rigid wings fitted with full-span ailerons, the wings having root flexibilities in roll and pitch. Provision was made for massbalancing the ailerons. Some general conclusions are drawn concerning the effects of aspect ratio and massbalance on control surface flutter.

N-57934*

Royal Aircraft Establishment (Gt. Brit.)
METHODS FOR ESTIMATING DISTRIBUTIONS AND INTENSITIES OF SONIC BANGS. D. G. Randall. August 1957. 53p. diagrs. RAE Tech. Note Aero 2524. (Ask for N-57934*)

Methods recently developed for estimating distributions and intensities of sonic bangs are described. They are applied to several interesting flight maneuvers and the results discussed in detail. The effect on sonic bang distributions and intensities of refraction (caused by the temperature gradient existing in the actual atmosphere) is also considered.

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N-57935*

Royal Aircraft Establishment (Gt. Brit.)
ELASTIC MODULI AND TENSILE PROPERTIES OF TITANIUM-CARBON AND TITANIUM-ALUMINIUM-CARBON ALLOYS. H. Brooks, G. I. Lewis, and J. I. M. Forsyth. June 1957. 19p. diagrs., photos., tabs. RAE Tech.Note Met. 265. (Ask for N-57935*)

Tensile tests and dynamic measurements on alloys hot-rolled to 0.06-in. strip confirmed the beneficial effect of carbon additions on the tensile and shear moduli of titanium. A Ti-2.5 percent C alloy has E's of 19.4 and 15.7 x 10^6 lb/in.^{2} at 20° and 400° C but its strength and elongation are rather low. Surface cracking of high-carbon alloys during hot-rolling can be prevented by cladding with unalloyed titanium but carbon is considered unlikely to be used as a modulus-raising addition in commercial sheet alloys unless its effect on service temperature ductility can be lessened. Ternary alloys containing both carbon and aluminum, in amounts sufficient to give a significant improvement in modulus, are brittle.

N-57936*

Royal Aircraft Establishment (Gt. Brit.)
THE PROPERTIES AT TEMPERATURES UP TO 240° C OF DTD 546 CLAD ALUMINIUM ALLOY SHEET AT VARIOUS STRAINING RATES. M. S. Binning and A. B. Osborn. June 1957. 18p. diagrs., photo., tab. RAE Tech.Note Met. 264. (Ask for N-57936*)

Tensile tests at room temperature, 150°, 200°, and 240° C have been made on specimens cut from clad aluminum alloy sheet to DTD 546. The specimens were raised to test temperatures by resistance heating in approximately 10 seconds and then tested at various straining speeds such that the 0.1-percent proof stress was reached in times ranging from approximately 200 to 10 seconds. Over the range investigated, with increasing straining speed the values of the proof stress were found to increase by up to 27 percent at 240° C, 19 percent at 200° C, 7 percent at 150° C, and 0 percent at room temperature.

N-57937*

Royal Aircraft Establishment (Gt. Brit.)
NEAR FIELD JET NOISE. M. O. W. Wolfe. (Paper presented at Structures and Materials Panel, Advisory Group for Aeronautical Research and Development, Copenhagen, April 1957.) September 1957. 43p. diagrs., photo. RAE Tech.Note Structures 228. (Ask for N-57937*)

This paper deals with the subject of jet engine noise in relation to its effects on aircraft structures. Near field noise measurements are described for a range of jet shear velocities on two representative turbojet engines, one of them operating with an afterburner. Contours of equal noise pressure in the horizontal plane containing the axis of the jet are presented for a range of shear velocity for overall noise pressure and for noise pressures in 1/3 octave frequency bands in the noise spectra. In the velocity range 790 to 1800 feet per second, 400 cps is the dominant frequency. At most velocities the noise pressures at this frequency are about 10 decibels less than the corresponding overall noise pressures. The increase in noise level due to reheat is not as great as would have been predicted from a consideration of the noise level trends at much lower values of velocity without reheat.

N-57938*

Aeronautical Research Council (Gt. Brit.)
THE UNSTEADY LAMINAR BOUNDARY LAYER IN FORCED FLOW AGAINST AN ARBITRARILY SPINNING PLATE. N. Curle, National Physical Laboratory. August 1, 1957. 13p. diagr., tab. ARC 19,442; FM 2566. (Ask for N-57938*)

The general solution depends upon two nonlinear partial differential equations, which reduce, for slow spin, to one linear equation. An approximate solution of this equation is given for impulsively started spinning. The results agree satisfactorily with exact solutions, valid for small and large times. To the same order, heat transfer is not affected by the spin.

N-57939*

Aeronautical Research Council (Gt. Brit.)
THE TWO-DIMENSIONAL LAMINAR FLOW NEAR THE STAGNATION POINT OF A CYLINDER WHICH HAS AN ARBITRARY TRANSVERSE MOTION. J. Watson, National Physical Laboratory. June 19, 1957. 21p. diagr., tab. ARC 19,353; FM 2557. (Ask for N-57939*)

Exact solutions are obtained for flow toward an infinite plane wall moving arbitrarily in its own plane. For motion from rest expansions of the velocity for small and large times are given, linking up well for uniform motion. A more general but approximate Pohlhausen type of solution is indicated.

N-58034*

Ministry of Supply (Gt. Brit.). STUDY OF FAST FRACTURE OF CENTRALLY NOTCHED SHEET SPECIMENS WITH PARTICULAR REFERENCE TO ALUMINIUM ALLOYS L72 AND L73. A. A. Golestaneh. December 1957. 137p. diagrs., photos., tabs. MOS S & T Memo. 27/57. (Ask for N-58034*)

The report describes studies of fast fracture occurrence in centrally transversely slotted sheets of aluminum alloys loaded in tension both statically and repeatedly. The alloys investigated were of aluminum, 4 percent copper type in the solution treated and precipitation hardened conditions, designated British Standard L72 and L73 respectively, and clad with pure aluminum. Specimen sizes ranged from 4 inches square to 48 inches square and thickness from 22 S.W.G. to 12 S.W.G.

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N-58036, pt.1*

Royal Aircraft Establishment (Gt. Brit.)
MEASUREMENTS OF THE EFFECT OF SURFACE COOLING ON BOUNDARY LAYER TRANSITION ON A 15° CONE. PART I - TESTS AT M = 2 AND 3 IN AN 8 IN. x 9 IN. WIND TUNNEL AT R.A.E./ BEDFORD. A. C. Browning, J. F. W. Crane, and R. J. Monaghan. September 1957. 41p. diagrs., photos., tab. RAE Tech.Note Aero 2527. (Ask for N-58036, pt.1*)

Tests on a steel cone of 15° included angle, cooled internally by the circulation of cold alcohol, gave the results that when the ratio (surface temperature ahead of transition)/(surface temperature for zero heat transfer) was reduced from 1.0 to 0.88, the transition Reynolds number at zero incidence was increased by a factor of about 1.8 for a local Mach number (M_1) of 1.86 and by a factor of 1.24-1.43 for $M_1 = 2.81$. Simultaneous records of transition position on the top and bottom generators of the cone were obtained in all cases, using the shadowgraph technique. When the cone was set at an incidence of 2°, transition on the windward generator moved aft with cooling at about the same rate as was found in the zero incidence tests (at each Mach number).

CN-58037*

Royal Aircraft Establishment (Gt. Brit.)
BIBLIOGRAPHY OF SUBJECTS RELATING TO THE ZINC-SILVER OXIDE CELL. M. E. Bedwell. June 1957. 50p. tabs. RAE Chem. 511. (Ask for CN-58037*)

The literature on the following topics has been surveyed from 1900 to 1956: the silver oxide-zinc alkaline primary cell; the solubility of silver monoxide and argentic oxide in water and in alkaline solutions; the polarization of the silver electrode; the potential of couples, silver-silver monoxide, silver monoxide-argentic oxide, and argentic oxide-silver sesquioxide; the preparation, general properties and magneto-chemistry of the oxides of silver, and corresponding complexes. A critical discussion of the findings of previous authors has been given, including suggestions for future work.

N-58038*

Royal Aircraft Establishment (Gt. Brit.)
THE MECHANICAL PROPERTIES OF NIMONIC 80, 90, AND 100 SHEET AT ROOM AND ELEVATED TEMPERATURES. D. C. Hayward. June 1957. 19p. diagrs., tabs. RAE Tech.Note Met. 266. (Ask for N-58038*)

Properties were determined in tension and compression for fully heat-treated Nimonic 80, 90, and 100 sheet at room temperature and in tension only at 200°, 400°, and 600° C. The effect of exposure to 600° C for 1000 hrs was examined. On annealed material at room temperature longitudinal and transverse minimum radius bend tests were made and on tensile specimens local and general elongations measured. In general, strength and stiffness were reduced slightly with rise in testing temperature throughout the range investigated; transverse values, determined at room temperature only, corresponded closely with values from longitudinal tests. Room temperature bend tests produced close bends without visible cracks except for Nimonic 100 which cracked slightly. Tensile strength at 600° C was slightly increased by soaking at this temperature for 1000 hrs.

CN-58039*

Royal Aircraft Establishment (Gt. Brit.)
CREEP AND RECOVERY OF SYNTHETIC YARNS AND FABRICS AT ROOM TEMPERATURE.
A. Baker, M. Keene, and J. E. Swallow. September 1957. 21p. diagrs., tabs. RAE Tech.Note Chem. 1315. (Ask for CN-58039*)

The creep and recovery of nylon, Terylene, and Fortisan have been measured at room temperature over a range of stress levels, preparatory to studying creep at elevated temperatures in relation to kinetic heating and heat setting. The present results are discussed in terms of viscoelastic hypotheses.

N-58041*

Royal Aircraft Establishment (Gt. Brit.)
MECHANICAL PROPERTIES OF MILD STEELS EN2C AND S84 OVER THE TEMPERATURE RANGE 800 TO 1200° C. M. S. Binning and B. F. Billing. July 1957. 27p. diagrs., photo., tabs. RAE Tech. Note Met. 267. (Ask for N-58041*)

Tensile tests have been made on mild steel EN2C at 800°, 900°, 1000°, and 1100° C at two rates of straining such that the 0.2 percent proof stress was reached in nominal times of 15 and 35 seconds, and tangent modulus values were derived from the stress/strain curves. A few tests were made at 1000° C on a similar material, S84, in two thicknesses, and where tests were made under the same conditions little difference was indicated in proof stress or tangent modulus between EN2C and S84. Heating was by resistance methods, and strain readings recorded photographically. Simple tests of degree of scaling after 2 minutes at 800°, 1000°, and 1200° C were made on material to EN2C. Creep tests at 1000° and 1200° C were made on EN2C, where permanent set after 2 minutes at load was measured, and curves of stress versus permanent set obtained, over a range of approximately 1-10 percent permanent set.

CN-58042*

Royal Aircraft Establishment (Gt. Brit.)
A SIMPLIFIED CODING SYSTEM FOR DEUCE.
K. N. Dodd. September 1957. 8p. RAE Tech. Note MS 39. (Ask for CN-58042*)

This note describes a system which enables programs for DEUCE to be coded in a simplified form.

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CN-58043*

Royal Aircraft Establishment (Gt. Brit.)
THE MATHEMATICAL THEORY UNDERLYING AN ASTRONOMICAL METHOD OF CALIBRATION OF GROUNDSPEED CAMERAS. W. J. Ferguson, Orfordness Research Station. June 1957. 58p. diagrs. RAE Tech. Note TD 22. (Ask for CN-58043*)

The mathematical theory of a method of camera calibration is described. The note includes a brief account of the astronomy required to develop the method. A further note will give practical and computational details of the method.

N-58481*

Aeronautical Research Council (Gt. Brit.)
RECORDS OF STATIC PRESSURE TESTS ON PRESSURE CABINS. P. B. Hovell and A. R. Butler. 1958. 4p. tab. ARC CP 376. (Ask for N-58481*)

Results of static pressure tests on 20 fuselages are given. The information is primarily for record and further use as required. Brief details of the locations of premature failures are given, and general conclusions are drawn to account for the difference in the results obtained for fighter and transport aircraft.

N-58482*

Aeronautical Research Council (Gt. Brit.)
CALCULATED VELOCITY DISTRIBUTIONS AND FORCE DERIVATIVES FOR A SERIES OF HIGH-SPEED AEROFOILS. C. S. Sinnott, National Physical Laboratory. 1957. 31p. diagrs., tabs. ARC R & M 3045; ARC 18,098. (Ask for N-58482*)

The Polygon method of Woods (CP 115) is used to calculate the velocity distribution over a number of two-dimensional airfoils at low angle of attack, subcritical flows only being considered. Lift slopes and aerodynamic centers at zero lift are also calculated. Some comparisons with experimental results are made, and these show good agreement at zero angle of attack.

N-58520*

Royal Aircraft Establishment (Gt. Brit.)
CONCEPT OF COMPLEX STIFFNESS APPLIED TO PROBLEMS OF OSCILLATIONS WITH VISCOUS AND HYSTERETIC DAMPING. S. Neumark. September 1957. 45p. diagrs. RAE Aero 2592. (Ask for N-58520*)

The concept of complex stiffness in problems of oscillations with viscous or structural (hysteretic) damping is often used in a wrong way, leading to erroneous solutions. It is shown in the paper that correct expressions for complex stiffness are different in the cases of forced and free oscillations. All fundamental cases for a single degree of freedom are critically reexamined and compared, and fallacious solutions eliminated. The law of hysteretic damping being only known for a simple harmonic oscillation, all problems involving decaying oscillations, or more than one oscillatory mode, can only be treated tentatively at present, until the general law is found. This requires further experimental work.

N-58521*

Royal Aircraft Establishment (Gt. Brit.)
TABLES OF AERODYNAMIC FLUTTER DERIVATIVES FOR THIN WINGS AND CONTROL SURFACES IN TWO DIMENSIONAL SUPERSONIC FLOW. I. T. Minhinnick and D. L. Woodcock. October 1957. 44p. diagrs., tabs. RAE Structures 228. (Ask for N-58521*)

This report gives tables of the two-dimensional supersonic flutter derivatives for infinitesimally thin airfoils. Most of the values given are based on the published work of several authors but some have been specially calculated for this report. Only the derivatives giving the forces on wings and control surfaces due to wing motion are tabulated but it is shown how the remaining derivatives can be very easily obtained from those tabulated. The values tabulated are for control surface/wing chord ratios of 0(0.1) 0.6, 1.0; for Mach numbers (M) given by $\lambda(= 1/M) = 0.3(0.1)\ 0.8$, and for at least 11 values of the frequency parameter between 0 and 1.5.

N-58528*

Royal Aircraft Establishment (Gt. Brit.)
A ROUTINE METHOD OF APPROXIMATING TO THE TRANSIENT RESPONSE OF A LINEAR SYSTEM FROM ITS FREQUENCY RESPONSE. E. Rushton. August 1957. 55p. diagrs., tabs. RAE Tech. Note IAP 1070. (Ask for N-58528*)

An approximate method, based on a Fourier series, is described for deriving the transient response from the graphical frequency response or the transfer function of a stable, linear system with any input. For accuracy a fairly large number of terms in the Fourier series may be required. To reduce the computation to a minimum, extensive tables are provided throughout the calculation. These cope with a series containing up to 40 harmonics. In addition, algebraic manipulation is presented in systematic form.

CN-58530*

Royal Aircraft Establishment (Gt. Brit.)
THE PROBABILITY DISTRIBUTION OF THE FILTERED OUTPUT OF A MULTIPLIER. D. C. M. Leslie. September 1957. 48p. diagrs. RAE Tech. Note GW 470. (Ask for CN-58530*)

This topic has already received a good deal of formal study, but the actual probability distribution has only been found for one special case of limited physical interest, and no numerical values have ever been published. In this note, the theory has been developed with the specific aim of overcoming this deficiency: As an example, the input to the multiplier is supposed to be filtered through a single tuned circuit and its output through a simple R-C circuit. It is

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not possible to evaluate the probability distribution of the output of this R-C circuit exactly, but two different approximations have been developed which are very accurate when the band-width ratio is large. Numerical examples are given. It is shown that as this ratio tends to infinity, the distribution of the final output tends to normality for all (physically reasonable) forms of pre- and post-multiplier filter.

CN-58531*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF THE EARTH'S OBLATENESS ON THE ORBIT OF A NEAR SATELLITE. D. G. King-Hele and D. M. C. Gilmore. October 1957. 67p. diagrs. RAE Tech. Note GW 475.
(Ask for CN-58531*)

The equations of motion of a satellite in an orbit over an oblate earth in vacuo are solved analytically by a perturbation method. The solution applies primarily to orbits for which the maximum and minimum altitudes of the satellite do not differ by more than 300 n. miles; the accuracy of the solution for radial distance should then be about 0.001 percent, and the error in angular travel about 0.001 percent per revolution. The four main effects of the earth's oblateness on the motion of the satellite are discussed.

N-58533*

Aeronautical Research Council (Gt. Brit.)
THE DESIGN OF LONGITUDINALLY STIFFENED PANELS. H. L. Cox and G. Angell, National Physical Laboratory. January 19, 1955. 13p. diagrs. ARC 17,315; Strut 1766. (Ask for N-58533*)

The purpose of this investigation is to present the conditions governing the buckling of panels stiffened only longitudinally in a form suitable for design. Diagrams are presented for a long, flat, rectangular panel with its edges simply supported and stiffened by one stringer midway between its edges. The effect of two or more stringers is briefly reviewed. It is concluded that it is always advantageous to use at least one stringer and the weight thereby saved may amount to 30 percent. The form of the single stringer required is no more than a plain rectangular section. With two stringers the stringer section required is more elaborate, and a high stiffening ratio with three or more stringers needs so efficient a stringer section that the use of more than two stringers is seldom likely to be economical.

N-58534*

Royal Aircraft Establishment (Gt. Brit.)
A TITANIUM VANADIUM ALLOY. A. R. G. Brown and P. M. R. Gates. July 1957. 13p. diagrs., photos., tabs. RAE Tech. Note Met 259.
(Ask for N-58534*)

An alloy of 56.8 percent Ti, 37.4 percent V, 5.4 percent Al, and 0.67 percent C has been made from pure materials, fabricated and tested at room temperature and 400° C. The ultimate tensile strength of the alloy is 67.2 tons/sq in. at room temperature and 60.5 tons/sq in. at 400° C. The Young's modulus of the alloy is 15.7×10^6 psi and 14.4×10^6 psi at room temperature and 400° C, respectively. The room temperature density was 4.94 g/cm^3. The properties of pure vanadium cold-worked (90 percent) sheet were also investigated. The ultimate strength of the sheet was 71.5 tons/sq in. at 20° C and 61.2 tons/sq in. at 400° C, and the Young's modulus at these temperatures 17.6×10^6 psi and 17.1×10^6 psi, respectively.

N-58536*

Aeronautical Research Council (Gt. Brit.)
AN APPROXIMATE METHOD OF CALCULATING THE LAMINAR BOUNDARY LAYER IN TWO-DIMENSIONAL INCOMPRESSIBLE FLOW. M. R. Head, University of Cambridge. March 26, 1957. 87p. diagrs. ARC 19,154; FM 2523.
(Ask for N-58536*)

In the present approximate method the use of a doubly infinite family of boundary-layer velocity profiles enables the momentum and energy integral equations of the boundary layer to be satisfied exactly, together with the first boundary condition at the surface. The principal characteristics of the velocity profiles used have been calculated, and are presented graphically in a series of charts which enable calculations to be carried out with a minimum of labor. Several examples of boundary-layer flow have been worked out in detail by the use of the method, and agreement with known exact solutions is in most cases extremely satisfactory.

N-58537*

Aeronautical Research Council (Gt. Brit.)
THE WAVE DRAG AT ZERO LIFT OF SLENDER DELTA WINGS AND SIMILAR CONFIGURATIONS. M. J. Lighthill. May 20, 1955. 15p. diagrs. ARC 17,646; FM 2254. (Ask for N-58537*)

This paper is concerned with bodies which terminate in a straight trailing edge at right angles to the stream, with a small but finite trailing-edge angle (which may vary along with it). This class of bodies includes delta wings. Bodies terminating in two such trailing edges at right angles to one another, or in a cylindrical section with two or four fins attached, are also treated.

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N-58540*

Royal Aircraft Establishment (Gt. Brit.)
STATIC RESPONSE OF A HEMISPHERICAL-HEADED YAWMETER AT HIGH SUBSONIC AND TRANSONIC SPEEDS. P. G. Hutton. August 1957. 24p. diagrs. RAE Tech. Note Aero 2525. (Ask for N-58540*)

Details are given of the static calibration of a hemispherical-headed differential pressure yawmeter, in the Mach number range from 0.6 to 1.2; the instrument has a central pitot pressure hole and two pairs of holes in perpendicular planes for flow direction measurement. The results show that the sensitivity to yaw (for angles up to 8°) as determined from pressure differences between opposing holes, varies smoothly with Mach number at transonic speeds; the sensitivity is little affected by a crossflow normal to the line joining the holes.

N-58542*

Royal Aircraft Establishment (Gt. Brit.)
DESIGN OF WARPED SLENDER WINGS WITH THE ATTACHMENT LINE ALONG THE LEADING EDGE. J. Weber. September 1957. 83p. diagrs., tabs. RAE Tech. Note Aero 2530. (Ask for N-58542*)

Wings with unswept trailing edge but otherwise arbitrary plan form which have, at the design lift coefficient, zero load along the leading edge and a near planar vortex sheet from the trailing edge are considered. The wing can have an arbitrary chordwise curvature on which a spanwise curvature is superposed so that in any spanwise section the wing is straight over the inner part of the wing and curved over the portion near to the leading edges; the position of this change can vary arbitrarily in the chordwise direction. Formulas and working charts are given for determining the local load coefficient (and with it the streamwise velocity component), the spanwise velocity component, the total lift coefficient, and the total drag. Numerical examples for the gothic plan form are given to illustrate some of the effects of the various parameters on the load distribution, the section shapes, and the drag.

N-58546*

Aeronautical Research Council (Gt. Brit.)
A PRELIMINARY NOTE ON A WIND-TUNNEL INVESTIGATION OF TRAILING-EDGE FLAP BLOWING ON A 5% THICK 60° DELTA WING. J. Williams and A. J. Alexander. March 1957. 12p. diagrs. ARC 19,240; Perf. 1558. (Ask for N-58546*)

Balance measurements, pressure-plotting, and surface tuft studies have been completed in the NPL 13-ft by 9-ft tunnel on a half-model of a 60° delta wing, 5-percent thick, with blowing over a trailing-edge flap. The tests were planned to investigate the effectiveness of T. E. flap blowing in the presence of the type of flow separations encountered at the leading edge of a thin highly swept wing, and with a hinge-line sweep considerably less than the L. E. sweep.

N-58548*

Aeronautical Research Council (Gt. Brit.)
NOTE ON A THEOREM OF LINEARISED SUPERSONIC THEORY RELATING TO THE WAVE DRAG OF CONSTANT SECTION WINGS WITH STREAMWISE TIPS AT ZERO LIFT. A. D. Young, Queen Mary College. January 29, 1955. 7p. diagrs. ARC 17,356; FM 2184. (Ask for N-58548*)

Detailed calculations have in a number of cases demonstrated the equivalence between the wave drags of yawed or swept wings of constant section and zero lift and the corresponding values in two-dimensional flow. These results and others are shown to follow readily from a general theorem for which a simple proof is given.

MISCELLANEOUS

N-41416, 1957

FORTY-THIRD ANNUAL REPORT OF THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS. ADMINISTRATIVE REPORTS WITHOUT TECHNICAL REPORTS. 1957. x, 80p. NACA.
(Ask for N-41416, 1957)

N-54139X

Advisory Group for Aeronautical Research and Development. THE INFLUENCE OF DRAG CHARACTERISTICS ON THE CHOICE OF LANDING APPROACH SPEEDS. D. Lean and R. Eaton. (Presented at 10th meeting of Flight Test Techniques Panel, London, May 20-24, 1957.) May 1957. 24p. diagrs., tabs. AGARD Report 122.
(Ask for N-54139X)

A study has been made of the lift-drag characteristics of 19 jet aircraft which have minimum comfortable approach airspeeds that are fairly well established. On about half these aircraft, drag effects, which determine speed stability, were stated to limit the approach airspeeds, though there was naturally some lack of unanimity as to the level of the effect which could be classed as tolerable. Limiting values of speed stability are proposed for the three types of landing approach used for carrier, airfield, and instrument landings. The speeds corresponding to these stability levels are in fair agreement with those actually used, even for those aircraft whose approach speeds were not primarily limited by drag effects. It is considered that drag effects must be taken into account in estimating approach airspeeds, and that this process materially improves the prediction of approach speeds for the latest types of aircraft. Further data should be collected and analyzed in order to confirm or modify the form or level of the proposed limits.

MISCELLANEOUS

N-55127X

Advisory Group for Aeronautical Research and Development. TUBE WIND TUNNEL - A SPECIAL TYPE OF BLOWDOWN TUNNEL. H. Ludwieg. (Presented at 11th meeting of Wind Tunnel and Model Testing Panel, Scheveningen, July 8-12, 1957.) July 1957. 11p. diagrs., photo. AGARD Report 143. (Ask for N-55127X)

A short description of the tube wind tunnel is given. This tunnel is a special type of blowdown tunnel, the air container of which consists of a long cylindrical tube. The air in the tube is preaccelerated by an expansion wave before entering the nozzle of the tube tunnel. In this way a good constancy of stagnation pressure and of stagnation temperature is reached without the use of any control valve and heat accumulator. The influence of the wall friction in the tube on the stagnation pressure and stagnation temperature in the test section is discussed. Experiments carried out in order to investigate this effect are reported. They show good agreement with the theoretical results. Means to reduce or to compensate the influence of the friction at the tube wall are dealt with. Possibilities for application of the tube tunnel are mentioned.

CN-58000

Advisory Group for Aeronautical Research and Development. A CLASSIFICATION SYSTEM FOR UNPREPARED LANDING AREAS. David P. Samson, Jr., United States Air Force. (Presented at 10th meeting of Flight Test Techniques Panel, London, May 20-24, 1957.) May 1957. 11p. tabs. AGARD Report 129. (Ask for CN-58000)

Describes a method of classifying any unprepared landing area under the main headings of (1) landing area, (2) terrain configuration, (3) surface roughness, and (4) soil description and bearing capacity. This classification, with subdivisions, results in a numerical "terrain designator" and should assist when stating design requirements for new aircraft.

UNPUBLISHED PAPERS

N-57933*

Applied Science Research Laboratory, University of Cincinnati. LOW-TEMPERATURE, VAPOR-PHASE OXIDATION OF FUEL-RICH HYDROCARBON MIXTURES - EFFECTS OF ADDITIVES. William House. (Final report.) September 1, 1957. 16p. diagr., tabs. Applied Science Research Lab., U. of Cincinnati. (Ask for N-57933*)

The effects of propionaldehyde and t-butylhydroperoxide additives on the vapor-phase oxidation of methylcyclohexane were studied at various temperatures under conditions of 0.1 the stoichiometric amount of oxygen at a contact time of 8 seconds. The effects of these additives on the products and on the negative temperature coefficient and the oxidation of methylcyclohexane were also noted. Also, the effect of propionaldehyde on the rate of decomposition of t-butylhydroperoxide was studied.

N-58301*

Georgia Institute of Technology Engineering Experiment Station. THE EQUATIONS FOR THE EQUILIBRIUM BLADE THRUST LOADING OF A LIFTING ROTOR HAVING ARBITRARY BLADE GEOMETRY AND INDUCED VELOCITY DISTRIBUTION, INCLUDING A FIRST ORDER CORRECTION FOR LOCAL BLADE ELEMENT MACH NUMBER. Walter Castles, Jr., and Howard L. Durham, Jr. September 1957. 43p. diagrs., tabs. Georgia Inst. of Tech. Engineering Experiment Station. (Ask for N-58301*)

General equations are derived which include a first-order correction for compressibility, for the integrated blade thrust, thrust moment, and rotor rolling and pitching moments for blades of arbitrary shape operating in an arbitrary induced-flow field. Polynominals were fitted to curves representing harmonic coefficients for type III induced-flow distribution. Relative effects of the nonlinear induced-flow terms and compressibility correction terms of the integrated thrust equation for a particular rotor under specified operating conditions are investigated.

N-58377*

Polytechnic Institute of Brooklyn. FURTHER CREEP BUCKLING TESTS WITH CYLINDERS SUBJECTED TO FLEXURE. Francis W. French and Burton Erickson. July 1957. 33p. diagrs., photos., tabs. Polytechnic Inst. of Brooklyn. PIBAL Report 412. (Ask for N-58377*)

Twenty-nine circular cylindrical shells manufactured of 5052-0 aluminum alloy were tested in pure bending at a temperature of 500° F. Ten of these were unreinforced, nine had longitudinal, and ten longitudinal and circumferential reinforcing elements. All the specimens failed in creep buckling. The results of the experiments are presented in tables and diagrams. A few theoretical considerations are given in three appendices.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification February 26, 1958.

NACA RM SA50A05, by Graham

NACA RM A51E01

LIFT, DRAG, AND PITCHING MOMENT OF LOW-ASPECT-RATIO WINGS AT SUBSONIC AND SUPERSONIC SPEEDS - TWISTED AND CAMBERED TRIANGULAR WING OF ASPECT RATIO 2 WITH NACA 0003-63 THICKNESS DISTRIBUTION. Charles F. Hall and John C. Heitmeyer. June 12, 1951. 24p. diagrs., photo., tab. (NACA RM A51E01)

This report presents the results of an investigation to ascertain the lift, drag, and pitching moment of a wing-body combination having a triangular wing of aspect ratio 2 with NACA 0003-63 thickness distribution in streamwise planes and twisted and cambered for a nearly elliptical span load distribution. Results are shown for Mach numbers from 0.60 to 0.90 and from 1.30 to 1.70 at Reynolds numbers of 3.0 million and 7.5 million.

NACA RM A52B08

LIFT, DRAG, AND PITCHING MOMENT OF LOW-ASPECT-RATIO WINGS AT SUBSONIC AND SUPERSONIC SPEEDS - TWISTED AND CAMBERED TRIANGULAR WING OF ASPECT RATIO 2 WITH NACA 0005-63 THICKNESS DISTRIBUTION. John C. Heitmeyer and Robert B. Petersen. April 1952. 20p. diagrs., tabs. (NACA RM A52B08)

This report presents the results of an investigation to ascertain the lift, drag, and pitching moment of a wing-body combination having a triangular wing of aspect ratio 2 with NACA 0005-63 thickness distribution in streamwise planes and twisted and cambered for a nearly elliptical span load distribution. Results are shown for Mach numbers from 0.60 to 0.90 and from 1.30 to 1.90 at Reynolds numbers of 3.0, 4.9, and 7.5 million.

NACA RM A53B11

A THEORETICAL STUDY OF THE EFFECT OF CONTROL-DEFLECTION AND CONTROL-RATE LIMITATIONS ON THE NORMAL ACCELERATION AND ROLL RESPONSE OF A SUPERSONIC INTERCEPTOR. Howard F. Matthews and Stanley F. Schmidt. April 1953. 28p. photos., diagrs., tabs. (NACA RM A53B11)

A theoretical study of the effects of limiting the control motion of a representative supersonic interceptor showed that for the particular conditions chosen, the normal-acceleration and roll response times decreased at a diminishing rate with increases in the limited rate of control motion, and that little advantage is gained in exceeding a rate of about 200° per second. A method of simulating a first-order servo with control-deflection limits is given in an appendix.

NACA RM A53B16

COMPARISON OF THE AERODYNAMIC CHARACTERISTICS AT TRANSONIC SPEEDS OF A PLANE WING AND A CAMBERED AND TWISTED WING, BOTH HAVING 45° OF SWEEPBACK AND AN ASPECT RATIO OF 6. George H. Holdaway. May 1953. 49p. diagrs., photos. (NACA RM A53B16)

A transonic investigation was made by the free-fall technique of the lift, drag, and pitching moment of a plane wing and a cambered and twisted wing, each having an aspect ratio 6, taper ratio of 0.5, and swept back 45°. The wings were mounted on similar fuselage-tail combinations of a fineness ratio of 12.4 with tail surfaces also swept back 45°. Aerodynamic coefficients were determined for the two wings and for the complete model over a Mach number range of 0.86 to 1.08, Reynolds numbers of 3,000,000 to 5,000,000, and angles of attack of approximately 0° to 12°. Wing buffet boundaries were also determined.

NACA RM A54B15

OPTIMUM LIFTING BODIES AT HIGH SUPERSONIC AIRSPEEDS. Meyer M. Resnikoff. May 1954. 22p. diagrs., photo. (NACA RM A54B15)

Optimum lifting bodies at high supersonic airspeeds are determined with the aid of Newtonian impact theory. Simple wedges are found to fall in the category of such bodies. Results of tests at a Mach number of 5 of several wedges and corresponding bodies of revolution having fineness ratios from 3 to 7 show that the wedges have up to 100-percent-higher lift-drag ratios.

UNAVAILABLE; contains proprietary or obsolete information.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM A55D11

INVESTIGATION OF THE EFFECTS OF AN AIRFOIL SECTION MODIFICATION ON THE AERODYNAMIC CHARACTERISTICS AT SUBSONIC AND SUPERSONIC SPEEDS OF A THIN SWEPT WING OF ASPECT RATIO 3 IN COMBINATION WITH A BODY. David Graham and William T. Evans. June 1955. 46p. diagrs., tabs. (NACA RM A55D11)

The basic wing had a taper ratio of 0.4, leading-edge sweep of 45°, and an NACA 64A006 section normal to the quarter-chord line. The modification consisted of greatly increased leading-edge radius and slight forward camber. A large-scale wind-tunnel model was tested at Mach numbers from 0.06 to 0.31 and Reynolds numbers from 4.4×10^6 to 21×10^6, and a small-scale wind-tunnel model was tested at Mach numbers from 0.6 to 1.9 and Reynolds numbers from 2.9×10^6 to 5.7×10^6. Lift, drag, and pitching moment were measured.

NACA RM A56B15

EFFECT OF MACH NUMBER ON BOUNDARY-LAYER TRANSITION IN THE PRESENCE OF PRESSURE RISE AND SURFACE ROUGHNESS ON AN OGIVE-CYLINDER BODY WITH COLD WALL CONDITIONS. Robert J. Carros. April 1956. 30p. diagrs., photos. (NACA RM A56B15)

Boundary-layer transition Reynolds number was measured in free flight on a high-fineness-ratio fin-stabilized ogive-cylinder body at Mach numbers from 1.8 to 7.4 at a constant length Reynolds number of 13.8 million. The wall to free-stream temperature ratio was 1.0 below $M = 4.5$ and was 1.8 at higher Mach numbers. The effects of roughness and pressure rise (associated with angle of attack) were investigated.

NACA RM A56B17

DATA FROM LARGE-SCALE LOW-SPEED TESTS OF AIRPLANE CONFIGURATIONS WITH A THIN 45° SWEPT WING INCORPORATING SEVERAL LEADING-EDGE CONTOUR MODIFICATIONS. William T. Evans. May 1956. 110p. diagrs., photo., tabs. (NACA RM A56B17)

The basic wing of aspect ratio 3, taper ratio 0.4, and 45° of sweep, had an NACA 64A006 section. The modifications consisted of increases of leading-edge radius, both with and without camber and spanwise section variation. The wing and body were tested with and without vertical and horizontal tails. The basic wing was also tested alone. Fences, chord extensions, split flaps, and ailerons were tested. Six-component force data were obtained at Reynolds numbers from 4.4×10^6 to 21×10^6.

NACA RM A56B21

LIGHT DIFFUSION THROUGH HIGH-SPEED TURBULENT BOUNDARY LAYERS. Howard A. Stine and Warren Winovich. May 1956. 46p. diagrs., photos., tabs. (NACA RM A56B21)

Optical transmission characteristics of turbulent boundary layers were measured photometrically with unpolarized white light for ranges of Mach number from 0.4 to 2.5, free-stream density from 0.12 to 0.93 sea-level density atmospheres, and boundary-layer thickness from 1-1/2 to 4-1/2 inches. The deterioration of resolving power of optical equipment due to scattering is related to the absolute change in mean density integrated along the radiation propagation path. Analysis indicates that photometric surveys of a scattered light field yield average values of the integral scale and intensity of density fluctuations.

NACA RM A56B27

INVESTIGATION OF THE USE OF AREA SUCTION TO INCREASE THE EFFECTIVENESS OF TRAILING-EDGE FLAPS OF VARIOUS SPANS ON A WING OF 45° SWEEPBACK AND ASPECT RATIO 6. Roy N. Griffin, Jr., and David H. Hickey. June 1956. 64p. diagrs., photo., tabs. (NACA RM A56B27)

Tests were made of area-suction inboard trailing-edge flaps of various deflection and span. The flaps of 0.50 span and 46° deflection attained the flap lift increment predicted by inviscid-flow theory. The flaps of longer span or greater deflection gave lift increments somewhat lower than theoretical. When the area-suction flaps were deflected differentially for lateral control they produced about 80 percent of theoretical rolling-moment coefficient and appear feasible as a means of roll control.

NACA RM E9B03

EXPERIMENTAL PRESSURE DISTRIBUTION ON AN ASYMMETRICAL NONCONICAL BODY AT MACH NUMBER 1.90. DeMarquis D. Wyatt. February 24, 1949. 58p. diagrs., photos., tabs. (NACA RM E9B03)

An investigation of pressure distribution on an asymmetrical nonconical body was conducted at Mach number 1.90 over wide range of angles of attack and yaw. Pressure distributions conformed to anticipated trends. Boundary-layer separation apparently occurred from upper surface at angles of attack above 24° and from lower surface at -15°. No separation from sides of body was evident at yaw angles up to 12°.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM E52B08

COMPONENT AND OVER-ALL PERFORMANCE EVALUATION OF AN AXIAL-FLOW TURBOJET ENGINE OVER A RANGE OF ENGINE-INLET REYNOLDS NUMBERS. Curtis L. Walker, S. C. Huntley, and W. M. Braithwaite. July 1952. 42p. diagrs., tabs. (NACA RM E52B08)

The performance of an axial-flow turbojet engine was investigated over a range of engine-inlet Reynolds number indices which includes a wide variation in altitude and flight Mach number. Component and overall performance variables are presented as functions of corrected engine speed and Reynolds number index. Combustion efficiency is presented as a function of combustor-inlet conditions. Reduced Reynolds number had the net effect of increasing corrected fuel flow but had no apparent effect on the corrected jet-thrust parameter. A method is presented whereby conventional performance parameters such as net thrust and specific fuel consumption may be obtained for any flight condition within the range of Reynolds numbers investigated.

NACA RM E52B19

TRANSONIC FREE-FLIGHT DRAG RESULTS OF FULL-SCALE MODELS OF 16-INCH-DIAMETER RAM-JET ENGINES. Wesley E. Messing and Loren W. Acker. April 1952. 17p. diagrs. (NACA RM E52B19)

A free-flight investigation on two full-scale model 16-inch-diameter ram-jet engines was conducted over a Mach number range of 0.6 to 1.43 and an altitude range of 35,000 feet to sea level in order to evaluate the component drag coefficients. At a Mach number of 1.15, the model with the larger restrictor plug encountered the highest total drag coefficient, 0.63. The external drag coefficient increased from a subsonic value of 0.105 to a maximum value of 0.215 at a Mach number of 1.30 as compared with an increase of from 1.105 at a Mach number of 0.90 to 0.17 at a Mach number of 1.30 for the other model.

NACA RM E52B22

PERFORMANCE OF AN IMPULSE-TYPE SUPERSONIC COMPRESSOR WITH STATORS. John F. Klapproth, Guy N. Ullman, and Edward R. Tysl. April 1952. 22p. diagrs., photo. (NACA RM E52B22)

An impulse-type supersonic compressor rotor with stators was tested in Freon-12 over a range of equivalent tip speeds and weight flows. The performance characteristics with a shock stabilized in either the stator or both rotor and stator were investigated. Pressure recoveries across the stators when diffusing from supersonic to subsonic Mach numbers were obtained.

NACA RM E52B25

ALTITUDE PERFORMANCE INVESTIGATION OF TWO FLAME-HOLDER AND FUEL-SYSTEM CONFIGURATIONS IN SHORT AFTERBURNER. S. C. Huntley and H. D. Wilsted. May 1952. 41p. diagrs., photos., tab. (NACA RM E52B25)

The performance of two dissimilar flame-holder and fuel-system configurations was evaluated in a short afterburner. The engine was operated at rated speed over a range of altitudes from 10,000 to 45,000 feet and flight Mach numbers from 0.4 to 1.0 and a range of afterburner fuel-air ratios. The altitude operating limits and the altitude performance of the V-gutter flame holder were found superior to those of the H-gutter configuration. Spontaneous ignition was obtained with the V-gutter configuration but the H-gutter configuration required the use of a torch ignition.

NACA RM E53B02

ALTITUDE STARTING CHARACTERISTICS OF AN AFTERBURNER WITH AUTOIGNITION AND HOT-STREAK IGNITION. P. E. Renas, R. W. Harvey, Sr., and E. T. Jansen. April 1953. 25p. diagrs., photos., tab. (NACA RM E53B02)

An investigation was conducted in an altitude test chamber at the NACA Lewis Laboratory to determine the altitude starting characteristics of an afterburner with autoignition and with hot-streak ignition. Transient afterburner ignition data were obtained over a range of altitudes from 30,000 to 50,000 feet at a flight Mach number of 0.60. Afterburner ignition with a torch igniter located axially at approximately the midpoint of the combustion chamber was possible over the entire altitude range, but ignition with a torch igniter located in the transition section 1-5/8 inches upstream of the turbine stators proved unsatisfactory at an altitude of 50,000 feet due to the inability to obtain flame through the turbine. Increasing the afterburner-inlet total pressure at a constant afterburner fuel-air ratio decreased the afterburner ignition time. Hot-streak ignition was possible within 2 seconds after the time required to obtain the preset, normal afterburner fuel pressure, whereas autoignition required from 4 to 7 seconds for the range of altitudes investigated. Following ignition there was a period of oscillatory operation existing in the engine afterburner before steady-state operation was attained. The time required for steady-state stable operation decreased as afterburner inlet total pressure increased. The duration of oscillations also decreased with hot-streak ignition because the fuel-air mixture was ignited before a large volume of combustible mixture was accumulated in the afterburner.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM E53B09

DESIGN PROCEDURE AND LIMITED TEST RESULTS FOR A HIGH SOLIDITY, 12-INCH TRANSONIC IMPELLER WITH AXIAL DISCHARGE. Linwood C. Wright and Karl Kovach. April 1953. 37p. photos., diagrs., tab. (NACA RM E53B09)

An approximate inverse design procedure based on the assumption of axisymmetric, nonviscous flow is presented along with limited experimental data obtained from a high solidity, 12-inch transonic impeller. The design procedure was utilized for the design of a 12-inch 0.40 hub-tip ratio impeller with sweptback leading edges to operate at 1200 feet per second equivalent tip speed. Because of an outlet annulus restriction and a partial structural failure which occurred before alterations could be made, the design speed experimental performance was restricted to a pressure ratio of 2.164 at an equivalent weight flow of 26.47 pounds per second (33.71 lb/sec-sq ft) and an impeller adiabatic efficiency of 0.81 percent.

NACA RM E54A06

HIGH-ALTITUDE PERFORMANCE OF 9.5-INCH-DIAMETER TUBULAR EXPERIMENTAL COMBUSTOR WITH FUEL STAGING. Wilfred E. Scull. March 1954. 55p. diagrs., photos., tabs. (NACA RM E54A06)

An experimental 9.5-inch-diameter tubular combustor was developed; this combustor embodied adjacent fuel-rich and air-rich regions and axial staging of liquid fuel introduction. Axial staging of fuel introduction increased combustion efficiencies at high fuel-air ratios and high air-flow rates. At all combustor inlet pressures investigated, the experimental combustor operated with higher combustion efficiencies than a current-production-model tubular combustor of the same diameter. At combustor-inlet conditions simulating 85 percent rated speed operation of a 5.2-pressure-ratio reference engine at a flight Mach number of 0.6 and an altitude of 56,000 feet, the experimental combustor operated at fuel-air ratios from 0.0035 to 0.029 with a maximum combustion efficiency of 94 percent and a maximum combustor-outlet total temperature of 1925° F. Altitude flight performance in the reference engine at rated speed was estimated to result in combustion efficiencies of 97 percent or greater at altitudes up to 59,000 feet. Isothermal combustor total-pressure loss, which was somewhat greater than that of the production-model reference combustor, was approximately 7 percent of the combustor-inlet total pressure for a reference velocity of 100 feet per second. Individual combustor outlet total temperatures at most operating conditions were within ±200° F of the mean outlet total temperature.

NACA RM E54A29

PHOTOGRAPHIC STUDY OF ROTARY SCREAMING AND OTHER OSCILLATIONS IN A ROCKET ENGINE. Theodore Male, William R. Kerslake, and Adelbert O. Tischler. May 1954. 37p. diagrs., photos. (NACA RM E54A29)

Rocket combustion instabilities due to lateral and longitudinal oscillations were photographed through transparent plastic chambers by streak photography and high-speed frame photography. The streak photographs show longitudinal oscillations and attendant shock waves of approximately 1000 cycles per second; they also show strong lateral oscillations of 4000 to 6000 cycles per second as well as weak lateral oscillations of approximately 10,000 cycles per second. The 40,000 frame-per-second photographs show that some of the lateral oscillations are rotary, and the pressure measurements indicate that the disturbance was a rotary pressure wave. Qualitative heat-transfer measurements, based on plastic erosion rates, indicate that the rotary oscillation causes heat transfer approximately five or six times the heat transfer of normal combustion.

NACA RM E54B03

EFFECT OF NOZZLE SECONDARY FLOWS ON TURBINE PERFORMANCE AS INDICATED BY EXIT SURVEYS OF A ROTOR. Warren J. Whitney, Howard A. Buckner, Jr., and Daniel E. Monroe. April 1954. 11p. diagrs. (NACA RM E54B03)

Detailed circumferential and radial surveys of total pressure and total temperature were made downstream of the turbine rotor of a high-speed, high-specific-mass-flow turbine at design operating conditions. The results of these surveys, when plotted as efficiency contours over the survey range of approximately 1-1/4 nozzle passages, indicated that large circumferential-loss gradients existed downstream of the turbine rotor, effecting a variation in the local efficiency of 14 points. These losses were caused by disturbances originating in the nozzle and probably represent the effect of nozzle secondary-flow vortices and wakes carrying through the rotor. From the indications of the survey results, it was concluded that losses in the nozzle blades due to secondary-flow vortices and wakes, although normally small, can induce much greater losses in the turbine rotor and can cause an appreciable effect on the overall turbine performance.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM E54B09

PERFORMANCE CHARACTERISTICS OF SEVERAL SHORT ANNULAR DIFFUSERS FOR TURBOJET ENGINE AFTERBURNERS. William E. Mallett and James L. Harp, Jr. May 1954. 31p. diagrs., photo. (NACA RM E54B09)

Recent research has been directed toward the development of a short annular diffuser which would have low pressure loss and provide a uniform (flat) velocity profile at the diffuser exit. The performance characteristics reported herein were made in four short annular diffusers with different diffuser passage area variations and with various combinations of straightening vanes, vortex generators, splitters, and boundary-layer suction for flow control. Elimination of whirl (approximately 20° at the turbine discharge of the engine used for this investigation) provided the greatest single gain by reducing the tailpipe pressure loss 2.4 percent, although with the elimination of whirl the flow separated severely from the curved inner body. The variation of diffusion rate investigated did not significantly change the tailpipe pressure loss, although the diffuser exit velocity profile varied considerably. Splitters improved the generators and boundary-layer removal gave no improvement.

NACA RM E54B12

EFFECT OF JET-NOZZLE-EXPANSION RATIO ON DRAG OF PARABOLIC AFTERBODIES. Gerald W. Englert, Donald J. Vargo, and Robert W. Cubbison. April 1954. 26p. diagrs., photos. (NACA RM E54B12)

The interaction of the flow from one convergent and two convergent-divergent nozzles on parabolic afterbodies was studied at free-stream Mach numbers of 2.0, 1.6, and 0.6 over a range of jet pressure ratio. The influence of the jet on boattail and base drag was very pronounced. Study of the total external afterbody drag values at supersonic speeds indicated that over most of the high-pressure-ratio range, increasing the nozzle design expansion ratio increased the drag even though the boattail area was reduced. Increasing the pressure ratio tended to increase slightly the total-drag increment caused by angle-of-attack operation.

NACA RM E54B16

LOW-VELOCITY TURNING AS A MEANS OF MINIMIZING BOUNDARY-LAYER ACCUMULATIONS RESULTING FROM SECONDARY FLOWS WITHIN TURBINE STATORS. Warner L. Stewart and Robert Y. Wong. May 1954. 18p. diagrs., photo. (NACA RM E54B16)

A series of three single-passage nozzles, designed to turn the flow at different velocity levels but to identical outlet conditions, were investigated to determine whether secondary-flow accumulations of boundary-layer fluids within nozzles could be minimized by use of low-velocity turning. The results of the investigation indicated that this type of turning with subsequent acceleration is highly effective in minimizing secondary-flow accumulations at the corner where the section surface joins the end walls. As applied to turbine stators, gains in turbine performance may be expected, provided that the long blade surfaces required do not cause excessive wake losses and that three-dimensional effects on the boundary layer of the long blade do not appreciably increase the secondary-flow accumulations. It is to be noted that the effect of reduced secondary-flow accumulation on turbine performance to date has not been evaluated.

NACA RM E54B23

INVESTIGATION OF A TRANSLATING-CONE INLET AT MACH NUMBERS FROM 1.5 TO 2.0. L. Abbott Leissler and William H. Sterbentz. May 1954. 29p. diagrs., photos., tab. (NACA RM E54B23)

An experimental investigation of a translating-cone inlet was conducted over a Mach number range from 1.5 to 2.0 at angles of attack to 9°. A comparison of a translating-cone inlet with two fixed-geometry inlets over a specified corrected air-flow schedule showed the translating-cone inlet to have significant performance gains. Inlet performance was adversely affected by external flow reexpansion over the cone shoulder and internal flow contraction.

NACA RM E54D19

TURBOPROP-ENGINE DESIGN CONSIDERATIONS. I - EFFECT OF MODE OF ENGINE OPERATION ON PERFORMANCE OF TURBOPROP ENGINE WITH CURRENT COMPRESSOR PRESSURE RATIO. Elmer H. Davison. May 1955. 34p. diagrs. (NACA RM E54D19)

A cycle analysis of a turboprop engine with low compressor pressure ratio indicated: (1) Varying the mode of operation or exhaust-nozzle area had little effect on specific fuel consumption at high power but did result in an improvement at low power; (2) decreasing either the flight speed or altitude, in general, increases the specific fuel consumption; and (3) turbine requirements can be made less critical by using a variable nozzle area.

NACA RM E54I28a

PHOTOGRAPHIC INVESTIGATION OF AIR-FLOW PATTERNS IN TRANSPARENT ONE-SIXTH SECTOR OF ANNULAR TURBOJET-ENGINE COMBUSTOR WITH AXIAL-SLOT-TYPE AIR ADMISSION. Charles C. Graves and J. Dean Gernon. December 1954. 24p. diagrs., photos. (NACA RM E54I28a)

A photographic study was made of gross air-flow patterns in a transparent one-sixth sector of an annular turbojet-engine combustor with axial-slot-type admission at reference velocities from 26 to 72 feet per second. Photographs taken along the longitudinal plane of the combustor primary zone disclosed a low-velocity recirculation region near the fuel manifold. Large-scale, spiral air currents occurred in the combustor secondary zone where the flow patterns appeared to be markedly affected by the combustor side walls. Effects of combustor air velocity on gross flow patterns were minor.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM E55B08

CORRELATION OF TURBINE-BLADE-ELEMENT LOSSES BASED ON WAKE MOMENTUM THICKNESS WITH DIFFUSION PARAMETER FOR A SERIES OF SUBSONIC TURBINE BLADES IN TWO-DIMENSIONAL CASCADE AND FOR FOUR TRANSONIC TURBINE ROTORS. Robert Y. Wong and Warner L. Stewart. April 1955. 31p. diagrs. (NACA RM E55B08)

Analyses of losses occurring in subsonic turbine blades in two-dimensional cascade and of rotor-blade-element losses at the hub, mean, and tip radius of four transonic turbines indicate that turbine-blade profile losses based on blade wake characteristics can be correlated with suction-surface diffusion. A considerable difference was found between the level of the transonic turbine rotor-blade-element loss and the two-dimensional cascade profile loss. From an analysis at zero diffusion, it was indicated that unsteady flow effects on probe measurements and the effects of stator wake mixing losses can considerably influence the indicated rotor-blade-element losses. About four-fifths of the true rotor-blade-element loss is attributable to compressible-flow profile losses, while the remainder is attributable to rotor three-dimensional and other effects.

NACA RM E55B18

TURBOPROP-ENGINE DESIGN CONSIDERATIONS. II - DESIGN REQUIREMENTS AND PERFORMANCE OF TURBOPROP ENGINES WITH A SINGLE-SPOOL HIGH-PRESSURE-RATIO COMPRESSOR. Elmer H. Davison and Margaret C. Stalla. May 1955. 32p. diagrs., tabs. (NACA RM E55B18)

A cycle analysis of turboprop engines with high compressor pressure ratios indicated that (1) compared with a single-spool engine, a free-turbine engine is restricted in the range of turbine-inlet temperature over which it can operate, and (2) operation with variable exhaust-nozzle area is desirable in order to reduce turbine blade stress and frontal area.

NACA RM E55H01

THE RATE OF DECOMPOSITION OF LIQUID PENTABORANE FROM 85° TO 202° C. Glen E. McDonald. October 1955. 22p. diagrs., tab. (NACA RM E55H01)

The thermal stability of pentaborane was measured over a wide range of reaction rates, and the composition of the reaction products was determined. Measurements of the effect of dilution with n-heptane on stability indicate that the reaction is second-order. An activation energy of 34.2 kcal/mole was calculated for the overall reaction. From the correlation of the effect of temperature with the rate of decomposition, estimates may be made of the rate of decomposition to be expected at other temperatures.

NACA RM E56A13a

THEORETICAL PERFORMANCE OF JP-4 FUEL WITH A 70-PERCENT-FLUORINE - 30-PERCENT-OXYGEN MIXTURE AS A ROCKET PROPELLANT. I - FROZEN COMPOSITION. Sanford Gordon and Vearl N. Huff. April 1956. 38p. diagrs., tabs. (NACA RM E56A13a)

Theoretical rocket performance parameters were calculated for JP-4 fuel with a 70.37-percent fluorine and 29.63-percent oxygen oxidant. Frozen composition was assumed during the expansion process. Data were calculated for equivalence ratios of 1 to 4, chamber pressures of 300 and 600 pounds per square inch, and pressure ratios of 1 to 1500. A correlation is given which permits the determination of performance for a wide range of chamber pressures. The maximum values of specific impulse for chamber pressures of 600 and 300 pounds per square inch absolute (40.83 and 20.41 atmospheres) and an exit pressure of 1 atmosphere were 301.1 and 278.2, respectively, at 20.7 weight percent fuel.

NACA RM E56A19

A STUDY OF FUEL-NITRIC ACID REACTIVITY. Charles E. Feiler and Louis Baker, Jr. April 1956. 48p. diagrs., photo., tabs. (NACA RM E56A19)

The relative reactivities of six fuels with red fuming nitric acid (19 percent NO_2) were determined in a 40-pound-thrust rocket engine with rapid liquid-phase mixing. The combustion-chamber characteristic length required to obtain 97 percent of maximum experimental characteristic exhaust velocity was used as the measure of reactivity. Hydrazine, trimethyl-trithiophosphite, furfuryl alcohol, unsymmetrical dimethyl-hydrazine, allylamine, and o-toluidine were studied; reactivity decreased in that order. Reactivities, injector-cup pressure drops, and ignition delays are compared and discussed.

NACA RM E56B21

EFFECT OF AMBIENT CONDITIONS ON THE PERFORMANCE OF A PRESSURE-JET POWERPLANT FOR A HELICOPTER. Richard P. Krebs. June 1956. 49p. diagrs. (NACA RM E56B21)

A generalized analysis of a pressure-jet powerplant was made. The effect of changes in ambient conditions on the powerplant performance is provided in a series of charts using parameters containing temperatures and pressures. Calculations were also made showing the effect of changes in ambient conditions on the hovering ceiling, hovering time, range, and rate of climb of a helicopter powered by a pressure-jet system.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM E56B27

TABLES AND CHARTS FOR THERMODYNAMIC CALCULATIONS INVOLVING AIR AND FUELS CONTAINING BORON, CARBON, HYDROGEN, AND OXYGEN. Eldon W. Hall and Richard J. Weber. July 1956. 82p. diagrs., tabs. (NACA RM E56B27)

Tables and charts of gas properties are presented for use in thermodynamic calculations for engine cycles involving the combustion of air and any fuel or combination of fuels containing carbon, boron, hydrogen, and oxygen. Dissociation and phase changes may be accounted for with the method presented, which does not require the presentation of separate data for each fuel-air ratio. Calculations are limited to stoichiometric or lesser fuel-air ratios. With boron-containing fuels, either equilibrium or frozen expansion may be assumed with respect to phase changes. Equations and examples are given illustrating calculations of combustion temperatures, expansion processes, and flow areas.

NACA RM E56B29

USE OF EFFECTIVE MOMENTUM THICKNESS IN DESCRIBING TURBINE ROTOR-BLADE LOSSES. Warner L. Stewart, Warren J. Whitney, and James W. Miser. May 1956. 26p. diagrs. (NACA RM E56B29)

The use of an effective rotor-blade momentum thickness in describing turbine rotor-blade losses is presented. Derivation of the necessary equations is presented for use in obtaining this momentum thickness for given overall turbine performance, stator performance, and rotor geometric quantities. Application is then made to a series of transonic turbine rotors to indicate the magnitude of the effective rotor-blade momentum thickness calculated for each of these rotors as well as the correlation obtained with a design rotor total surface diffusion parameter. A comparison of these results is made with the results calculated from previous low-speed two-dimensional cascade tests.

NACA RM E56D26

THERMAL DECOMPOSITION OF ETHYLPENTABORANE IN GAS PHASE. Glen E. McDonald. July 1956. 20p. diagrs., tab. (NACA RM E56D26)

The thermal decomposition of ethylpentaborane at temperatures of 185° to 244° C is approximately a 1.5-order reaction. The products of the decomposition were hydrogen, methane, a nonvolatile boron hydride, and traces of decaborane. Measurements of the rate of decomposition of pentaborane showed that ethylpentaborane has a greater rate of decomposition than pentaborane.

NACA RM E56F04

THEORETICAL PERFORMANCE OF JP-4 FUEL WITH A 70-30 MIXTURE OF FLUORINE AND OXYGEN AS A ROCKET PROPELLANT. II - EQUILIBRIUM COMPOSITION. Sanford Gordon and Vearl N. Huff. October 1956. 49p. diagrs., tabs. (NACA RM E56F04)

Data were calculated for equivalence ratios of 1 to 4, chamber pressures of 300 and 600 pounds per square inch absolute, and pressure ratios of 1 to 1500. Parameters included are specific impulse, combustion and exit temperatures, molecular weight, characteristic velocity, coefficient of thrust, ratio of nozzle-exit area to throat area, specific heat at constant pressure, isentropic exponent, viscosity, and thermal conductivity. A correlation is given which permits determination of performance for a wide range of chamber pressures. A method for obtaining specific impulse of JP-4 fuel with OF_2 and O_3-F_2 mixtures is given.

NACA RM L52B27

AERODYNAMIC LOADING CHARACTERISTICS OF A WING-FUSELAGE COMBINATION HAVING A WING OF 45° SWEEPBACK MEASURED IN THE LANGLEY 8-FOOT TRANSONIC TUNNEL. Donald L. Loving and Claude V. Williams. May 1952. 58p. diagrs., photos., tab. (NACA RM L52B27)

Results of an investigation of the loading over a wing-fuselage combination at transonic speeds are presented. The tests were made at Mach numbers from 0.94 to 1.13 for angles of attack of 4°, 8°, and 12°. Additional data were obtained for an angle of attack of 20° from a Mach number of 0.60 to 1.11. The Reynolds number of the investigation covered the range from 1.73×10^6 to 2.01×10^6. The wing had the quarter-chord line swept back 45°, an aspect ratio 4, taper ratio 0.6, and NACA 65A006 airfoil sections parallel to the airstream. Data are included from a previous investigation of the same wing-fuselage combination tested in the closed-throat test section at Mach numbers from 0.60 to 0.96 and at a Mach number of 1.2. Dynamic measurements of the wing-tip angle of twist are presented and compared with values calculated by utilizing the spanwise loadings in the moment-area method.

NACA RM L52E26

INVESTIGATION OF INTERFERENCE LIFT, DRAG, AND PITCHING MOMENT OF A SERIES OF RECTANGULAR WING AND BODY COMBINATIONS AT MACH NUMBERS OF 1.62, 1.93, AND 2.41. Donald E. Coletti. August 1952. 74p. diagrs., tabs. (NACA RM L52E26)

An investigation was made of a series of rectangular wing and body combinations at Mach numbers 1.62, 1.93, and 2.41 to determine the effects of aspect ratio, incidence angle, and forebody length on the interference lift, drag, and pitching moment. The angle-of-attack range was ±6°, and the Reynolds number range was from 0.33×10^6 to 1.40×10^6.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM SL52K13a, by Shanks; also Film Supplement L-1

NACA RM L53A08

SOME APPROXIMATE METHODS FOR ESTIMATING THE EFFECTS OF AEROELASTIC BENDING OF ROCKET-PROPELLED MODEL-BOOSTER COMBINATIONS. Richard G. Arbic, George White, and Warren Gillespie, Jr. March 1953. 40p. diagrs., photos., tabs. (NACA RM L53A08)

Methods are presented for estimating the aeroelastic effects and structural requirements of rocket propelled model-booster combinations that are nearly symmetrical. Each method is presented according to its suitability for special types of model-booster configuration. The methods differ principally in the manner in which booster stiffness, reference axis, and inertia loading are considered, and permit estimation of the Mach number at which either a structural bending divergence or an aerodynamic pitching divergence of the combination may occur.

NACA RM L53B03

THE INFLUENCE OF A CHANGE IN BODY SHAPE ON THE EFFECTS OF TWIST AND CAMBER AS DETERMINED BY A TRANSONIC WIND-TUNNEL INVESTIGATION OF A 45° SWEPTBACK WING-FUSELAGE CONFIGURATION. Daniel E. Harrison. August 1953. 23p. diagrs., tab. (NACA RM L53B03)

An investigation has been made in the Langley 8-foot transonic tunnel to determine the influence of a body modification on the effects of twist and camber. The wing of the 45° sweptback wing-fuselage configuration was twisted and cambered to obtain a uniform load distribution at a Mach number of 1.2 and a lift coefficient of 0.4. The fuselage was modified in the region of the wing on the basis of the transonic drag-rise rule. Lift, drag, and pitching-moment results are presented at Mach numbers varying from 0.80 to 1.10 and Reynolds numbers varying from about 1.90×10^6 to 2.00×10^6 based on the mean aerodynamic chord.

NACA RM L54B09

THE EFFECT OF A CHANGE IN BODY SHAPE ON THE LOADING OF A 45° SWEPTBACK WING-BODY COMBINATION AT TRANSONIC SPEEDS. Donald L. Loving. April 1954. 67p. diagrs., photo. (NACA RM L54B09)

Transonic-tunnel pressure-distribution tests were made at Mach numbers from 0.60 to 1.13 of a wing-body configuration having a 45° sweptback wing of aspect ratio 4 on a fineness-ratio-11.8 body having an afterbody which was cylindrical from the region of the wing-body juncture rearward to the base. In order to demonstrate the effect of a change in body shape on the loading characteristics, comparisons are made with similar data obtained for the same wing on a fineness-ratio-10 body which was curved from the nose to the base. Results are presented for angles of attack of 0°, 4°, 8°, 12°, and 20°. The Reynolds numbers of the investigation covered the range from 1.74×10^6 to 2.03×10^6.

NACA RM L54B11

AERODYNAMIC CHARACTERISTICS OF A CRUCIFORM-WING MISSILE WITH CANARD CONTROL SURFACES AND OF SOME VERY SMALL SPAN WING-BODY MISSILES AT A MACH NUMBER OF 1.41. M. Leroy Spearman and Ross B. Robinson. April 1954. 27p. diagrs., tabs. (NACA RM L54B11)

An investigation has been made to determine the aerodynamic characteristics of a cruciform 70° delta-wing missile configuration with 70° delta canard control surfaces at $M = 1.41$ in the Langley 4- by 4-foot supersonic pressure tunnel. The complete model, various combinations of component parts, and modifications to the basic configuration were tested through an angle-of-attack range of 0° to about 28° at a sideslip angle of 0° and through an angle-of-sideslip range of 0° to about 20° at an angle of attack of 0°. Modifications to the configuration included variation of the body length and canard area and the substitution of a series of very small span wings for the cruciform delta wings and canard controls.

NACA RM L54B16

COMPARISON OF EXPERIMENTAL WITH CALCULATED RESULTS FOR THE LIFTING EFFECTIVENESS OF A FLEXIBLE 45° SWEPTBACK WING OF ASPECT RATIO 6.0 AT MACH NUMBERS FROM 0.8 TO 1.3. Richard E. Walters. April 1954. 35p. diagrs., photos., tab. (NACA RM L54B16)

Tests of the effective lift-curve slope of a flexible sweptback wing were made to evaluate the usefulness of the general methods used to predict the effective lift-curve-slope ratio. Wings of three degrees of flexibility were tested through a Mach number range of 0.8 to 1.3. The aspect-ratio-6.0, taper-ratio-0.6 wing which was tested had 45° sweep of the quarter-chord line and an NACA 65A009 streamwise airfoil section. The results from the tests show that the method used predicted values of the effective lift ratio which are within 5 percent of the experimental values.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM L54B18

INVESTIGATION AT HIGH SUBSONIC SPEEDS OF FINNED AND UNFINNED BODIES MOUNTED AT VARIOUS LOCATIONS FROM THE WINGS OF UNSWEPT, AND SWEPT-WING—FUSELAGE MODELS, INCLUDING MEASUREMENTS OF BODY LOADS. William J. Alford, Jr., and H. Norman Silvers. April 1954. 93p. diagrs., photos., tabs. (NACA RM L54B18)

Finned and unfinned ogive-cylinder bodies of fineness ratio 9.34 were tested in the Langley high-speed 7- by 10-foot tunnel on unswept- and swept-wing—fuselage models. The bodies, symmetrically located about the plane of symmetry, were suspended by pylons in the inboard location and also were mounted directly to the wing tip. Measurements were made of the forces and moments in pitch of the combined model and bodies, in addition to six-component force and moment measurements of the bodies in the presence of the models over a Mach number range of 0.50 to 0.91.

NACA RM L54B19

THE EFFECTS OF WING-MOUNTED EXTERNAL STORES ON THE TRIM, BUFFET, AND DRAG CHARACTERISTICS OF A ROCKET-PROPELLED MODEL HAVING A 45° SWEPTBACK WING. Allen B. Henning. April 1954. 25p. diagrs., photos., tabs. (NACA RM L54B19)

A rocket-propelled model has been flown to determine the effects of four wing-mounted bomb-type external stores on the trim, buffet, and drag characteristics of a wing-fuselage configuration having a 45° swept-back wing over a Mach number range of 0.7 to 1.4. The data are compared with data from a similar model without stores. Trim angle of attack, trim normal- and transverse-force coefficients, wing-tip helix angle, buffet intensities, and drag are plotted against Mach number.

NACA RM L54B23

PRESSURE RECOVERY AND DRAG CHARACTERISTICS OF A FORWARD LOCATED CIRCULAR SCOOP INLET AS DETERMINED FROM FLIGHT TESTS FOR MACH NUMBERS FROM 0.8 TO 1.6. Charles F. Merlet. April 1954. 23p. diagrs., photos., tab. (NACA RM L54B23)

A flight test was conducted on a circular scoop inlet located well forward on a parabolic body of revolution. Results are presented for a Mach number range of 0.8 to 1.6 at Reynolds numbers of 3×10^6 to 9×10^6, respectively, based on maximum body diameter, and a mass-flow-ratio range from 0.3 to 1.1. At maximum mass-flow ratio, the installation of the inlet caused only a small difference in drag as compared to the drag of the body alone. Total-pressure recoveries at the inlet-minimum-area station ranged from a value of 1.0 at subsonic speeds to a minimum value of 0.95 at $M = 1.6$.

NACA RM L55B10

LIFT, DRAG, AND LONGITUDINAL STABILITY AT MACH NUMBERS FROM 0.8 TO 2.1 OF A ROCKET-POWERED MODEL HAVING A TAPERED UNSWEPT WING OF ASPECT RATIO 3 AND INLINE TAIL SURFACES. Warren Gillespie, Jr. April 1955. 29p. diagrs., photo., tabs. (NACA RM L55B10)

A configuration having a body of fineness ratio 16.9, an unswept wing of aspect ratio 3 and taper ratio 0.4, and inline tail surfaces was aeropulsed continuously in pitch during free flight with and without a sustainer rocket motor operating. The Mach number range covered by the investigation was from 0.8 to 2.1. Zero-lift drag and drag-due-to-lift data were obtained during coasting flight of the model. Normal force, pitching moment, static longitudinal stability, and downwash and wake effects at the horizontal tail were obtained with and without the rocket motor thrusting.

NACA RM L55B11

COMPARISON OF THE STATIC STABILITY OF A 68.7° DELTA-WING MODEL WITH DIHEDRAL AND A TWISTED AND CAMBERED WING MODEL OF THE SAME PLAN FORM. John W. Paulson. April 1955. 18p. diagrs., tab. (NACA RM L55B11)

A force-test investigation at a Reynolds number of 440,000 of the static stability characteristics of a 68.7° delta-wing model with dihedral showed that, with vertical tail off or on, the model had large values of directional stability at high angles of attack with 20° and 30° of inboard dihedral.

NACA RM L55B15

EFFECTS OF A DETACHED TAB ON THE HINGE-MOMENT AND EFFECTIVENESS CHARACTERISTICS OF AN UNSWEPT TRAILING-EDGE CONTROL ON A 60° DELTA WING AT MACH NUMBERS FROM 0.75 TO 1.96. Odell A. Morris and Gertrude C. Westrick. April 1955. 36p. diagrs., photo. (NACA RM L55B15)

A wind-tunnel investigation has been made on a constant-chord trailing-edge control equipped with a detached tab on a 60° delta wing at Mach numbers from 0.75 to 1.96. Reynolds number of the test varied from 2.4×10^6 to 3.2×10^6. Rolling moment and lift effectiveness as well as hinge moments of the flap-tab combination were obtained for flap deflections of 0° to 15°, tab deflections of 0° to -15°, and angles of attack from 0° to ±12°.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM L55B25

INVESTIGATION OF INTERFERENCE LIFT, DRAG, AND PITCHING MOMENT OF A SERIES OF TRIANGULAR WING AND BODY COMBINATIONS AT A MACH NUMBER OF 1.62. Donald E. Coletti. May 1955. 49p. diagrs., photo., tabs. (NACA RM L55B25)

An investigation was made at a Mach number of 1.62 of a series of triangular wings of varying scale having half-apex angles of 30° and 45° in combinations with a body to determine the interference lift, drag, and pitching moment. The angle-of-attack range was approximately $\pm 6^{\circ}$, and the Reynolds number varied from 0.30×10^6 to 2.10×10^6 based on wing mean aerodynamic chord. Comparisons are made with theory.

NACA RM SL55G07a, by Windham

NACA RM L56B01

LOW-SPEED MEASUREMENTS OF STATIC STABILITY, DAMPING IN YAW, AND DAMPING IN ROLL OF A DELTA, A SWEPT, AND AN UNSWEPT WING FOR ANGLES OF ATTACK FROM 0° TO 90°. Joseph L. Johnson, Jr. April 1956. 19p. diagrs., tabs. (NACA RM L56B01)

A low-speed investigation was conducted to determine the static stability, damping-in-yaw, and damping-in-roll derivatives of a 60° delta wing, a 45° swept wing of aspect ratio 2.61, and an unswept wing of aspect ratio 3 over an angle-of-attack range from 0° to 90°.

NACA RM L56B10

INVESTIGATION AT HIGH SUBSONIC SPEEDS OF THE EFFECT OF HORIZONTAL-TAIL LOCATION ON LONGITUDINAL AND LATERAL STABILITY CHARACTERISTICS OF A COMPLETE MODEL HAVING A SWEPTBACK WING IN A HIGH LOCATION. H. Norman Silvers and Thomas J. King, Jr. April 1956. 46p. diagrs., tab. (NACA RM L56B10)

This paper presents results of an investigation made at high subsonic speeds to determine the static longitudinal and lateral stability characteristics of a complete model having four vertical locations of the horizontal tail and a sweptback wing located in a high position on the fuselage. The wing had 45° of sweepback, an aspect ratio of 4.0, taper ratio of 0.3, and NACA 65A006 airfoil sections. The results were obtained in the Langley high-speed 7- by 10-foot tunnel at Mach numbers from 0.80 to 0.92 and covered an angle-of-attack range from -2° to 23° and an angle-of-sideslip range from -4° to 12°.

NACA RM L56B14

EFFECTS OF REYNOLDS NUMBER AND LEADING-EDGE SHAPE ON THE LOW-SPEED LONGITUDINAL STABILITY OF A 6-PERCENT-THICK 45° SWEPTBACK WING. William C. Schneider. April 1956. 32p. diagrs. (NACA RM L56B14)

Force-test data showing the effects of changes in leading-edge radius on the longitudinal stability of a 6-percent-thick 45° sweptback wing of aspect ratio 3 are presented for several ranges of Reynolds number and Mach number. Data are presented for wings with NACA 0006-(4.76)3, NACA 0006-(6.74)3, and modified NACA 0006-(3.88)3 airfoil sections with leading-edge radii of 0.0025, 0.0050, and 0.0025 of the local wing chord parallel to the plane of symmetry, respectively, and for Reynolds numbers up to 6.6×10^6 and Mach numbers up to 0.20. This study is a continuation of the studies published in NACA RM L55F06, NACA RM L55H04, and NACA RM L55L30.

NACA RM L56B17

EXPLORATORY INVESTIGATION OF A HELICOPTER PRESSURE-JET SYSTEM ON THE LANGLEY HELICOPTER TEST TOWER. Robert A. Makofski and James P. Shivers. July 1956. 38p. diagrs., photo. (NACA RM L56B17)

An exploratory investigation of a helicopter pressure-jet system has been conducted on the Langley helicopter test tower. The effects of tip speed, fuel-air ratio, and pressure ratio on the propulsive characteristics of the pressure-jet system have been determined for a range of tip speeds from 442 to 559 feet per second, blade-root stagnation-pressure ratios of 1.9, 2.14, and 2.31, and fuel-air ratios from 0 to 0.03. A constant-area exit nozzle was used in the investigation. Without tip burning, a minimum overall specific fuel consumption of 2.28 pounds per hour per horsepower and a ratio of rotor propulsive horsepower to equivalent compressed-air horsepower of about 0.45 was obtained at a stagnation-pressure ratio of 2.31 and a tip speed of 558 feet per second. With burning at a fuel-air ratio of 0.02 at the tip unit, the overall specific fuel consumption was increased by about 11 percent and the power ratio was increased to about 1.0.

NACA RM L56B20

FREE-FLIGHT INVESTIGATION OF THE CONTROL EFFECTIVENESS OF A DIFFERENTIALLY DEFLECTED HORIZONTAL TAIL AT MACH NUMBERS FROM 0.8 TO 1.6. Jesse L. Mitchell and A. James Vitale. April 1956. 25p. diagrs., photo., tabs. (NACA RM L56B20)

A free-flight investigation has been made to determine the control effectiveness of a differentially deflected horizontal tail in the Mach number range from 0.8 to 1.6. The results of this investigation agreed in general with results of other investigations.

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These results indicate that the rolling moment of the differentially deflected horizontal tail has relatively small variation with Mach number over the range of the test and that the yawing moment, in a direction usually referred to as favorable, is about two to three times as great as the rolling moment and has a comparatively large variation with Mach number.

NACA RM L56G18

BOUNDARIES OF SUPERSONIC AXISYMMETRIC FREE JETS. Eugene S. Love, Mildred J. Woodling, and Louise P. Lee. October 1956. 98p. diagrs. (NACA RM L56G18)

Calculations have been made by the method of characteristics of 2960 boundaries of supersonic axisymmetric free jets exhausting from conically divergent nozzles into still air. The calculations cover jet Mach numbers from 1.5 to 3.0, ratio of specific heats of the jet from 1.115 to 1.667, divergence angles of the nozzle from 5° to 20°, and jet static-pressure ratios from 1 to 10. The results are presented nondimensionally and in a form that facilitates practical use. Some random examples of the effects of the variables involved are shown, and the possibilities of the simulation of one jet by another are examined for jets exhausting into still air and into supersonic streams.

NACA RM L57E30

NOTES ON A LARGE-SCALE STATISTICAL PROGRAM FOR THE ESTABLISHMENT OF MANEUVER-LOADS DESIGN CRITERIA FOR MILITARY AIRPLANES. John P. Mayer, Ralph W. Stone, Jr., and Harold A. Hamer. July 1957. 57p. diagrs., tabs. (NACA RM L57E30)

An outline is presented of a statistical program to collect data for the establishment of more realistic maneuver-loads design criteria. Some details on the loads derivable from the measured quantities and the accuracy with which these loads may be obtained are discussed. In addition, some sample experimental data are used to indicate possible methods of statistical analysis for the assessment of maneuver-loads criteria and some remarks are made on the sample size required for the overall program. The methods used and the results possible from such a statistical program represent a goal which could be obtained under the assumptions made; however, many of the operations indicated in the outline for the statistical analysis are not known and will require further study. An actual program may differ in many respects to that presented, such differences depending in part upon the type and accuracy of the recording instrument selected.

#NACA Reactor Facility Hazards Summary. (Preliminary draft), by Lewis Flight Propulsion Laboratory Staff, April 17, 1956.

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National Advisory Committee for Aeronautics

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1299

CORRELATION, EVALUATION, AND EXTENSION OF LINEARIZED THEORIES FOR TIRE MOTION AND WHEEL SHIMMY. Robert F. Smiley. 1957. v, 48p. diagrs., tab. (NACA Rept. 1299. Supersedes TN 3632)

An evaluation is made of the existing theories of linearized tire motion and wheel shimmy. It is demonstrated that most of the previously published theories represent varying degrees of approximation to a summary theory developed herein which is a minor modification of the basic theory of Von Schlippe and Dietrich. In most cases where strong differences exist between the previously published theories and the summary theory, it is shown that the previously published theories possess certain deficiencies. A series of systematic approximations to the summary theory is developed for the treatment of problems too simple to merit the use of the complete summary theory and procedures are discussed for applying the summary theory and its systematic approximations to the shimmy of more complex landing-gear structures than have previously been considered. Comparisons of the existing experimental data with the predictions of the summary and systematic approximation theories provide a fair substantiation of the higher approximate theories.

NACA Rept. 1307

LIFT AND CENTER OF PRESSURE OF WING-BODY-TAIL COMBINATIONS AT SUBSONIC, TRANSONIC, AND SUPERSONIC SPEEDS. William C. Pitts, Jack N. Nielsen, and George E. Kaattari. 1957. ii, 70p. diagrs., tabs. (NACA Rept. 1307)

A method is presented for calculating the lift and centers of pressure of wing-body and wing-body-tail combinations at subsonic, transonic, and supersonic speeds. A set of design charts and a computing table are presented which reduce the computations to routine operations. Comparison between the estimated and experimental characteristics for a number of wing-body and wing-body-tail combinations shows correlation to within ±10 percent on lift and to within about ±0.02 of the body length on center of pressure.

NACA Rept. 1317

CLOUD-DROPLET INGESTION IN ENGINE INLETS WITH INLET VELOCITY RATIOS OF 1.0 AND 0.7. Rinaldo J. Brun. 1957. ii, 35p. diagrs., tab. (NACA Rept. 1317. Supersedes TN 3593)

The paths of cloud droplets into two engine inlets are calculated. The amount of water in droplet form ingested by the inlets and the amount and distribution of water impinging on the inlet walls are obtained from these droplet-trajectory calculations. In both types of inlet a prolate ellipsoid of revolution (10-percent thick) represents either part or all of the forebody at the center of an annular inlet to an engine. The configurations can also represent a fuselage of an airplane with side ram-scoop inlets. The principal difference between the two inlets studied is that the inlet air velocity of one is 0.7 that of the other.

NACA Rept. 1324

COMPARISON OF SEVERAL METHODS FOR OBTAINING THE TIME RESPONSE OF LINEAR SYSTEMS TO EITHER A UNIT IMPULSE OR ARBITRARY INPUT FROM FREQUENCY-RESPONSE DATA. James J. Donegan and Carl R. Huss. 1957. ii, 13p. diagrs., tabs. (NACA Rept. 1324. Supersedes TN 3701.)

The comparison indicates that all of the methods give good accuracy when applied to a second-order system; the main difference is the required computing time to obtain the same degree of accuracy. When applied to higher order systems, however, the methods generally classified as inverse Laplace transform methods were found most effective. Some discussion is given of the use of the methods as flight-data-analysis techniques in predicting loads and motions for a flexible aircraft when the aircraft frequency response is known.

NACA Rept. 1327

THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE SUBSONIC-FLOW FIELDS BENEATH SWEPT AND UNSWEPT WINGS WITH TABLES OF VORTEX-INDUCED VELOCITIES. William J. Alford, Jr. 1957. ii, 43p. diagrs., photo., tabs. (NACA Rept. 1327. Supersedes TN 3738)

The flow characteristics around swept and unswept wings necessary in first-order estimations of aerodynamic loadings, trajectories, and jettison characteristics of missiles, fuel tanks, or bombs as determined experimentally are compared with the flow

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fields as calculated by potential-flow theory. The theoretical predictions of the flow-field characteristics were qualitatively correct in all cases considered, although there were indications that the magnitude of the downwash angles tended to be overpredicted as the tip of the swept wing was approached and that the sidewash angles ahead of the unswept wing were underpredicted.

NACA Rept. 1328

A SECOND-ORDER SHOCK-EXPANSION METHOD APPLICABLE TO BODIES OF REVOLUTION NEAR ZERO LIFT. Clarence A. Syvertson and David H. Dennis. 1957. ii, 20p. diagrs., tabs. (NACA Rept. 1328. Supersedes TN 3527)

A second-order shock-expansion method applicable to bodies of revolution is developed by the use of the predictions of the generalized shock-expansion method in combination with characteristics theory. Equations defining the zero-lift pressure distributions and the normal-force and pitching-moment derivatives are derived. Comparisons with experimental results show that the method is applicable at values of the similarity parameter, the ratio of free-stream Mach number to nose fineness ratio, from about 0.4 to 2.

NACA Rept. 1330

EXPERIMENTAL AND PREDICTED LONGITUDINAL AND LATERAL-DIRECTIONAL RESPONSE CHARACTERISTICS OF A LARGE FLEXIBLE 35° SWEPT-WING AIRPLANE AT AN ALTITUDE OF 35,000 FEET. Henry A. Cole, Jr., Stuart C. Brown, and Euclid C. Holleman. 1957. ii, 39p. diagrs., photo., tabs. (NACA Rept. 1330. Supersedes RM A54H09; TN 3874)

Longitudinal and lateral-directional response to control surface motions are presented for a large flexible swept-wing airplane over a range of Mach numbers at 35,000 feet. Frequency responses, transfer functions, and stability derivatives are evaluated from transient response to elevator, aileron, and rudder inputs. Comparisons are made between response characteristics predicted for the rigid and flexible airplane, and those evaluated from transient flight data.

NACA Rept. 1334

RELATION OF TURBOJET AND RAMJET COMBUSTION EFFICIENCY TO SECOND-ORDER REACTION KINETICS AND FUNDAMENTAL FLAME SPEED. J. Howard Childs, Thaine W. Reynolds, and Charles C. Graves. 1957. ii, 13p. diagrs. (NACA Rept. 1334)

Theoretical studies of jet-engine combustion processes are summarized, and the equations are applied to experimental data. A parameter derived with the assumption that chemical reaction kinetics control the combustion rate correlates most turbojet combustion efficiencies. Another parameter derived with the assumption that flame spreading governs the combustion rate correlates ram-jet combustion efficiencies but is inadequate for the turbojet. Data indicate that a shift from one rate-controlling process to another occurs as combustor pressure is varied. The reaction-kinetics parameter best correlates the data at low pressures, whereas the flame-spreading parameter is better at higher pressures.

NACA Rept. 1335

MINIMUM WAVE DRAG FOR ARBITRARY ARRANGEMENTS OF WINGS AND BODIES. Robert T. Jones. 1957. ii, 6p. diagrs., photo. (NACA Rept. 1335. Supersedes TN 3530)

Studies of various arrangements of wings and bodies designed to provide favorable wave interference at supersonic speeds lead to the problem of determining the minimum possible value of the wave resistance obtainable by any disposition of the elements of an aircraft within given dimensions defined by a region. Under the assumptions that the total lift and the total volume of the aircraft are given, conditions that must be satisfied if the drag is to be a minimum are found. For arbitrary regions the minimum value can be estimated by a simple formula giving a lower bound.

NACA Rept. 1336

AN INVESTIGATION OF SINGLE- AND DUAL-ROTATION PROPELLERS AT POSITIVE AND NEGATIVE THRUST, AND IN COMBINATION WITH AN NACA 1-SERIES D-TYPE COWLING AT MACH NUMBERS UP TO 0.84. Robert M. Reynolds, Robert I. Sammonds, and John H. Walker. 1957. ii, 58p. diagrs., photos., tabs. (NACA Rept. 1336)

The results presented include propeller force characteristics, local velocity distributions in the propeller planes, inlet pressure recoveries, and static-pressure distributions on the cowling surfaces measured for a wide range of blade angles, advance ratios, and inlet-velocity ratios for the NACA 4-(5)(05)-041 four-blade, single-rotation propeller and the NACA 4-(5)(05)-037 six- and eight-blade, dual-rotation propellers in various combinations with NACA 1-series spinners, extended cylindrical spinners, and NACA D-type spinner cowlings.

NACA RM E57K12

PRELIMINARY STUDIES OF ROLLING-CONTACT FATIGUE LIFE OF HIGH-TEMPERATURE BEARING MATERIALS. Thomas L. Carter. April 1958. 27p. diagrs., tab. (NACA RM E57K12)

Preliminary studies of rolling-contact fatigue life of both races and balls of some promising high-temperature bearing materials were made at room temperature in the rolling-contact fatigue spin rig. The results may be of assistance in judging the relative potential of bearing steels for use at high temperatures. The following materials were investigaged: SAE 52100, MHT, TMT, MV-1, Halmo vacuum-melt, and AISI T-1, M-10, M-1, and M-50.

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NACA RM E58A03a

DILUTION OF LIQUID OXYGEN WHEN NITROGEN IS USED FOR PRESSURIZATION. Thomas J. Walsh, R. R. Hibbard, and Paul M. Ordin. April 1958. 17p. diagrs. (NACA RM E58A03a)

A graphic method for determining the composition and phases existing within an oxygen propellant tank when pressurized with nitrogen gas is presented, and an example of the calculations involved is included. Adiabatic flow of the pressurizing gas from the pressure tank and the equilibrium state for the oxygen-nitrogen system are assumed as the limiting conditions. Enthalpy-concentration plots for the oxygen-nitrogen mixtures at constant pressures from 100 to 600 pounds per square inch absolute are presented. Both the equilibrium considerations and a small amount of experimental testing show that gaseous nitrogen may be unsuited for pressurizing liquid-oxygen systems.

NACA RM L58B05

LOW-SUBSONIC INVESTIGATION TO DETERMINE THE CHORDWISE PRESSURE DISTRIBUTION AND EFFECTIVENESS OF SPOILERS ON A THIN, LOW-ASPECT-RATIO, UNSWEPT, UNTAPERED, SEMI-SPAN WING AND ON THE WING WITH LEADING- AND TRAILING-EDGE FLAPS. Delwin R. Croom. April 1958. 133p. diagrs., tabs. (NACA RM L58B05)

Results are presented, without discussion, of a wind-tunnel investigation to determine the effect that spoilers at various spanwise and chordwise locations have on the lateral-control characteristics and the chordwise pressure distribution on a thin, untapered, unswept wing having an aspect ratio of 3.33 and NACA 65A004 airfoil sections. The wing was equipped with leading-edge and trailing-edge flaps.

NACA TM 1407

FREE CONVECTION UNDER THE CONDITIONS OF THE INTERNAL PROBLEM. (Svobodnaya convectzia v ousloviakh vnoutrennei zadachi.) G. A. Ostroumov. April 1958. vii, 233p. diagrs., photos., tabs. (NACA TM 1407. Translation of Russian Book, 1952)

This report attempts to fill the gap in scientific literature on convective processes in the gravitational-force field. Mathematical theory of steady and unsteady gravitational convection is presented. General nonlinear equations that can be linearized are emphasized. A discussion of the nonlinear theory is also presented. Experimental investigations of phenomena described by both the linear and nonlinear equations are considered, and experimental techniques are discussed. One chapter is concerned with the characteristics of water as the working fluid. Tabulated data are given on the thermal and convective parameters of water and are compared with those for other fluids.

NACA TM 1418

THE INTERACTION OF A REFLECTED SHOCK WAVE WITH THE BOUNDARY LAYER IN A SHOCK TUBE. Herman Mark, Cornell University. March 1958. ii, 128p. diagrs., photos., tabs. (NACA TM 1418)

By theoretical analysis the existence of several different types of interaction in different ranges of initial shock Mach number is predicted. This analysis is verified experimentally. The most complicated interaction is studied in detail, and a model is proposed. The features of the phenomenon are analyzed, based on this model, and are checked experimentally. The case of interaction with a turbulent boundary layer is also considered. A method is proposed whereby the effect of the laminar-boundary-layer interaction on the strength of the reflected shock may be calculated, and a comparison with experimental results is presented.

NACA TM 1433

STABILITY OF CYLINDRICAL AND CONICAL SHELLS OF CIRCULAR CROSS SECTION, WITH SIMULTANEOUS ACTION OF AXIAL COMPRESSION AND EXTERNAL NORMAL PRESSURE. (Ob ustoĭchivosti tsilindricheskikh i konicheskikh obolochek krugovogo cecheniia pri sovmestnom deĭstvii osevogo szhatiia i vneshnego normalnogo davleniia.) Kh. M. Mushtari and A. V. Sachenkov. April 1958. 15p. (NACA TM 1433. Translation from Prikladnaia Matematika i Mekhanika, v. 18, no. 6, November-December 1954, p. 667-674.)

The expressions for the upper limit of critical loads are presented for cylindrical and conical shells under the combined action of uniform compression and isotropic external normal pressure. The differential equations for neutral equilibrium are solved for conical shells with simply supported boundaries. These solutions are used to obtain approximate expressions for the determination of the critical external pressure with simultaneous longitudinal compression. Also included is a discussion of the accuracy of the approximate expressions.

NACA TM 1434

EXTREME SPEEDS AND THERMODYNAMIC STATES IN SUPERSONIC FLIGHT. (Extreme Geschwindigkeiten und thermische Zustände beim Überschallflug.) Klaus Oswatitsch. April 1958. 39p. diagrs., tabs. (NACA TM 1434. Translation from Zeitschrift für Flugwissenschaften, v. 4, no. 3/4, 1956, p. 95-108)

Typical of all cases of high-speed flow is the conversion of high kinetic energy into extreme thermodynamic states with temperatures of several thousand degrees; frequently, the gas is dissociated and ionized. A small sensitivity to high speeds is characteristic of gases of low molecular weight. With a minimum of mathematical and physical complexity, these matters are discussed in relation to meteors, shock tubes, ram jets, and rockets. The discussion is directed primarily to experts in neighboring fields and interested novices.

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NACA TN 4140

TURBULENT SHEARING STRESS IN THE BOUNDARY LAYER OF YAWED FLAT PLATES. Harry Ashkenas, Cornell University. April 1958. 58p. diagrs., photos., tab. (NACA TN 4140)

Hot-wire anemometer measurements of the turbulent shearing stress in a turbulent boundary layer on a yawed flat plate are presented. Two plates with angles of yaw of 0° and 45° were studied. Measurements of the intensity of turbulence were made simultaneously with the shear measurements, using a technique developed by the author. The experimental procedure is reviewed briefly and an attempt is made to evaluate the precision of the results.

NACA TN 4150

APPROXIMATIONS FOR THE THERMODYNAMIC AND TRANSPORT PROPERTIES OF HIGH-TEMPERATURE AIR. C. Frederick Hansen. March 1958. 67p. diagrs., tabs. (NACA TN 4150)

Approximations are presented for the thermodynamic and transport properties of high-temperature air. Compressibility, energy, entropy, the specific heats, the speed of sound, the coefficients of viscosity and thermal conductivity, and the Prandtl number for air are tabulated from 500° to $15,000^{\circ}$ K over a range of pressures from 0.0001 to 100 atmospheres.

NACA TN 4206

MEASUREMENTS OF TOTAL HEMISPHERICAL EMISSIVITY OF VARIOUS OXIDIZED METALS AT HIGH TEMPERATURE. William R. Wade. March 1958. 43p. diagrs., photos. (NACA TN 4206)

The results of measurements of total hemispherical emissivity over the temperature range of 600° to $2,000^{\circ}$ F for various heavily oxidized metals are presented, together with a description of the equipment and the procedures used. The variation of total emissivity due to oxidation of the materials is presented, up to the highest temperature which produces an adherent oxide coating. Results from investigations to determine any deviation of the thermal radiation from Lambert's cosine law for the oxidized metals are presented.

NACA TN 4207

EFFECT OF A STRINGER ON THE STRESS CONCENTRATION DUE TO A CRACK IN A THIN SHEET. J. Lyell Sanders, Jr. March 1958. 19p. diagrs., tab. (NACA TN 4207)

A coefficient is obtained for determining the effect of a reinforcing stringer on the stress concentration factor at the tip of a crack in a thin sheet. The results are given for the case in which the stringer is intact and for the case in which the stringer is broken. In the first case the stress concentration factor for the stringer is also given.

NACA TN 4212

CENTRAL AUTOMATIC DATA PROCESSING SYSTEM. By the Staff of the Lewis Laboratory. Chapter I: GENERAL DESCRIPTION. Bert A. Coss. Chapter II: CENTRAL RECORDING SYSTEM. Robert L. Miller. Chapter III: AUTOMATIC VOLTAGE DIGITIZERS. Leonard Jaffe and Richard L. Smith. Chapter IV: FREQUENCY DATA. John Ryskamp. Chapter V: DIGITAL AUTOMATIC MULTIPLE PRESSURE RECORDER. Leonard Jaffe, Arthur J. Gedeon, and Richard N. Bell. Chapter VI: PLAYBACK AND CONTROL ROOM EQUIPMENT. John Ryskamp. April 1958. (iii), 96p. diagrs., photos. (NACA TN 4212)

A centralized system has been developed and installed for the automatic recording and processing of data from several remotely located testing stations. Pressures, voltages, frequencies, and other pertinent variables are recorded on magnetic tape in digital form. The magnetic tape is fed into a high-speed digital computer to convert raw data to dimensioned quantities and to compute any terminal calculations called for by the test engineer. Computed data can be returned to the test engineer the next day; raw data can be returned immediately. The system has been in operation for 2 years.

NACA TN 4215

APPLICATION OF A HIGH-TEMPERATURE STATIC STRAIN GAGE TO THE MEASUREMENT OF THERMAL STRESSES IN A TURBINE STATOR VANE. R. H. Kemp, C. R. Morse, and M. H. Hirschberg. March 1958. 36p. diagrs., photos., tab. (NACA TN 4215)

Static high-temperature resistance-wire strain gages were used to measure the thermal stresses in a turbine stator vane that was subjected to a temperature variation simulating engine operating conditions. Stresses of -18,000 and -27,000 psi were measured in the leading and trailing edges, respectively. The measured values, in general, compared favorably with analytically determined stresses.

NACA TN 4217

EFFECT OF JET TEMPERATURE ON JET-NOISE GENERATION. Vern G. Rollin. March 1958. 13p. diagrs., photo. (NACA TN 4217)

Sound measurements were made on a 9/16-inch-model air jet over a range of pressure ratios from 1.3 to 1.9 and jet-air temperatures from 80° to 1000° F. Results indicated that sound power can be adequately predicted by the Lighthill parameter based on ambient temperature over the range of temperatures investigated.

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NACA TN 4218

ANALYSIS OF STRESSES AND DEFLECTIONS IN A DISK SUBJECTED TO GYROSCOPIC FORCES. M. H. Hirschberg and A. Mendelson. March 1958. 37p. diagrs. (NACA TN 4218)

The differential equations governing the stresses and deflections of a disk of variable thickness subjected to gyroscopic loading are derived. For a disk of constant thickness, solutions are obtained by a finite-difference method for a wide range of disk geometry and loading.

NACA TN 4219

PROPELLANT VAPORIZATION AS A CRITERION FOR ROCKET ENGINE DESIGN; RELATION BETWEEN PERCENTAGE OF PROPELLANT VAPORIZED AND ENGINE PERFORMANCE. Marcus F. Heidmann and Richard J. Priem. March 1958. 19p. diagrs. (NACA TN 4219)

A method is presented for evaluating experimental rocket-engine performance in terms of the percentage of liquid propellant vaporized. The method is based on a hypothesis that rocket performance is limited by the rate of vaporization of the propellants. An expression relating characteristic exhaust velocity to the percentages of oxidant and fuel vaporized and burned is given. The analysis is applied to the hydrogen-fluorine, hydrogen-oxygen, ammonia-fluorine, and JP-4 - oxygen propellant combinations.

NACA TN 4220

A FLIGHT EVALUATION AND ANALYSIS OF THE EFFECT OF ICING CONDITIONS ON THE ZPG-2 AIRSHIP. William Lewis and Porter J. Perkins, Jr. April 1958. 66p. diagrs., photos., tab. (NACA TN 4220)

Test flights conducted by the U. S. Navy in a number of typical icing conditions are described. The airship operated successfully in all icing conditions encountered, but the desirability of limited protection for certain components was indicated. Icing in clouds was confined to wires and small components, but freezing rain and drizzle produced some icing on the envelope also. Theoretical calculations are presented which suggest that, while hazardous icing in freezing rain can occur under certain meteorological conditions, the probability of encountering these conditions is very small in coastal areas and approaches zero 200 to 300 miles offshore.

NACA TN 4222

DROP-SIZE DISTRIBUTIONS FOR IMPINGING-JET BREAKUP IN AIRSTREAMS SIMULATING THE VELOCITY CONDITIONS IN ROCKET COMBUSTORS. Robert D. Ingebo. March 1958. 23p. diagrs., photos., tab. (NACA TN 4222)

Data obtained with a high-speed camera were analyzed by using the Nukiyama-Tanasawa expression $dR/dD = (3.915/D_{30})^6(D^5/120)\exp[-3.915\ D/D_{30}]$, where R is the volume fraction of drops having diameters < D, and D_{30} is the volume-number-mean drop diameter. A range of orifice diameters (D_j = 0.029, 0.060, and 0.089 in.), liquid-jet velocities (V_j = 30, 65, and 100 ft/sec), and velocity differences between the airstream and the liquid jets (ΔV = 0 to 235 ft/sec) gave maximum-observed drop diameters ranging from 180 to 1160 microns. Values of D_{30} varied from 68 to 347 microns, and the following empirical expression was derived: $D_j/D_{30} = 2.64\sqrt{D_jV_j} + 0.97\ D_j\Delta V$, where diameters are expressed in inches and velocities in feet per second.

NACA TN 4223

RELATION OF JOURNAL BEARING PERFORMANCE TO MINIMUM OIL-FILM THICKNESS. F. W. Ocvirk and G. B. DuBois, Cornell University. April 1958. 48p. diagrs., tab. (NACA TN 4223)

The minimum thickness of the oil film is used as a basic variable in performance curves of plain journal bearings under a steady load. Analytical curves based on the short-bearing approximation and the solution of Cameron and Wood are compared with various experimental data. Load capacity and predicted film thickness at friction-curve hook points are correlated with peak-to-valley surface roughnesses. Analytical curves show the effect of bearing-clearance changes on friction power loss, film thickness, and peak pressure in the oil film.

NACA TN 4224

EFFECT OF OVERHEATING ON CREEP-RUPTURE PROPERTIES OF M-252 ALLOY. John P. Rowe and J. W. Freeman, University of Michigan. March 1958. 83p. diagrs., photos., tabs. (NACA TN 4224)

The effects of overheats to temperatures of 1,650°, 1,800°, 1,900°, and 2,000° F were evaluated in terms of the changes in creep-rupture properties at 1,500° F of M-252 alloy under stresses within the range of rupture strengths of the alloy for 80 to 1,000 hours. Overheat periods were predominantly of 2-minute duration and were applied cyclically at approximately 5- or 12-hour intervals. The results are compared with results of similar tests on S-816 and HS-31 alloys.

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NACA TN 4229

STAGNATION-POINT HEAT TRANSFER TO BLUNT SHAPES IN HYPERSONIC FLIGHT, INCLUDING EFFECTS OF YAW. A. J. Eggers, Jr., C. Frederick Hansen, and Bernard E. Cunningham. April 1958. 54p. diagr. (NACA TN 4229)

An approximate theory is developed for the heat flux to the stagnation region of blunt bodies in hypersonic flight. The theory is found to agree with available experimental results including real gas effects such as dissociation. The effect of yaw on heat transfer to a cylindrical stagnation region is treated, and it is predicted that large yaw should cause sizable reductions in the heat-transfer rate.

NACA TN 4230

PRANDTL-MEYER EXPANSION OF CHEMICALLY REACTING GASES IN LOCAL CHEMICAL AND THERMODYNAMIC EQUILIBRIUM. Steve P. Heims. March 1958. 17p. diagrs. (NACA TN 4230)

It is shown how Prandtl-Meyer flow, in which chemical reactions are occurring and are in equilibrium, can be simply and exactly calculated. The property of air which governs the flow is found to be a quantity which depends only on the ratio of enthalpy to the square of the speed of sound; the analogous quantity for an inert gas depends only on the ratio of specific heats. A numerical example is given.

NACA TN 4231

SKIN-FRICTION MEASUREMENTS IN INCOMPRESSIBLE FLOW. Donald W. Smith and John H. Walker. March 1958. 67p. diagrs., photo., tabs. (NACA TN 4231)

Experiments have been conducted to measure the local surface-shear stress and the average skin-friction coefficient in incompressible flow for a turbulent boundary layer on a smooth flat plate having zero pressure gradient. Data were obtained for a range of Reynolds numbers from 1 million to 45 million. The local surface-shear stress was measured by a floating-element skin-friction balance and also by a calibrated total head tube located on the surface of the test wall. The average skin-friction coefficient was obtained from boundary-layer velocity profiles.

NACA TN 4232

A METHOD FOR THE CALCULATION OF WAVE DRAG ON SUPERSONIC-EDGED WINGS AND BIPLANES. Harvard Lomax and Loma Sluder. March 1958. 24p. (NACA TN 4232)

A method is presented for finding the lift, moment, and drag on three-dimensional wings or biplanes with supersonic edges and a straight trailing edge normal to the free stream. The minimum wave drag for fixed lift or volume is given for several special cases. Simple applications of the method may provide some measure of the degree to which more abstract methods for finding minimums can be relied upon as a measure of optimum real systems.

NACA TN 4233

EXPERIMENTAL STUDY OF THE EQUIVALENCE OF TRANSONIC FLOW ABOUT SLENDER CONE-CYLINDERS OF CIRCULAR AND ELLIPTIC CROSS SECTION. William A. Page. April 1958. 45p. diagrs., photos., tab. (NACA TN 4233)

An experimental investigation at transonic speeds of the pressures on a flat, winglike, elliptic cone cylinder and its equivalent body, a circular cone cylinder, provides confirming evidence of the equivalence relationships theoretically predicted by transonic slender-body theory.

NACA TN 4234

PRESSURE DISTRIBUTIONS AT TRANSONIC SPEEDS FOR PARABOLIC-ARC BODIES OF REVOLUTION HAVING FINENESS RATIOS OF 10, 12, AND 14. Robert A. Taylor and John B. McDevitt. March 1958. 80p. diagrs., photo. (NACA TN 4234)

The measured static-pressure distributions at the model surface and in the surrounding flow field are presented for the bodies at zero angle of attack. The Mach number range extended from 0.80 to 1.20 and the Reynolds number range was 23.4×10^6 to 28.6×10^6 (based on the theoretical length of the model).

NACA TN 4236

EFFECTS OF MACH NUMBER AND WALL-TEMPERATURE RATIO ON TURBULENT HEAT TRANSFER AT MACH NUMBERS FROM 3 TO 5. Thorval Tendeland. April 1958. 46p. diagrs. (NACA TN 4236)

Heat-transfer data were evaluated from temperature time histories measured on a cooled cone-cylinder model with turbulent flow at Mach numbers 3.00, 3.44, 4.08, 4.56, and 5.04. The effects of Mach number and wall-temperature ratio on Stanton number are compared with predictions from existing theories. The data were correlated by the T' method which has been used to correlate turbulent skin-friction data.

NACA TN 4239

EXPERIMENTAL INVESTIGATION OF THE DRAG OF FLAT PLATES AND CYLINDERS IN THE SLIPSTREAM OF A HOVERING ROTOR. John W. McKee and Rodger L. Naeseth. April 1958. 42p. diagrs., photos., tab. (NACA TN 4239)

An experimental study has been made of the drag of flat plates and cylinders in the slipstream of a rotor for the condition of hovering away from the effect of the ground. Random fluctuations and a very nonuniform average radial distribution of dynamic pressure

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existed in the slipstream. The drag of constant-chord models spanning the rotor disk was relatively unaffected by distance from the plane of the rotor. An attempt to compare model drag coefficients with values obtained from wind-tunnel tests led to rather inconclusive results, particularly for the cylinders.

NACA TN 4249

A THEORETICAL ANALYSIS OF THE EFFECT OF ENGINE ANGULAR MOMENTUM ON LONGITUDINAL AND DIRECTIONAL STABILITY IN STEADY ROLLING MANEUVERS. Ordway B. Gates, Jr., and C. H. Woodling. April 1958. 20p. diagrs., tab. (NACA TN 4249. Supersedes RM L55G05)

The effect of engine momentum on the longitudinal and directional stability of aircraft in steady rolling maneuvers has been investigated. The results presented indicate that the gyroscopic moments produced on the aircraft by the rotating engine in rolling maneuvers can have an appreciable effect on the range of rolling velocities for which longitudinal or directional instability might occur.

NACA TN 4260

GROUND REFLECTION OF JET NOISE. Walton L. Howes. April 1958. 56p. diagrs., photo. (NACA TN 4260)

The effect of a reflecting plane is determined from theory and experiment. From the theoretical characteristics of far-field acoustic decay a correction-to-free-field procedure is developed for data obtained in the presence of a plane. Measurements of jet noise indicated the practical significance of reflections. Several theoretical predictions were confirmed from experimental decay curves and corrected spectra.

NACA TN 4262

ANALYSIS OF TURBULENT FLOW AND HEAT TRANSFER ON A FLAT PLATE AT HIGH MACH NUMBERS WITH VARIABLE FLUID PROPERTIES. R. G. Deissler and A. L. Loeffler, Jr. April 1958. 61p. diagrs. (NACA TN 4262)

A previous analysis of turbulent heat transfer and flow with variable fluid properties in smooth passages is extended to flow over a flat plate at high Mach numbers, and the results are compared with experimental data. Velocity and temperature distributions are calculated for a boundary layer with appreciable effects of frictional heating and external heat transfer. Viscosity and thermal conductivity are assumed to vary as a power of the temperature, while Prandtl number and specific heat are taken as constant. Skin-friction and heat-transfer coefficients are calculated and compared with incompressible values. The rate of boundary-layer growth is obtained for various Mach numbers.

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N-1597X*

Aeronautical Research Council (Gt. Brit.)
AN EXPERIMENTAL INVESTIGATION OF THE EFFECT OF ENGINE LOADS ON WING STRUCTURES. J. L. Reddaway. 1957. 15p. diagrs., photo. ARC R & M 3062; ARC 13,309. Supersedes RAE Structures 64. (Ask for N-1597X*)

Three cellulose-nitrate model wings, identical except for rib flexibility, have been tested under conditions reproducing typical engine loads. Stress distributions have been found experimentally by means of electrical resistance strain gages. The distribution due to an abrupt change of torsion has been compared with a theory by Williams, and that due to an abrupt change of shear with a theory by Taylor. Local stresses at the engine nacelle are found to be appreciably higher in practice than would have been predicted by either of these theories. The discrepancies, moreover, are found to increase with rib flexibility.

N-11238X*

Aeronautical Research Council (Gt. Brit.)
GUST ALLEVIATION FACTOR. PARTS I, II, AND III. J. K. Zbrozek. 1958. 50p. diagrs., tabs. ARC R & M 2970; ARC 14,319. Supersedes RAE Aero 2421. (Ask for N-11238X*)

The report presents the theoretical calculations of gust alleviation factor made for rigid aircraft and with one degree of freedom only (that is, vertical motion). It is shown that for average gust lengths and for orthodox (tailed) aircraft the influence of the second degree of freedom (that is, pitching) on the value of the gust alleviation factor is negligibly small, providing the pitching moment of inertia and damping are not unduly small. The influence of aspect ratio, the importance of the mass parameter, and the gust shape on the values of the gust alleviation factor are shown.

N-16759X*

Aeronautical Research Council (Gt. Brit.)
INVESTIGATIONS OF THE BEHAVIOUR OF AIRCRAFT WHEN MAKING A FORCED LANDING ON WATER (DITCHING). A. G. Smith, C. H. E. Warren, and D. F. Wright. 1957. iv, 53p. diagrs., photos. ARC R & M 2917; ARC 15,040. Supersedes RAE Aero 2457. (Ask for N-16759X*)

This investigation reviews the work done up to 1948. It is confined in detail to the tests made on hydrodynamic and structural performance in the Free Launching Tank at RAE and the Controlled Launching Tank at MAEE, and includes an analysis of the air-sea rescue questionnaires sent in by air crews who have experienced actual ditchings. Reference is also made to parallel work in the U.S.A. and Germany. The work is analyzed in terms of the techniques of testing used and the results obtained

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for (a) the best approach and touchdown techniques, and (b) the hydrodynamic design and structural strength requirements to permit the aircraft to float for sufficient time to allow the occupants to escape to their dinghies.

N-17505X*

Aeronautical Research Council (Gt. Brit.)
THEORETICAL LOAD DISTRIBUTION ON A WING WITH A CYLINDRICAL BODY AT ONE END. J. Weber. 1957. 18p. diagrs. ARC R & M 2889; ARC 18,413. Supersedes RAE Aero 2467.
(Ask for N-17505X*)

A method is derived for calculating the spanwise load distribution over a lifting wing having a long circular-cylindrical body at one end. The solution is derived for arrangements giving constant induced downwash, but can be generalized to obtain approximate results for other plan forms including those with sweepback. Charts are given for the case in which the sectional lift slope is constant along the span. The lift distribution over both wing and body can be determined quickly, or the overall load obtained directly. The results are applicable to the determination of side forces on a fin in combination with the rear fuselage of an aircraft, or of the lift loading on a wing with a weapon or fuel tank at one tip.

N-34848Y*

Aeronautical Research Council (Gt. Brit.)
TESTS IN THE ROYAL AIRCRAFT ESTABLISHMENT 10-FT X 7-FT HIGH-SPEED TUNNEL ON 50-DEG SWEPT-BACK WINGS. PART I. THREE OF 7.5 PER CENT THICKNESS. PART II. ONE OF 7.5 PER CENT THICKNESS WITH STALL FENCES AND LEADING-EDGE CHORD EXTENSION. A. B. Haines and C. W. Rhodes. 1957. 84p. diagrs., photos., tabs. ARC R & M 3043; ARC 17,414. Supersedes RAE Aero 2522 and RAE Aero 2521.
(Ask for N-34848Y*)

Two wings had sections of RAE 101 shape (maximum thickness at 0.31c) and differed principally in aspect ratio (3.1 and 3.5). The third wing had an aspect ratio of about 3.1 but a different section shape with its maximum thickness further aft at 0.4c and, as shown by the results of the tests, an effectively sharper nose than for the RAE 101 shape. Lift, drag, pitching moment, and root bending moment were measured over the range $M = 0.50$ to about 0.95 at a Reynolds number of about 2×10^6 for all three wings, and for the two smaller aspect-ratio wings for three Reynolds numbers up to about 6×10^6 at $M = 0.2$. Flow patterns were investigated by an oil-film technique and with surface tufts.

N-36637X*

Aeronautical Research Council (Gt. Brit.)
FLIGHT INVESTIGATION OF SOME AIRWORTHINESS PROBLEMS OF CIVIL BOAT SEAPLANES. J. Taylor, J. E. Allen, and A. G. Smith. 1958. 57p. diagrs., photos., tabs. ARC R & M 3017; ARC 17,461. Supersedes MAEE F/Res/228.
(Ask for N-36637X*)

A general investigation has been made into measurement, control, and performance problems associated with boat seaplane take-off and initial climb. Particular attention was paid to engine failure during take-off and initial climb, and also to the criteria to be used for defining the minimum speed for control in the air. The general conclusion is that the present methods used for landplanes are also applicable to seaplanes, with certain modifications to meet water-stability requirements and the greater freedom of maneuver available with respect to heading and position on the water.

N-36899X*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF WING-TAILPLANE AERODYNAMIC INTERACTION ON TAIL FLUTTER. D. E. Williams. 1958. 24p. diagrs. ARC R & M 3065; ARC 17,783. Supersedes RAE Structures 176.
(Ask for N-36899X*)

When aerodynamic coefficients are calculated for tail-plane flutter calculations it is usual to neglect the aerodynamic effect on the tail plane of the disturbance due to the wing and to assume that the tail plane oscillates in a steady stream. In this report a two-dimensional theory, which includes the effect of the wing-tail-plane aerodynamic interaction, is developed for any wing and tail plane in the same horizontal plane. To represent this effect the standard derivatives are introduced.

N-38124X*

Aeronautical Research Council (Gt. Brit.)
THE USE OF PITOT-TUBES IN THE MEASUREMENT OF LAMINAR BOUNDARY LAYERS IN SUPERSONIC FLOW. R. J. Monaghan. 1957. 24p. diagrs., photos., tabs. ARC R & M 3056; ARC 17,896. Supersedes RAE Tech. Note Aero 2369.
(Ask for N-38124X*)

Consideration of experimental results obtained with relatively large pitot tubes in relatively thin laminar boundary layers on cones and flat plates in supersonic wind tunnels and then analyzed using standard pitot equations, shows that the most noticeable distortion of the velocity profile is the appearance of a peak near the outer edge of the boundary layer. The displacement of the main body of the profile, familiar in incompressible-flow tests, may be small in supersonic flow and difficult to detect when making measurements with small-diameter pitot tubes.

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N-38562X*

Aeronautical Research Council (Gt. Brit.)
FLIGHT EXPERIMENTS ON BOUNDARY-LAYER CONTROL FOR LOW DRAG. M. R. Head, D. Johnson, and M. Coxon. 1957. 29p. diagrs., photos., tabs. ARC R & M 3025; ARC 17,780. Supersedes RAE Aero 2541. (Ask for N-38562X*)

Tests have been made with distributed suction applied to a short-span sleeve fitted to the upper surface of the wing of a single-seat Vampire aircraft. Full-chord laminar flow was maintained up to RN in the region of 29 million and Mach number up to 0.70, which was very nearly the critical Mach number of the sleeve section. The suction quantities required were sufficiently small to result in overall reductions in profile drag of between 70 and 80 percent, account being taken of the power required for suction. Difficulties were experienced due to surface roughness, and although these are believed to have resulted largely from the particular type of porous covering used in the tests, the problem of maintaining a sufficiently smooth and clean surface is evidently of crucial importance to full-scale application.

N-40083, pt. 2*

Aeronautical Research Council (Gt. Brit.)
MEASUREMENTS OF TWO-DIMENSIONAL DERIVATIVES ON A WING-AILERON-TAB SYSTEM WITH A 1541 SECTION AEROFOIL. PART II - DIRECT TAB AND CROSS AILERON-TAB DERIVATIVES. K. C. Wight, National Physical Laboratory. 1958. 28p. diagrs., tabs. ARC R & M 3029; ARC 17,437. (Ask for N-40083, pt. 2*)

Measurements have been made for a 1541 section two-dimensional airfoil (N.P.L. 282) with a 20-percent aileron and 4-percent (approx.) tab. In addition some measurements of the direct aileron derivatives have been made for comparison with earlier results together with a number of static derivatives for the wing and controls. The influence is shown of frequency parameter, Reynolds number, position of transition, mean tab angle, and sealing of the control hinge gaps. Some tests have been made with the aileron set at -8° and the tab at $+12^{\circ}$ for which condition the hinge moment on the aileron was zero.

N-42627*

Royal Aircraft Establishment (Gt. Brit.)
AN ABRIDGED LIST OF REPORTS, SPECIFICATIONS, AND INSTRUCTION LEAFLETS, ISSUED BY INSTRUMENTATION DEPARTMENT 1945-1957. N. E. G. Hill. January 1958. 18p. RAE Tech. Memo. Instn. 273, Issue 2. (Ask for N-42627*)

The memorandum contains a list of documents, selected from the publications of Instrumentation Department, R.A.E., during the past 12 years, which are relevant to present technical thought, available, and suitable for general circulation.

N-42806, pt. 3*

Royal Aircraft Establishment (Gt. Brit.)
THE POLYMERISATION OF PHOSPHONITRILIC CHLORIDES. PART III. THE EFFECT OF WATER ON POLYPHOSPHONITRILIC CHLORIDE. F. G. R. Gimblett. November 1957. 13p. diagrs., tabs. RAE Tech. Note Chem. 1322. (Ask for N-42806, pt. 3*)

The influence of water on polyphosphonitrilic chloride has been studied at 25° C and 30° C. The results show that the polymer is rapidly attacked by water, being completely decomposed in 4 to 5 days. The decomposition is brought about essentially by the interchange of chloride and hydroxyl ions between the water and polymer, and its rate is influenced by the temperature, and the gel fraction of the polymer. Some considerations concerning the polymeric gel fraction are discussed.

N-42808Y*

Aeronautical Research Council (Gt. Brit.)
FLUTTER PREDICTION IN PRACTICE. E. G. Broadbent. (Presented to AGARD Structures and Materials Panel, Washington, D. C., April 1956.) 1957. 31p. diagrs., tabs. ARC CP 373. (Ask for N-42808Y*)

Gives a brief summary of the resources available for flutter prediction, both experimental and theoretical. Specific flutter investigations are described for four actual recent flutter incidents, in all of which good agreement is eventually obtained between calculations and full-scale experience. Conclusions for future guidance are drawn from all the examples, and a few points are given from a more general statistical survey of recent incidents.

N-44914X*

Aeronautical Research Council (Gt. Brit.)
A METHOD FOR CALCULATING THE PRESSURE DISTRIBUTION OVER JET-FLAPPED WINGS. D. Küchemann. 1957. 25p. diagrs. ARC R & M 3036; ARC 18,474. Supersedes RAE Aero 2573. (Ask for N-44914X*)

The incompressible flow past an airfoil with a thin jet emerging from its lower surface somewhere near the trailing edge is considered. Based on work of Gates, Maskell, and Spence, a simple method is described for calculating the pressure distribution over wings of nonzero thickness. The effects of finite aspect ratio and of camber are included and the method can be used for design purposes. The possible effects of sweep are briefly discussed. It is pointed out that a saddleback chordwise loading is typical for airfoils with jets and that this is the basic reason for most of the aerodynamic advantages of the jet-flap system.

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N-44960X*

Aeronautical Research Council (Gt. Brit.)
EXPERIMENTAL CORRELATION BETWEEN THE ENDURANCE OF A WING SPAR JOINT AND THE RATIO BETWEEN 0.1 PER CENT PROOF AND ULTIMATE TENSILE STRENGTHS OF THE MATERIAL. W. A. P. Fisher. 1958. 18p. diagrs., photos., tabs. ARC CP 371. (Ask for N-44960X*)

Axial fatigue tests were made on a series of specimens representing the Viking outer wing spar joint. Significant correlation was found between low Proof/U.T.S. ratios of the material and high endurance of the joint. Tests on Dove boom research specimens indicate that this correlation is not peculiar to the Viking joint and the results are in agreement with theoretical and experimental work published by K. Gunn.

N-48431X*

Aeronautical Research Council (Gt. Brit.)
AN ANALOGUE COMPUTER FOR CONVECTIVE HEATING PROBLEMS. H. G. R. Robinson. 1957. 24p. diagrs., photo., tabs. ARC CP 374. (Ask for N-48431X*)

The computer was designed to assist in the solutions of kinetic heating problems which occur in guided weapon design. Its flexibility allows it to be used for a number of problems involving one-dimensional convective heating in a wall of finite thickness, providing the basic data such as the source temperature of the convective medium and the heat transfer coefficient in the region of interest are known. Completely arbitrary time varying functions of source temperatures and heat transfer coefficient are acceptable.

N-48614, 301-350*

Aeronautical Research Council (Gt. Brit.)
LIST OF CURRENT PAPERS PUBLISHED FOR THE AERONAUTICAL RESEARCH COUNCIL (NUMBERS 301-350). 1957. 5p. ARC CP 350. (Ask for N-48614, 301-350*)

N-48652X*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT ON WEATHER MINIMA OF APPROACH SPEED, COCKPIT CUT-OFF ANGLE AND TYPE OF APPROACH COUPLER FOR A GIVEN LANDING SUCCESS RATE AND LEVEL OF SAFETY. E. S. Calvert and J. W. Sparke. 1958. 21p. diagrs. ARC CP 378. (Ask for N-48652X*)

This note attempts to make a realistic assessment of the performance of various approach couplers using the results of some tests made during the past 2 years, both full scale and on a landing simulator. The influence of cockpit cut-off angle, approach speed, ground lighting pattern, and runway width on the weather which can be defeated by a coupler of given accuracy is discussed. One important result of the simulator tests is that in marginal weather visual guidance in the vertical plane may be defective at heights above 100 feet. The implications of this on the cockpit and G.C.A. procedures are pointed out, and some suggestions are made for improving safety.

N-48789X*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF INLET CIRCUMFERENTIAL MALDISTRIBUTION ON AN AXIAL COMPRESSOR STAGE. R. C. Turner, J. Ritchie, and C. E. Moss. 1958. 16p. diagrs. ARC R & M 3066; ARC 19,047. Supersedes NGTE R.203. (Ask for N-48789X*)

This report describes tests on a single compressor stage with circumferentially nonuniform inlet conditions. The stage was a model of the first stage of a typical modern aircraft-engine compressor, and the tests were planned as part of an investigation into the surge behavior of compressors with inlet flow maldistribution. It was found that with a roughly rectangular inlet velocity distribution of amplitude ±25 percent of the mean value, the surge flow instead of showing an expected increase was almost unchanged, being in fact slightly reduced. The efficiency fell greatly, with an accompanying small drop in temperature-rise coefficient. The velocity profile was distorted and its amplitude greatly decreased at the outlet of the stage.

CN-48808, pt. 3*

Royal Aircraft Establishment (Gt. Brit.)
RAIN EROSION PART III. A GRAVIMETRIC ASSESSMENT OF THE EROSION RESISTANCE OF VARIOUS MATERIALS. A. A. Fyall, R. B. King, and R. N. C. Strain. September 1957. 24p. diagrs., tabs. RAE Report Chem. 513. (Ask for CN-48808, pt. 3*)

Details are given of a gravimetric assessment of the rain erosion characteristics of a variety of materials, including a selection of metallic alloys and several polymers. From results obtained on Perspex, empirical laws are derived relating erosion rates with intensity of rainfall and variation of speed in the range 300-500 miles per hour; a threshold velocity is postulated below which no erosion occurs. Initiation times for surface breakdown and steady erosion rates are tabulated and graphs are shown illustrating the characteristics of Perspex, various polyethylenes, polytetrafluoroethylene, nylon and copper, magnesium, and aluminum alloys.

N-50131, pt. 2*

Royal Aircraft Establishment (Gt. Brit.)
THE SHRINKAGE AND EXTENSIBILITY OF HEATED YARNS. PART II. J. E. Swallow. October 1957. 24p diagrs., tabs. RAE Tech.Note Chem.1319. (Ask for N-50131, pt. 2*)

The effects of heat on the creep and recovery of nylon, Terylene, and Fortisan yarns at various stress levels are described. The residual deformation after cycles of heat and stress is discussed, with

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special reference to heat setting. Load-extension curves at elevated temperatures are considered in relation to thermal shrinkage and creep.

N-52439Y*

Aeronautical Research Council (Gt. Brit.)
THE THEORETICAL DETERMINATION OF NORMAL MODES AND FREQUENCIES OF VIBRATION. I. T. Minhinnick. 1957. 30p. diagrs. ARC R & M 3039; ARC 18,414. Supersedes RAE Structures 197. (Ask for N-52439Y*)

Various methods that have been devised for the determination of the natural frequencies and normal modes of aircraft are discussed and their accuracy and the amount of work that they entail are compared. An extensive bibliography is given in an appendix. The discussion is mainly from the point of view of the flutter analyst, who commonly bases his analyses on the normal modes, but the description and comparison of the various methods should be of general interest.

N-57277X*

Aeronautical Research Council (Gt. Brit.)
A SIMPLIFIED FORM OF THE AUXILIARY EQUATION FOR USE IN THE CALCULATION OF TURBULENT BOUNDARY LAYERS. T. J. Black, Cambridge University. 1958. 19p. diagrs. ARC CP 370. (Ask for N-57277X*)

A new type of auxiliary equation has been evolved for calculating the development of the form-parameter H $(= \delta^*/\theta)$ in turbulent boundary layers with adverse pressure gradients. This has been achieved by considerably extending part of a previous analysis by Spence. The chief advantage of this new method lies in the rapidity and ease with which the growth of H may be calculated, while results compare favorably with those obtained using the methods of other investigators. Several results of the calculations are compared with experiment.

N-58770*

Aeronautical Research Council (Gt. Brit.)
THE ACCURACY OF MEASUREMENT OF TURBULENT SKIN FRICTION BY MEANS OF SURFACE PITOT-TUBES AND THE DISTRIBUTION OF SKIN FRICTION ON A FLAT PLATE. R. A. Dutton, University of Cambridge. 1957. 18p. diagrs. ARC R & M 3058; ARC 18,658. (Ask for N-58770*)

An experimental study has been made of two-dimensional turbulent boundary-layer flow with zero pressure gradient. The investigation was made to determine the accuracy of a method proposed by Preston for measuring the local turbulent skin friction. The general momentum equation was used in conjunction with measurements of skin friction by Preston's method, to obtain increments in momentum thickness which could be compared with the measured values. The experiments were made on a smooth flat plate, 6 feet long, which spanned the working section of a return-circuit wind tunnel. Transition was promoted by trip wires and glass-paper strips. A constant Reynolds number of 3.9×10^5 per foot was maintained throughout the experiments.

N-58771*

Aeronautical Research Council (Gt. Brit.)
SOME PROPOSALS REGARDING THE DEFINITIONS OF TERMS RELATING TO VARIOUS FLOW REGIMES OF A GAS. C. H. E. Warren and A. D. Young. 1958. 7p. diagr. ARC CP 368. (Ask for N-58771*)

This paper proposes definitions for the following terms: Speed of sound, Mach number, flow Mach number, stream Mach number, aircraft or flight Mach number, subsonic speed, supersonic speed, subsonic flow, supersonic flow, transonic flow, transonic speed, hypersonic flow, hypersonic speed, continuum flow, slip flow, free molecule flow, subsonic wind tunnel, supersonic wind tunnel, transonic wind tunnel, hypersonic wind tunnel, and low-density wind tunnel.

N-58861*

Royal Aircraft Establishment (Gt. Brit.)
THE MECHANICAL PROPERTIES IN TENSION AND COMPRESSION AT ROOM TEMPERATURE AND 1000° C OF THREE MOULDED CARBON MATERIALS. M. S. Binning and B. F. Billing. September 1957. 21p. diagrs., photos., tab. RAE Tech. Note Met. 271. (Ask for N-58861*)

Three grades of molded carbon have been tested in tension and compression at room temperature and 1000° C. Tests at 1000° C were made with the specimens in an argon atmosphere, and heating was by electrical resistance methods. Values of Young's modulus, failing stress, and plastic strain at fracture were obtained and found to vary considerably with grade of molded carbon. Young's modulus in both tension and compression was approximately 6 percent higher at 1000° C than at room temperature, while the failing strength in compression increased by between 20 and 75 percent depending on the grade, in going from room temperature to 1000° C.

N-58986*

Aeronautical Research Council (Gt. Brit.)
REPORT OF THE DEFINITIONS PANEL ON DEFINITIONS TO BE USED IN THE DESCRIPTION AND ANALYSIS OF DRAG. 1958. 11p. diagrs. ARC CP 369. (Ask for N-58986*)

Terms used in the description and analysis of the external drag of a body (with or without internal flow) are considered, and definitions suggested for the various components of the drag. Care has been taken to insure that the proposed terms are consistent with those used in the Panel's report on thrust.

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N-59106*

Royal Aircraft Establishment (Gt. Brit.)
THE TENSILE AND FATIGUE PROPERTIES OF A LARGE SECTION LIGHT ALLOY SPAR WITH REFERENCE TO MASS AND DIRECTIONALITY EFFECTS. T. R. G. Williams. October 1957. 23p. diagrs., photos., tabs. RAE Tech.Note Met.274. (Ask for N-59106*)

The spar which was to specification DTD 363 was of an irregular section 8-1/2 inches in width by 6 inches in depth. Tensile and fatigue properties were determined on material taken from the outside and inside regions and in both the longitudinal and transverse directions. A large variation in tensile properties was found between center and outside, and in the longitudinal and transverse directions, but little variation in fatigue strength occurred for long endurances. However, fatigue strengths for short endurances were more closely related to the tensile properties. Metallographic observations of fatigue behavior were made on previously electropolished material in various conditions.

N-59109*

Royal Aircraft Establishment (Gt. Brit.)
SUBSONIC WIND-TUNNEL TESTS OF VARIOUS FORMS OF AIR INTAKE INSTALLED IN A FIGHTER-TYPE AIRCRAFT. B. J. Prior and C. N. Hall. September 1957. 83p. diagrs., photos., tabs. RAE Report Aero 2576. (Ask for N-59109*)

Tests have been made at Mach numbers up to 0.93 in the R.A.E. 10-ft by 7-ft wind tunnel to examine how the longitudinal characteristics of a fighter-type aircraft are affected by the installation of air intakes in either the nose, fuselage sides, or wing roots. None of these intakes alter the lift or pitching-moment characteristics significantly, but their effects on external drag vary, and only the nose intake avoids an increase.

N-59111*

Royal Aircraft Establishment (Gt. Brit.)
REAL GAS EFFECTS ON SHOCK-TUBE PERFORMANCE AT HIGH SHOCK STRENGTHS. J. L. Stollery, Imperial College. November 1957. 24p. diagrs. RAE Tech.Note Aero 2413. (Ask for N-59111*)

Calculations have been made to find the flow conditions behind shock waves in argon-free air of strengths $M_S = U/a_1$ up to about 35. The tables used are based on the currently accepted value for the dissociation energy of nitrogen of 9.758 e.v. per molecule, and are for equilibrium conditions. Two cases only have been considered, namely:

(1) $P_1 = \frac{1}{10}$ atm, $T_1 = 290^\circ$ K

(2) $P_1 = \frac{1}{100}$ atm, $T_1 = 290^\circ$ K

The driving conditions needed to produce such strong shocks have been calculated assuming "ideal" hydrogen ($\gamma = 1.41$) to be the driving gas. In conclusion, the test conditions available through expanding the flow behind the shock are presented for an expansion ratio of 225 and the question of flight simulation is discussed.

N-59115*

National Gas Turbine Establishment (Gt. Brit.)
INVESTIGATIONS ON AN EXPERIMENTAL AIR COOLED TURBINE. PART III. THE EFFECTS OF COOLING ON THE OVERALL TURBINE AERODYNAMIC PERFORMANCE AND INITIAL OPERATION AT AN INLET GAS TEMPERATURE OF 1400° K. D. E. Fray and N. E. Waldren. January 1958. 28p. diagrs., photos. NGTE Report R.219. (Ask for N-59115*)

Further tests on an experimental air-cooled turbine have been carried out to examine the effect on the turbine aerodynamic performance of cooling-air discharge from the blade tips into the main gas stream. With the design quantities of cooling air applied, a measured loss of efficiency of 2 percent was recorded. The effect of the nozzle blade tip clearance of 0.052 inch was also examined and it is demonstrated that a gain in efficiency of 5 percent can be realized if this clearance is eliminated. Initial operation of the turbine at an inlet gas temperature of 1400° K for 50 hours is also reported and is shown to be satisfactory.

N-59116*

National Gas Turbine Establishment (Gt. Brit.)
SOME TESTS ON CASCADES OF COMPRESSOR BLADES FITTED WITH VORTEX GENERATORS. R. Staniforth. January 1958. 18p. diagrs., photos. NGTE Memorandum M.314. (Ask for N-59116*)

Cascade tests showed that the fitting of vortex generators to the convex surface of compressor blades increased the two-dimensional losses under all conditions. A more detailed investigation indicated that the vortex generators were, in fact, suppressing shock-induced flow separation, but that boundary-layer separation still occurred at about 50 percent chord - probably due to the increased boundary-layer thickness produced by the vortex generator drag. While there is always a possibility that some different configuration will be successful, the scheme of increasing the drag critical Mach number of a compressor cascade by means of vortex generators is, on the basis of available test evidence, a failure.

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N-59118*

Aeronautical Research Council (Gt. Brit.)
THE VIBRATIONS OF A THIN-WALLED STIFFENED CYLINDER IN AN ACOUSTIC FIELD. J. H. Foxwell and R. E. Franklin, University of Southampton. December 23, 1957. 22p. diagrs., tab.
ARC 19,743; LA 71. (Ask for N-59118*)

When a vibrating structure encloses a volume of fluid the acoustic effects within this volume modify considerably the response characteristics of the structure, provided the cylinder is vibrating in radial modes only. Measurements made of the displacement caused by a particular sound wave are of the same order as the values predicted. The calculation of the response of the cylinder to an acoustic wave also yields the sound field inside the cylinder and again the results are in general agreement with practical experience.

N-59119*

Aeronautical Research Council (Gt. Brit.)
ON THE ACCURACY OF THE REPRESENTATION OF A LIFTING LINE BY A FINITE SET OF HORSESHOE VORTICES. A. R. Collar, University of Bristol. December 1957. 15p. diagrs.
ARC 19,784; LA 75; FM 2630. (Ask for N-59119*)

Many problems in aeronautics arise in which it is convenient to represent a lifting surface by a lifting line, and further to represent the lifting line by a finite set of horseshoe vortices. Given the strengths of the vortices, the induced downwash is readily written down; but the inverse problem is less easy. The present note has been written because there are some points of interest in the method of reciprocation of the matrix involved in the solution of the inverse problem, and because the final result sheds some light on the accuracy of the representation.

N-59122, pt. 1*

Aeronautical Research Council (Gt. Brit.)
A RAPIDLY CONVERGENT PROCESS FOR SOLVING THE EQUATIONS OF SUBSONIC FLOW. I. TWO-DIMENSIONAL FLOW. A. B. Tayler, Mathematical Institute. August 14, 1957. 41p. diagrs., tabs.
ARC 19,470; FM 2573. (Ask for N-59122, pt. 1*)

The irrotational inviscid compressible equations for the flow of a perfect gas have been transformed into a symmetrical form by introducing new variables $\underline{s} = \left(\frac{\rho}{\rho_0}\right)^{\frac{1}{2}} \frac{q}{a_0}$ and $\sigma = \frac{1}{2} \log_e \frac{\rho_0}{\rho}$. Bernoulli's equation then becomes a relationship between $|\underline{s}|^2$ and σ which is independent of initial conditions. Results are given for a circular cylinder without circulation at $M_\infty = 0.4$.

N-59531*

Aeronautical Research Council (Gt. Brit.)
TESTS ON A TWO-DIMENSIONAL SLOTTED-WALL WIND TUNNEL WITH LATERAL OBSTRUCTIONS BEHIND THE SLOTS. A. Chinneck, C. J. Berry, and P. J. Peggs, National Physical Laboratory. 1958. 28p. diagrs., photos. ARC CP 372.
(Ask for N-59531*)

Tests have been made with lateral strips fixed to the back of the slotted walls of the N.P.L. 9- by 3-inch high-speed wind tunnel to find whether such strips would have a serious effect on the flow. The strips gave rise to shock waves at the beginning of the slotted section at supersonic speeds but the strength of these shock waves could be greatly reduced by displacing the strips a small distance from the wall. Observations of the flow round a two-dimensional 10-percent-thick RAE 104 airfoil showed that the strips had an effect similar to that of reducing the ratio of open to total area.

N-59532*

Aeronautical Research Council (Gt. Brit.)
A NUMERICAL METHOD FOR CALCULATING THE STARTING AND PERTURBATION OF A TWO-DIMENSIONAL JET AT LOW REYNOLDS NUMBER. R. B. Payne, University of Manchester. 1958. 50p. diagrs. ARC R & M 3047; ARC 18,846.
(Ask for N-59532*)

There is a great need for a method of attacking directly the full equations of motion of an unsteady viscous flow. Recent advances in high-speed electronic computers made available a powerful device for performing the computations. In order to follow numerically a turbulent flow, a large number of closely spaced mesh points would be required to include both the large-scale and small-scale effects. It is therefore necessary to confine the range of eddy sizes, so that a suitably low Reynolds number must be chosen. The plane jet was chosen because of the simplicity of the image vortex system required to satisfy the boundary condition. The method could also be applied to the flow past a circular cylinder and the formation of the Kármán vortex street.

N-59533*

Aeronautical Research Council (Gt. Brit.)
ON FLUTTER TESTING IN HIGH-SPEED WIND TUNNELS. N. C. Lambourne and C. Scruton, National Physical Laboratory. 1958. 20p. diagrs., tab. ARC R & M 3054; ARC 18,714.
(Ask for N-59533*)

The requirements for simulating in a wind tunnel flutter conditions appropriate to high-speed flight are discussed, and an assessment is made of the desirable features of a wind tunnel suitable for flutter testing at transonic and supersonic speeds.

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N-59534*

Aeronautical Research Council (Gt. Brit.)
SOME EXPERIMENTS WITH SONIC THROATS DOWNSTREAM FROM THE WORKING-SECTION OF A SLOTTED-WALL HIGH-SPEED TUNNEL.
A. Chinneck and N. A. North, National Physical Laboratory. 1957. 26p. diagrs., photos.
ARC R & M 3053; ARC 18,396. (Ask for N-59534*)

Tests have been made in the 9- by 3-inch high-speed tunnel to investigate the use of sonic throats downstream from the working section of a slotted-wall high-speed tunnel employing diffuser suction. It was found that such throats behaved at subsonic speeds in a manner similar to their behavior in a solid-wall tunnel. Tests were made with various configurations, including the conditions which could be expected on the 18- by 14-inch and 36- by 14-inch high-speed tunnels at the N.P.L. It was found that the throat mechanisms at present used with the subsonic liners on these tunnels should work satisfactorily, and that the power required should be of the same order as that required to run the unchoked slotted walls at unit Mach number.

N-59612, 2751-2850*

Aeronautical Research Council (Gt. Brit.)
PUBLISHED REPORTS AND MEMORANDA OF THE AERONAUTICAL RESEARCH COUNCIL. 1958.
6p. ARC R & M 2850.
(Ask for N-59612, 2751-2850*)

CN-59674*

Royal Aircraft Establishment (Gt. Brit.)
THE MEASUREMENT OF THE TIME DELAY OF ULTRASONIC DELAY LINES. J. Sears. December 1957. 19p. diagrs. RAE Tech.Note GW 478.
(Ask for CN-59674*)

A method of determining the delay of wide-band ultrasonic delay lines to an accuracy of better than 0.1 microsecond is described. The experimental technique and estimation of errors are given. A digest of alternative methods is appended.

N-59676*

Royal Aircraft Establishment (Gt. Brit.)
THE PRESENT STATUS OF AIRCRAFT STABILITY PROBLEMS IN THE AEROELASTIC DOMAIN.
A. S. Taylor. December 1957. 29p. RAE Tech. Note Aero 2538. (Ask for N-59676*)

Recent developments in the study of the effects of structural flexibility on aircraft stability and control (with particular reference to dynamic stability) are discussed. The relevant literature, relating to both theoretical and experimental work, is reviewed (section 3) against the theoretical background outlined in section 2, with a view to assessing the importance of these effects and establishing how elaborate a mathematical treatment is necessary to predict them with reasonable accuracy. The advantages of an integrated approach to this and associated aeroelastic problems, whereby the solutions to several related problems may be obtained as special cases of a more generalized problem, are briefly discussed.

N-59677*

Royal Aircraft Establishment (Gt. Brit.)
THE CALCULATION OF THE INVISCID FLOW BETWEEN A DETACHED BOW WAVE AND A BODY.
K. W. Mangler and M. E. Evans. October 1957. 37p. diagrs. RAE Tech.Note Aero 2536.
(Ask for N-59677*)

The inviscid flow past a symmetrical blunt body at high supersonic speed is calculated by a numerical method. It starts from the shock, the shape of which must be assumed. The region of the flow between the shock and the body which includes the subsonic part is obtained by a step-by-step process and the shape of the body producing the shock is calculated. The remainder of the supersonic part is calculated by the method of characteristics for which the body shape can be prescribed. The results of the calculation obtained for the two-dimensional flow past a circular cylinder at a Mach number of 7 and a specific heat ratio $\gamma = 1.4$ are described in detail.

N-59678*

Royal Aircraft Establishment (Gt. Brit.)
A THEORY OF THE SEPARATED FLOW FROM THE CURVED LEADING EDGE OF A SLENDER WING.
J. H. B. Smith. November 1957. 25p. diagrs., tabs. RAE Tech.Note Aero 2535.
(Ask for N-59678*)

The simple model used by Brown and Michael to represent the flow past a slender delta wing with leading-edge separation is extended to wings of more general plan form, which still have unswept trailing edges and pointed apexes. The vorticity of the fluid near the leading edge is represented by an isolated vortex of varying strength which is curved in the non-conical cases considered here. A step-by-step method of calculation is used which starts from an assumed conical flow near the apex and employs the condition of zero total force on the vortex system in one cross-flow plane to obtain the configuration in the next. Numerical values of the coordinates and strength of the vortex, the lift coefficient, and the center-of-pressure position are found for three planform families at different incidences.

BRITISH REPORTS

N-59686*

Royal Aircraft Establishment (Gt. Brit.)
THE INFLUENCE OF AERODYNAMIC HEATING ON THE FLEXURAL RIGIDITY OF A THIN WING.
E. H. Mansfield. September 1957. 38p. diagrs.
RAE Report Structures 229. (Ask for N-59686*)

This report considers the loss of flexural rigidity of a thin wing due to the presence of middle surface stresses resulting from aerodynamic heating. The spanwise properties of the wing are assumed constant but the wing section is arbitrary. The loss of flexural rigidity is comparable with the corresponding loss of torsional rigidity.

N-59688*

National Gas Turbine Establishment (Gt. Brit.)
TESTS ON AN EXPERIMENTAL THREE-STAGE TURBINE FITTED WITH LOW REACTION BLADING OF UNCONVENTIONAL FORM. I. H. Johnston and G. E. Sansome. January 1958. 36p. diagrs., photo., tabs. NGTE Report R.218.
(Ask for N-59688*)

A three-stage turbine designed for high stage loading has been tested cold over a wide range of operating conditions and the test results have been compared with calculated performance figures. Interblade row traverses have demonstrated the development of flow in a multistage turbine and have provided direct measurements of stator blade loss coefficients.

N-59728*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE CONVERGENCE OF NUMERICAL SOLUTIONS OF THE NAVIER-STOKES EQUATIONS.
A. Thom and C. J. Apelt. 1958. 8p. diagrs.
ARC R & M 3061; ARC 18,481. (Ask for N-59728*)

A criterion is given for the convergence of numerical solutions of the Navier-Stokes equations in two dimensions under steady conditions. The criterion applies to all cases of steady viscous flow in two dimensions and shows that if the local "mesh Reynolds number," based on the size of the mesh used in the solution, exceeds a certain fixed value, the numerical solution will not converge.

N-59729*

Aeronautical Research Council (Gt. Brit.)
CALCULATION OF DERIVATIVES FOR A CROPPED DELTA WING WITH SUBSONIC LEADING EDGES OSCILLATING IN A SUPERSONIC AIR STREAM.
J. Watson, National Physical Laboratory. 1958.
34p. diagrs., tab. ARC R & M 3060; ARC 18,573.
(Ask for N-59729*)

The lift, pitching moment, and full-span constant-chord control hinge moment are derived for a cropped delta wing describing harmonic plunging and pitching oscillations of small amplitude and low-frequency parameter in a supersonic airstream. It is assumed that (a) the wing has subsonic leading edges, and (b) the wing is sufficiently thin and the Mach number sufficiently supersonic to permit the use of linearized theory. Expressions for the various derivative coefficients are obtained for a particular delta wing of aspect ratio 1.8 and taper ratio 1/7; these are evaluated and tabulated for Mach numbers 1.1, 1.15, 1.2, 1.3, 1.4, 1.5, 1.6, and 1.944.

CN-59995*

Royal Aircraft Establishment (Gt. Brit.)
THE PREPARATION AND PROPERTIES OF GLASS-POLYESTER LAMINATES OF LOW VOID CONTENT: PART I. THE REPRODUCIBILITY OF GLASS-POLYESTER LAMINATES. PART II. VOID FORMATION IN GLASS-POLYESTER LAMINATES.
N. C. W. Judd and P. L. McMullen. October 1957.
40p. diagrs., photos., tabs. RAE Report Chem.514.
(Ask for CN-59995*)

A series of 15 low void-content laminates have been made under strictly controlled conditions by three operators of varying degrees of skill using a standard technique. Some properties of these laminates have been studied, the most important of which was the flexural strength. Attempt has been made to define the different types of void which are formed during application of the vacuum bag molding technique. A method of determining void content has been suggested.

CN-59996*

Royal Aircraft Establishment (Gt. Brit.)
FINAL REPORT ON SINTERING OF ZINC OXIDE.
J. Hutchings and J. P. Roberts, (with determination of excess zinc by H. J. Allsopp). October 1957.
38p. diagrs., tab. RAE Report Met.93.
(Ask for CN-59996*)

Oxygen enhanced the shrinkage of powder pressings of some zinc oxide materials but retarded the shrinkage of pressings of others. A connection between excess zinc content and chemisorption of oxygen was found. Change in the surface of the oxide, probably involving interstitial zinc-chemisorbed oxygen complexes, was considered to explain enhanced sintering in oxygen. Change of composition of the volume of the oxide was considered to explain retardation of sintering by oxygen. A diffusion model for shrinkage accounted for the observations better than one based on plastic flow. Calculation suggested that zinc diffusion into the pores during sintering occurred predominantly through the grain boundaries. Various subsidiary influences on the sintering were observed and interpreted.

CN-59997*

Aeronautical Inspection Directorate (Gt. Brit.)
THE PRECISION MEASUREMENT OF THE DIAMETER AND DEFORMATION OF SMALL STEEL BALLS. V. H. Cripps. February 1957. 6p. diagr.
AID Report Metro/7. (Ask for CN-59997*)

A new method of measuring steel balls for miniature bearings is described in which a series of continuous and high precision measurements are obtained - the

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ball being rolled between the anvils of a specially designed measuring apparatus. The method reveals the existence of such diametral variations as might remain unrecorded by a method relying on random point to point measurements. Furthermore, the handling difficulties associated with the latter method are almost completely eliminated. The apparatus has also been used to determine the maximum load a ball will withstand without permanent deformation when placed between hardened, flat, and parallel steel surfaces.

N-59998*

Royal Aircraft Establishment (Gt. Brit.)
SHEAR STRENGTH, CREEP AND STRESS-RELAXATION OF METAL ADHESIVE JOINTS AT ELEVATED TEMPERATURES. A. Baker. March 1957. 19p. diagrs., tabs. RAE Tech.Note Chem. 1300. (Ask for N-59998*)

Light alloy joints of Redux and Araldite were tested at normal and elevated temperatures. Data are presented for shear strength at 100° and 150° C, and for stress relaxation at 100° and (for Araldite only) at 120° C. The effect of aging or overcuring is discussed and additional data on creep are given for Redux. The note is a sequel to R.A.E. Technical Note Chem. 1168.

CN-59999*

Royal Aircraft Establishment (Gt. Brit.)
EXPERIMENTS ON MELTING TITANIUM IN OXYGEN DEFICIENT THORIA CRUCIBLES. R. L. Bickerdike, G. Hughes, and D. Clark. January 1958. 12p. photos., tabs. RAE Tech.Note Met.281. (Ask for CN-59999*)

Eight crucibles, of about 8 cc capacity, of composition corresponding to $ThO_{1.5}$ were obtained from the Atomic Weapons Research Establishment, Aldermaston. Samples of titanium were heated in them under vac. at temperatures between 1550° and 1770° C for various periods. After cooling, metallographic examination and hardness measurements were made, oxygen was determined by vacuum fusion, X-ray work was done, and some thorium determinations were made. Titanium was melted in a commercial ThO_2 pot for comparison. The $ThO_{1.5}$ crucibles contained free thorium, and all except one leaked. The metal retained contained particles of a thoria phase, some free thorium, and a small amount of oxygen in solid solution in the titanium; it had a hardness of 172 to 200 D.P.N. A higher hardness, with more oxygen in solid solution resulted from melting in commercial thoria. The $ThO_{1.5}$ material would not be a satisfactory crucible material.

N-60000*

Royal Aircraft Establishment (Gt. Brit.)
SPECTROGRAPHIC INVESTIGATION OF A CORDITE FLAME AT HIGH PRESSURES. G. A. Heath. December 1957. 22p. diagrs., photos., tabs. RAE Tech.Note RPD 161. (Ask for N-60000*)

The structure of the SU/K cordite flame over the pressure range of 400 to 1600 lb/sq in. (gage) has been studied spectrographically. The intense brightness of the final reaction ("explosion") zone of the flame has been shown to be due to continuous radiation from carbon particles. From quantitative intensity measurements the temperature of the explosion zone at all pressures was found to be 2350° K which is less than the theoretical value assuming no loss of heat by radiation. It is pointed out, however, that this discrepancy could be explained by such loss.

N-60002*

Aeronautical Research Council (Gt. Brit.)
THE VELOCITY DISTRIBUTION IN A TURBULENT BOUNDARY LAYER ON A FLAT PLATE. R. A. Dutton, University of Cambridge. October 4, 1957. 24p. diagrs. ARC 19,576; FM 2595. (Ask for N-60002*)

Detailed velocity traverses have been made in a turbulent boundary layer on a flat plate with zero pressure gradient. Local skin friction was measured using Preston's surface pitot-tube technique. A constant Reynolds number per foot of 3.9×10^5 was maintained throughout the experiments. The velocity distributions are compared with established inner laws and velocity defect laws. The influence of the turbulent fluctuating velocities on measurements with a pitot tube, and the effect of variation of static pressure through the boundary layer, are also considered; these are shown to be appreciable in the region where the inner law is assumed to hold.

N-60003*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF JET NOISE ON AIRCRAFT STRUCTURES. B. L. Clarkson, University of Southampton. December 5, 1957. 24p. diagrs. ARC 19,712; LA 67. (Ask for N-60003*)

The present state of knowledge on the problem of fatigue failure due to vibrations excited by jet noise is reviewed. It is concluded that it should currently be possible to make reasonable estimates of the stress levels set up in a structure by jet noise but, in general, the resultant fatigue life of the components cannot be estimated with any confidence.

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N-60006*

Royal Aircraft Establishment (Gt. Brit.)
THE CALCULATION OF THE ROTARY LATERAL STABILITY DERIVATIVES OF A JET-FLAPPED WING. H. H. B. M. Thomas and A. J. Ross. January 1958. 24p. diagrs., tab. RAE Tech.Note Aero 2545. (Ask for N-60006*)

The problem of calculating the rotary lateral stability derivatives for a straight wing with a thin jet emerging at the trailing edge is considered. Based on Maskell's analysis of the effect of finite aspect ratio on lift and drag, a solution is described which shows that the presence of the jet has considerable effect on the stability derivatives.

CN-60007*

Royal Aircraft Establishment (Gt. Brit.)
MECHANICAL ANISOTROPY OF INFLATABLE WING FABRICS UNDER BIAXIAL STRESS. A. Baker and E. Mikolajewski. August 1957. 17p. diagrs. RAE Tech.Note Chem.1314. (Ask for CN-60007*)

Biaxial stress-strain relationships have been derived for samples of gray and aluminized inflatable wing fabrics at particular fiber orientations. The two-ply rubber-proofed cotton fabrics were highly anisotropic, on account of their differing warp and weft extensibilities, in spite of their bias construction. A partial correlation was found between biaxial and bursting tests. The influence of time is briefly discussed.

CN-60008*

Royal Aircraft Establishment (Gt. Brit.)
ON TRANSIENT RESPONSE RECORDING WITH AN OSCILLATORY INSTRUMENT. H. Voepel. November 1957. 19p. diagrs. RAE Tech.Note Aero 2540. (Ask for CN-60008*)

The problems involved in recording, by means of an oscillatory instrument, the transient response of a second-order system have been investigated, with special reference to the beginning of the response including the analysis of discontinuous initial values. The theoretical investigation has been extended to the recording of the motions of systems having finite damping, and it is shown that even a small amount of damping (0.1 of critical) has a marked influence on recording errors in that the useful range of frequency ratios is reduced compared with the more well-known ratios for recording the response of a system performing a simple harmonic motion of constant amplitude.

CN-60011*

Royal Aircraft Establishment (Gt. Brit.)
NOTE ON THE POSSIBILITY OF RAINDROPS BEING SHATTERED BY THE AIR DISTURBANCES CAUSED BY A MOVING BODY. D. C. Jenkins. October 1957. 36p. diagrs., photos. RAE Tech.Note Mech. Eng. 239. (Ask for CN-60011*)

The possibility of raindrops being shattered by the air disturbances caused by a moving body is considered in relation to the air-flow conditions imposed on the drops and the conditions necessary to cause shatter. The limited data available are applied to some cases corresponding to aircraft flight in rain. This analysis suggests that disintegration of some of the drops may be well advanced before they reach the aircraft surface.

MISCELLANEOUS

Errata on NACA Rept. 1299, by Smiley. 1957.

Errata on NACA Rept. 1328, by Syvertson and Dennis. 1957.

Errata on NACA TN 3985, by Priem. July 1957.

Errata on NACA TN 4046, by Eggers, Jr., Allen, and Neice. October 1957.

CN-46124

Advisory Group for Aeronautical Research and Development. ON THE STABILIZATION OF COHESIVE SOIL BY MEANS OF CEMENT AND BITUMINOUS BINDING AGENTS. Rudolf Klein. (Presented at 9th AGARD Wind Tunnel and Model Testing Panel, August 27-31, 1956, Brussels, Belgium.) August 1956. iv, 18p. diagrs., tabs. AGARD Report 79. (Ask for CN-46124)

The purpose of soil stabilization and the basic principles involved are explained. A brief historical review is given of work on soil stabilization carried out mainly in Germany, in which two kinds of binding agents were used, namely, bituminous materials and cement. It is shown that soils - at least those involved in the experiments described - have optimal ranges of stabilization which lie within relatively small limits and the conclusion is drawn that for good results machinery for soil stabilization should be specially designed.

MISCELLANEOUS

N-48593X

Advisory Group for Aeronautical Research and Development. AIRCRAFT LOADS IN CONTINUOUS TURBULENCE. N. I. Bullen. (Presented at 5th meeting of AGARD Structures and Materials Panel, April 29-May 3, 1957, Copenhagen, Denmark.) April-May 1957. vi, 26p. diagrs., tabs. AGARD Report 116. (Ask for N-48593X)

There is evidence to suggest that the distribution of aircraft normal acceleration is not usually Gaussian, even for very short periods of time, but follows the form of a modified Bessel function, and gives rise to an exponential distribution of peak values. From the distribution of peak values the root-mean-square value of the variable (normal acceleration) can be determined. Where the duration of turbulence has been measured directly, or can be inferred, the number of zero crossings per second of the variable can also be found from the peak distribution. Two examples of this are given, each for two intensities of turbulence.

N-48821X

Advisory Group for Aeronautical Research and Development. CRITICAL FLIGHT CONDITIONS AND LOADS RESULTING FROM INERTIA CROSS-COUPLING AND AERODYNAMIC STABILITY DEFICIENCIES. W. J. G. Pinsker. (Presented at 5th meeting of AGARD Structures and Materials Panel, April 29-May 3, 1957, Copenhagen, Denmark.) April-May 1957. viii, 47p. diagrs. AGARD Report 107. (Ask for N-48821X)

The effects of the gyroscopic forces on aircraft with large inertias during rolling maneuvers are discussed and criteria given for the three resulting divergent flight conditions: yaw divergence, pitch divergence, and autorotational rolling. The critical loading cases in practical rolling maneuvers are discussed and methods for the determination of peak loads outlined. Aircraft responses in inadvertent pitch-up are analyzed and data are given for the estimation of peak loads both for uncontrolled conditions and for pitch-up with pilot's counteraction. The principal causes for loss of directional stability are indicated and possible dangerous flight conditions are outlined.

N-51482X

Advisory Group for Aeronautical Research and Development. A STUDY OF THE CORRELATION BETWEEN FLIGHT AND WIND-TUNNEL BUFFET LOADS. Wilber B. Huston, NACA. (Presented at 5th meeting of AGARD Structures and Materials Panel, Copenhagen, Denmark, April 29-May 3, 1957.) April-May 1957. vi, 25p. diagrs. AGARD Report 111. (Ask for N-51482X)

Methods and concepts developed in the study of random processes are applied to the loads on an airplane wing in buffeting. The power spectrum and probability distribution of the buffet loads as measured by electrical wire resistance strain gages suggest that these loads can be considered as the linear response of a lightly damped single-degree-of-freedom system to a random input. Dimensional analysis and beam theory are employed to develop a relation between the buffet loads on an airplane in flight and the loads on a model in a wind tunnel. Flight and model results are compared for several different configurations.

N-51483X

Advisory Group for Aeronautical Research and Development. ATMOSPHERIC TURBULENCE ENVIRONMENT WITH SPECIAL REFERENCE TO CONTINUOUS TURBULENCE. Harry Press, NACA, LAL. (Presented at 5th meeting of AGARD Structures and Materials Panel, April 29-May 3, 1957, Copenhagen, Denmark.) April-May 1957. vi, 39p. diagrs. AGARD Report 115. (Ask for N-51483X)

The flight-test techniques for measuring continuous atmospheric turbulence are briefly outlined and available measurements of the power spectrum of atmospheric turbulence reviewed. The measured results are examined in order to determine how well they approximate the idealized models of a stationary Gaussian random process and of isotropic turbulence. Finally, some recent results on the variation with altitude of the probability distribution of the root-mean-square gust velocity are presented and the application of these results to operational response history calculations indicated.

N-51605X

Advisory Group for Aeronautical Research and Development. SOME EFFECTS OF SHED VORTICES ON THE FLOW FIELDS AROUND STABILIZING TAIL SURFACES. Ralph W. Stone, Jr., and Edward C. Polhamus, NACA. (Presented at 5th meeting of AGARD Structures and Materials Panel, Copenhagen, Denmark, April 29-May 3, 1957.) April-May 1957. vii, 25p. diagrs., photos. AGARD Report 108. (Ask for N-51605X)

A brief study is made of the effects of vortices shed primarily from bodies on the flow angularities in the regions of stabilizing tail surfaces. The results generally show a rather large adverse effect of such flow fields on the tail loads and tail-load distributions. The results further indicate that, for some conditions, an oscillatory characteristic of vortex flows exists and this may be conducive to tail buffeting.

MISCELLANEOUS

N-52150X

Advisory Group for Aeronautical Research and Development. PHYSICAL GAS DYNAMICS RESEARCH AT THE AVCO RESEARCH LABORATORY. P. H. Rose. (Presented at 11th meeting of AGARD Wind Tunnel and Model Testing Panel, Scheveningen, Holland, July 8-12, 1957.) July 1957. viii, 43p. diagrs., photos., tabs. AGARD Report 145. (Ask for N-52150X)

A resumé of the first year's work of the AVCO Research Laboratory on high-temperature gas dynamics. The advantages of the straight shock tube for investigation in this field are discussed. Several investigations conducted in shock tubes, into critical gas dynamic problems associated with the high temperatures of flight at hypersonic Mach numbers are described and preliminary studies of magnetohydrodynamics are summarized.

N-52588X

Advisory Group for Aeronautical Research and Development. THE SHOCK TUNNEL AND ITS APPLICATIONS TO HYPERSONIC FLIGHT. A. Hertzberg, Cornell Aeronautical Laboratory. (Presented at 11th meeting of AGARD Wind Tunnel and Model Testing Panel, Scheveningen, Holland, July 8-12, 1957.) July 1957. viii, 32p. diagrs., photos. AGARD Report 144. (Ask for N-52588X)

The development of the shock tube into a short-duration wind tunnel for the study of supersonic air flow is reviewed historically. Modifications of the conventional shock tube which extend the shock tube into a tool for the study of hypersonic flows are described. The problems of operation and technique which these modified shock tubes introduce are discussed. The techniques of instrumentation for the brief flow durations of hypersonic shock tunnels are outlined. In particular, a technique is described for accurately measuring heat transfer within the short testing times available in shock tunnels. A new technique for generating strong shock waves required for shock tunnel operation is described.

N-52868X

Advisory Group for Aeronautical Research and Development. SOME POSSIBLE IMPLICATIONS OF MINIMUM DRAG SPEED AT ALTITUDE. R. P. Dickinson. (Presented at 10th meeting of AGARD Flight Test Techniques Panel, London, May 20-24, 1957.) May 1957. iv, 8p. diagrs. AGARD Report 131. (Ask for N-52868X)

Indications are given of the spheres in which minimum drag speed should be considered in flight testing at the higher altitudes.

N-53242X

Advisory Group for Aeronautical Research and Development. INTRODUCTORY REMARKS CONCERNING SOME ASPECTS OF HYPERSONIC RESEARCH AND RESEARCH FACILITY REQUIREMENTS. E. O. Pearson, Jr., NACA. (Presented at 11th meeting of AGARD Wind Tunnel and Model Testing Panel, July 8-12, 1957, Scheveningen, Holland.) July 1957. vii, 27p. diagrs., photos., tab. AGARD Report 132. (Ask for N-53242X)

Outlines the history of research in hypersonic aerodynamics. Brief reference to the characteristics of the hypersonic regime and to the tendency toward two-dimensionality. Discusses skin friction, heat-transfer coefficients, and the problems of boundary layer and shock wave interaction. Introduces the possibility of different types of hypersonic flight vehicles and concludes with a survey of research problems and experimental facilities up to $M \simeq 15$.

N-54612X

Advisory Group for Aeronautical Research and Development. MOLECULAR APPROACH TO PROBLEMS OF HIGH-ALTITUDE, HIGH-SPEED FLIGHT. G. N. Patterson, University of Toronto, Canada. (Presented at 11th meeting of AGARD Wind Tunnel and Model Testing Panel, Scheveningen, Holland, July 8-12, 1957.) July 1957. viii, 58p. diagrs., photos., tab. AGARD Report 134. (Ask for N-54612X)

The zones of the upper atmosphere, the regimes of fluid mechanics based on considerations of rarefaction and temperature, and the modern experimental methods for investigations in some of these regimes are discussed. Rarefaction effects are then discussed in terms of gas-surface interactions, free molecule flow and slip flow, and Newtonian flow is considered as an extension of free molecule motion. The effects of high temperature are indicated for undissociated air and air in dissociation equilibrium, and the important effects of relaxation are outlined.

N-55018X

Advisory Group for Aeronautical Research and Development. SELECTED PROPERTIES OF STRUCTURAL MATERIALS AT ELEVATED TEMPERATURES. D. A. Shinn, Wright Air Development Center. (Presented at 5th meeting of AGARD Structures and Materials Panel, April 24-27, 1957, Oslo, Norway.) April 1957. vi, 40p. diagrs., photos. AGARD Report 104. (Ask for N-55018X)

This paper discussed the various selected properties of metals in the following order: (a) static properties, that is, bearing, shear, compression, etc.; (b) long time compression, bearing, and shear tests; (c) short time (rapid loading) tensile and other tests; (d) variable temperature and loading; (e) creep and rupture affected by state of stress; (f) column creep; (g) miscellaneous elevated temperature effects; and (h) low temperature.

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N-55025X

Advisory Group for Aeronautical Research and Development. MERIT INDICES FOR STRUCTURAL MATERIALS. H. B. Howard. (Presented at 5th meeting of AGARD Structures and Materials Panel, Oslo, Norway, April 24-27, 1957.) April 1957. vii, 24p. diagrs., tabs. AGARD Report 105. (Ask for N-55025X)

Merit indices are derived to give weight efficiency for a number of simple structural properties. These include direct strength and stiffness, the buckling of Euler and of plate struts, the wrinkling of thin-walled tubes, thermal stress, and deformation. The indices are applied to typical aluminum and titanium alloys and to a stainless steel over a temperature range from room temperature to 400° C.

N-55027X

Advisory Group for Aeronautical Research and Development. A SURVEY OF THE STRUCTURAL PROPERTIES OF SOME HIGH STRENGTH SHEET STEELS. M. A. Melcon, Lockheed Aircraft Corporation. (Presented at 5th meeting of AGARD Structures and Materials Panel, Oslo, Norway, April 24-27, 1957.) April 1957. vii, 25p. diagrs., photos., tabs. AGARD Report 101. (Ask for N-55027X)

This paper deals primarily with the structural properties of the sheet steels; however, a brief strength-weight evaluation of steel, titanium, and aluminum is made for purposes of orientation. The heat-treatable stainless steels which are specifically covered are 420, 422, 422M, AM350, and 17-7PH. Tri-cent and Thermold "J" are also discussed. Mechanical properties at room and elevated temperature are summarized. Stress-strain curves in both tension and compression are presented at room and elevated temperature. Heat treatment, corrosion resistance, and formability of the various alloys are discussed. Some fatigue, creep, and stress-rupture data are presented. Tear strength is evaluated for some of the materials. Fabrication problems such as welding, machining, and distortion during heat treatment are also covered.

N-55379X

Advisory Group for Aeronautical Research and Development. INSTRUMENTATION AND DATA HANDLING METHODS FOR DETERMINING LOAD DISTRIBUTION ON WIND TUNNEL MODELS BY PRESSURE DISTRIBUTION MEASUREMENTS. Joseph P. Doyle, Wright Air Development Center. (Presented at 5th meeting of AGARD Structures and Materials Panel, Copenhagen, Denmark, April 29-May 3, 1957.) April-May 1957. vi, 29p. diagrs., photos. AGARD Report 114. (Ask for N-55379X)

A discussion is presented of pressure distribution measurements on wind-tunnel models from the viewpoint of the instrumentation and data handling requirements. Two types of instrumentation are described, a serial scanning system as employed in testing the Convair B-58 1/17-scale pressure model and a parallel system now being installed in the Wright Air Development Center 10-ft transonic wind tunnel. Some limitations imposed on the data collection by wind-tunnel operations and model geometry and on the subsequent data reduction methods are considered.

N-56099X

Advisory Group for Aeronautical Research and Development. RESPONSE OF ELASTIC AIRCRAFT TO CONTINUOUS TURBULENCE. R. L. Bisplinghoff, T. H. H. Pian, and K. A. Foss, Massachusetts Institute of Technology. (Presented at 5th meeting of AGARD Structures and Materials Panel, Copenhagen, Denmark, April 29-May 3, 1957.) April-May 1957. vi, 20p. diagrs. AGARD Report 117. (Ask for N-56099X)

A review is made of a method for determining the disturbed motion and the corresponding stresses of an elastic aircraft. The method is applied to the solution of the response of aircraft to continuous turbulence. Results are presented of the stress amplification due to flexibility of the structures. Discussions include effects of the scale of turbulence and of the spanwise variations of gust intensity on the responses and stresses of flexible aircraft.

N-57669*

THE MEASUREMENT OF UNSTEADY PRESSURES IN WIND TUNNELS. Eugene L. Davis, Jr. (Presented to Wind Tunnel and Model Testing Panel of Advisory Group for Aeronautical Research and Development, London, England, March 24-28, 1958.) vi, 31p. diagrs. (Ask for N-57669*)

Practical solutions to the problem of accurately measuring unsteady pressures in wind tunnels are described with emphasis on the response of pressure systems, calibration techniques and equipment, and wind-tunnel instrumentation. Basic guides for the selection of a pressure-gage-volume—connecting-tubing system are given. A cam-type pulsator calibrator with a sinusoidal pressure variation up to ±3 pounds per square inch and a frequency range up to 5,000 cycles per second is described. The minimum number of pressure gages required for lift and moment measurements is discussed. A brief comment on the interpretation of pressure fluctuations in terms of velocity fluctuations is given.

CN-58824

Advisory Group for Aeronautical Research and Development. STUDY OF THE RELIABILITY OF IRREVERSIBLE SERVO-SYSTEMS. (Essais d'endurance de servo-commandes irreversibles.) L. Vandenberghe, Centre d'Essais en Vol. (Presented at 10th meeting of AGARD Flight Test Techniques Panel, May 20-24, 1957, London.) May 1957. iii, 6p. (French text). AGARD Report 128. (Ask for CN-58824)

This paper describes the numerous tests imposed on an irreversible servocontrol (with mechanical input) from manufacture up to series installation. These

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include bench tests of performance, stability (perhaps the most important), preendurance, and endurance, with frequent inspections and periodical check of the dimensions. Flight tests must confirm the proper functioning of the jack in all flight conditions and at the limits of its performance. Finally, there are endurance tests in flight during which the jack is taken out of the aircraft and carefully inspected periodically.

N-58825

Advisory Group for Aeronautical Research and Development. SINTERED ALUMINIUM S. A. P. F. Bollenrath. (Presented at 5th meeting of AGARD Structures and Materials Panel, April 24-27, 1957, Oslo, Norway.) April 1957. v, 18p. diagrs., photos., tabs. AGARD Report 103. (Ask for N-58825)

A new material made by compressing, sintering, and extruding aluminum powder is described. This material is called S. A. P. (sintered aluminum powder) and has been developed by Aluminium-Industrie A. G., Neuhausen, Switzerland. Outstanding are the mechanical properties at elevated temperatures.

N-58826

Advisory Group for Aeronautical Research and Development. CERMETS AS POTENTIAL MATERIALS FOR HIGH-TEMPERATURE SERVICE. O. A. Sandven, Norwegian Defence Research Establishment. (Presented at 5th meeting of AGARD Structures and Materials Panel, April 24-27, 1957, Oslo, Norway.) April 1957. iv, 24p. diagrs., tabs. AGARD Report 99. (Ask for N-58826)

A review is given of the chemical, physical, and mechanical properties of the most important and promising hard metals and cermet systems, with special attention to the creep resistance and ductility. Some experimental results on the system NbC-TiC Ni are reported.

CN-58827

Advisory Group for Aeronautical Research and Development. MEASURING CLIMB PERFORMANCE OF A PROPELLER ENGINED TRANSPORT AEROPLANE USING THE ACCELERATOR TECHNIQUE. J. P. K. Vleghert. (Presented at 10th meeting of AGARD Flight Test Techniques Panel, May 20-24, 1957, London.) May 1957. v, 15p. diagrs. AGARD Report 127. (Ask for CN-58827)

Some possibilities of the accelerometer technique are given, together with a discussion of some problems in instrumentation, especially measuring angle of attack and longitudinal acceleration. With the accelerometer technique it is feasible to analyze the total airplane drag into its components, that is, basic drag with the propellers feathered, propeller slipstream drag and extra drag in one engine out flight due to sideslip and control deflection.

CN-58828

Advisory Group for Aeronautical Research and Development. HIGH SPEED COMPUTERS IN THE AIRCRAFT INDUSTRY. Frank P. Cozzone, Lockheed Aircraft Corporation. (Presented at 10th meeting of AGARD Flight Test Techniques Panel, May 20-24, 1957, London). May 1957. iv, 12p. diagrs., tabs. AGARD Report 130. (Ask for CN-58828)

The phenomenal growth of the use of high-speed digital computers for solving typical problems associated with the aircraft industry is discussed in this report. A capability comparison is made between the progressive computers utilized to date and this comparison is extrapolated to computers that will be available in the next few years. The variety of problems capable of being solved in a practical manner is also discussed, with pertinent comments as to the future role of the engineer.

CN-58855

Advisory Group for Aeronautical Research and Development. PROCEEDINGS OF THE SIXTH AGARD GENERAL ASSEMBLY. THE BELGIAN AGARD CONFERENCE AUGUST 28-31, 1956. (Procès-verbal de la sixième assemblée générale de l'AGARD.) August 28-31, 1956. 104p. AGARD. (Ask for CN-58855)

The proceedings include a review of aeronautics in Belgium, both past and present. A series of discussions devoted to research and development activities bearing on the NATO mission included: Mutual Weapons Development Team; Military Agency for Standardization (NATO); operational research in planning aerial defense; SHAPE Air Defense Technical Center; Training Center for Experimental Aerodynamics; and support of research by ARDC in Europe. Short reports on the activities of the individual panels of AGARD are also included.

N-58856*

Advisory Group for Aeronautical Research and Development. SECOND GUIDED MISSILES SEMINAR - GUIDANCE AND CONTROL. (Papers presented at an AGARD Guided Missiles Seminar, held September 24-28, 1956, in Venice, Italy.) September 1956. iv, 391p. diagrs., photos., tabs. AGARDograph 21. (Ask for N-58856*)

Contents: WEAPONS SYSTEM PHILOSOPHY. George H. Clement, Rand Corp. ORO WEAPON SYSTEM PHILOSOPHY. Harlan C. Meal, Johns Hopkins University. NEW PRINCIPLES IN THE DESIGN OF SUPERIOR COMMUNICATIONS, NAVIGATION, AND MISSILE GUIDANCE SYSTEMS. W. P. Lear, Sr., Lear, Inc. GUIDANCE TECHNIQUES. Walter L. Webster, Jr. CONSIDERATIONS IN THE CHOICE OF A MISSILE GUIDANCE AND CONTROL SYSTEM. Robert William Mayer, General Electric Co. INERTIAL NAVIGATION. Norman F. Parker and Charles P. Greening, North American Aviation, Inc. AIDING THE INERTIAL NAVIGATION SYSTEM. William F. Ballhaus and Frederick Stevens, Jr., Northrop Aircraft, Inc. LINEAR HOMING NAVIGATION. Robert K. Roney,

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Hughes Aircraft Co. PITFALLS IN MISSILE CONTROL. Robert L. Johnson, Douglas Aircraft Co. THE EFFECTS OF AIRFRAME CHARACTERISTICS ON CONTROL SYSTEM DESIGN. F. E. Perry, Boeing Airplane Co. GEOMETRICAL STABILIZATION BASED ON SERVODRIVEN GIMBALS AND INTEGRATING GYRO UNITS. Charles S. Draper and Roger B. Woodbury, Massachusetts Institute of Technology. SAMPLED-DATA SYSTEMS. John R. Ragazzini, Columbia University. DIGITAL TECHNIQUES IN MISSILE GUIDANCE SYSTEMS. Sidney Darlington, Bell Telephone Laboratories, Inc. THE USE OF DIGITAL COMPUTER TECHNIQUES IN MISSILE DESIGN AND CONTROL. D. H. Gridley, Naval Research Laboratory. THE APPLICATION OF NOISE AND FILTER THEORIES TO GUIDANCE PROBLEMS. R. J. Parks and Robert M. Stewart, California Institute of Technology. RECENT DEVELOPMENTS IN FIXED AND ADAPTIVE FILTERING. A. G. Carlton and J. W. Follin, Jr., Johns Hopkins University. PRACTICAL PROBLEMS ENCOUNTERED IN MISSILE GUIDANCE AND CONTROL DESIGN. R. E. Whiffen, Bendix Aviation Corp. APPLICATION OF METHODS OF SCIENCE TO THE PROBLEM OF RELIABILITY. C. Raymond Knight, Aeronautical Radio, Inc. RELIABILITY OF GUIDED MISSILES. Edwin A. Speakman, Fairchild Engineering and Airplane Corp. LABORATORY VS. FLIGHT EVALUATION OF AIRBORNE GUIDANCE COMPONENTS. W. H. Clohessy, Army Ordnance Proving Ground. TRENDS IN FIELD TESTING OF GUIDED MISSILES. Ernst A. Steinhoff, Holloman Air Development Center. LOW SIGNAL LEVEL MISSILE INSTRUMENTATION. L. G. deBey, Aberdeen Proving Ground. ON THE WAY TO AUTOMATED PROCESSING OF FLIGHT MEASUREMENTS. W. E. Klemperer, Douglas Aircraft Co., Inc. PAPER ON THE GUIDANCE AND CONTROL OF MISSILES. Stephen Waldron, Office of the Chief of Naval Operations.

CN-58975*

Advisory Group for Aeronautical Research and Development. FORWARD SCATTER COMMUNICATION VIA METEOR TRAILS AND RELATED PROBLEMS. Tor Hagfors, Editor. (Papers presented at Ionospheric Research meeting, The Hague, Netherlands, July 1957.) July 1957. (vi), 69p. diagrs., tabs. AGARDograph 26.
(Ask for CN-58975*)

Contents: FORWARD SCATTERING FROM METEOR TRAILS. P. A. Forsyth, Canadian Defense Research Board. METEOR SIGNAL CHARACTERISTICS OF IMPORTANCE IN COMMUNICATION. P. A. Forsyth. SOME CHARACTERISTICS OF RADIO COMMUNICATION VIA METEOR IONIZATION TRAILS. V. R. Eshleman, Stanford University. SOME STATISTICAL RESULTS ON REFLECTIONS FROM METEORIC TRAILS OBTAINED BY FORWARD-SCATTER EXPERIMENTS IN NORWAY. Tor Hagfors, Norwegian Defence Research Establishment. ARTIFICIAL ELECTRON CLOUDS. J. Pressman, F. F. Marmo, L. M. Aschenbrand, A. S. Jursa, and M. Zelikoff, Air Force Cambridge Research Center. THE PROBLEM OF INTRODUCING IONISPHERIC SCATTER COMMUNICATION SYSTEMS INTO THE EUROPEAN FREQUENCY REGION. E. Fitch, Ministry of Supply. OPERATING PRINCIPLES AND DESIGN CONSIDERATIONS OF JANET SYSTEMS. D. R. Hansen, Canadian Defense Research Board. SOME OPERATIONAL CHARACTERISTICS OF THE CANADIAN JANET SYSTEM. D. R. Hansen.

CN-59733

Advisory Group for Aeronautical Research and Development. STRUCTURAL PLASTICS FOR AIRFRAME CONSTRUCTION. N. J. L. Megson. (Presented at 6th meeting of Structures and Materials Panel, Paris, November 4-8, 1957.) November 1957. 16p. tabs. AGARD Report 162.
(Ask for CN-59733)

A general account of the development and methods of fabrication of reinforced plastics which can be molded at low pressures. Discusses various applications, including wings, radomes, fuselages and drop tanks, and the use of plastics in the Fokker "Friendship." Future trends are outlined.

N-59734

Advisory Group for Aeronautical Research and Development. A REVIEW OF LANDING GEAR AND GROUND LOADS PROBLEMS. J. F. McBrearty, Lockheed Aircraft Corp. (Presented at 5th meeting of Structures and Materials Panel, Copenhagen, April 29-May 3, 1957.) April-May 1957. 22p. diagrs., photos., tabs. AGARD Report 118.
(Ask for N-59734)

This paper presents a brief assessment of the aircraft weight attributable to the landing gear and ground loads in general and a discussion of some of the less common ground loads phenomena which have become more and more important to aircraft design. *Skidding oscillations, brake chatter, shimmy,* taxiing loads, and fatigue are singled out for more detailed consideration. Discussion of the methods employed to provide practical solutions to these problems is presented. It is concluded that experimental development techniques in conjunction with analytical methods provide reasonably satisfactory designs but that a great deal of operational data is needed to refine the design targets for these phenomena.

N-59735

Advisory Group for Aeronautical Research and Development. HIGH-SPEED STABILITY AND CONTROL PROBLEMS AS THEY AFFECT FLIGHT TESTING. Malcolm J. Abzug, Douglas Aircraft Company. (Presented at 10th meeting of Flight Test Techniques Panel, London, May 20-24, 1957.) May 1957. 36p. diagrs. AGARD Report 120.
(Ask for N-59735)

Discusses high-speed stability and control flight testing from the standpoints of the maximum envelopes of attainable Mach number and altitude, and load factor and Mach number. Also describes testing techniques which have been used for some special high-speed stability and control problems, and

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touches upon the flight-testing of irreversible flight-control systems and automatic systems. Concludes that reliance on analytical methods is essential to the success of such a flight-testing program.

N-59736

Advisory Group for Aeronautical Research and Development. NEAR FIELD JET NOISE. M. O. W. Wolfe. (Presented at 5th meeting of Structures and Materials Panel, Copenhagen, April 29-May 3, 1957.) April-May 1957. 41p. diagrs., photo. AGARD Report 112. (Ask for N-59736)

This paper deals with the subject of jet engine noise in relation to its effects on aircraft structures. Near field noise measurements are described for a range of jet shear velocities on two representative turbojet engines, one of them operating with an afterburner. Contours of equal noise pressure in the horizontal plane containing the axis of the jet are presented for a range of shear velocity for overall noise pressure and for noise pressures in 1/3 octave frequency bands in the noise spectra. In the velocity range 790 to 1800 ft/sec, 400 cycles/sec is the dominant frequency. At most velocities the noise pressures at this frequency are about 10 decibels less than the corresponding overall noise pressures. The increase in noise level due to reheat is not as great as would have been predicted from a consideration of the noise level trends at much lower values of velocity without reheat.

UNPUBLISHED PAPERS

N-58772*

Stanford University. INVESTIGATION OF AIRFOILS, PLATES, GRIDS, AND RODS FOR BOUNDARY LAYER CONTROL IN SUBSONIC DIFFUSERS. C. A. Moore and S. J. Kline. (Progress report.) August 16, 1954. 56p. diagrs., photos., tabs. Stanford U. (Ask for N-58772*)

Progress on a current program to investigate the use of vanes and other mechanical means for the control of the boundary layer in diffusers is reported. Two main aspects of the work are covered: (1) Design and construction of a full-scale air diffuser with a wide range of experimental flexibility; and (2) study of the flow regimes and boundary-layer behavior in a water-table model. The air apparatus is now essentially complete. Its performance has not been checked, and a few modifications may still be required. The water-table tests have proved very fruitful and the effects observed or deduced are discussed.

N-58790*

Stanford University. SOME NEW MECHANISMS AND CONCEPTIONS OF STALL INCLUDING THE BEHAVIOR OF VANED AND UNVANED DIFFUSERS. Stephen J. Kline. March 15, 1957. 112p. diagrs. Stanford U. MD-1. (Ask for N-58790*)

The flow in subsonic, plane-walled, two-dimensional diffusers with thin inlet boundary layers is discussed. It is shown that only some of the results found in unvaned diffusers and little or none of the results found for vaned diffusers can be rationalized by arguments based solely on the conventional model of the flow employing a two-dimensional boundary layer. The work is primarily qualitative in nature; this applies both to the discussion of mechanisms and to the rationalization of performance based on the resulting concepts. While fragmental mathematical analyses are given, they are used primarily to bolster the arguments rather than as proofs. This is in keeping with the objective of the discussion which is to attempt to clarify, distinguish, and explain the basic flow models for the various types of stall.

N-59502*

THE HEAT CONDUCTIVITY OF AQUEOUS SOLUTIONS OF STRONG ELECTROLYTES. (Die Wärmeleitfahigheit von wässrigen Lösungen starker Elektrolyte.) L. Riedel. 16p. diagrs., tabs. Translation from Chemie-Ingenieur-Technik, v. 23, 1951, p. 59-64. (Ask for N-59502*)

In ideal solutions of strong electrolytes each type of ion will have its own particular effect on the thermal conductivity λ of the solution. The effect is an independent property of the ion. The separable effect of each type of ion may therefore be added to give the total effect. From plots of λ against molar concentration for several common electrolytes, the effect of each type of ion on λ was determined and tabulated relative to the sodium ion on the basis of 1 mole. It was also found that the temperature dependence of λ for water and for a given solution was essentially the same. Thus, λ for many solutions may be predicted for a given temperature and concentration knowing only the properties of water and the tabulated relative ion values. The text reviews the data of several other authors.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification April 15, 1958.

NACA RM A50C30

WIND-TUNNEL TESTS OF A 0.16-SCALE MODEL OF THE X-3 AIRPLANE AT HIGH SUBSONIC SPEEDS. - ADDITIONAL STABILITY AND CONTROL CHARACTERISTICS AND THE AERODYNAMIC EFFECTS OF EXTERNAL STORES AND RAM JETS. Joseph W. Cleary and Jack A. Mellenthin. June 13, 1950. 86p. diagrs., photos., tabs. (NACA RM A50C30)

Additional wind-tunnel tests of the 0.16-scale X-3 model were made at low and high subsonic Mach numbers to investigate the static longitudinal and lateral stability and control characteristics of a variety of model configurations. Included are the effects of dive brakes, external stores, and wing-tip ram jets on the stability characteristics and measurements of the effectiveness of the aileron, leading-edge flaps, and horizontal tail. The results indicated generally satisfactory stability and control characteristics at all Mach numbers of the test.

NACA RM A50D07

WIND-TUNNEL TESTS OF A 0.16-SCALE MODEL OF THE X-3 AIRPLANE AT HIGH SUBSONIC SPEED - WING AND FUSELAGE PRESSURE DISTRIBUTION. Joseph W. Cleary and Jack A. Mellenthin. June 22, 1950. 61p. diagrs., photos. (NACA RM A50D07)

Wind-tunnel measurements of wing and fuselage pressure distribution were made in pitch and in yaw at Mach numbers from 0.40 to 0.925 on a 0.16-scale model of the projected X-3 research airplane. The wing pressure distributions are presented for leading-edge-flap angles of 0°, 10°, and 30°. Also included are measurements of total pressure in the fuselage boundary layer at the location of the left boundary-layer bleed scoop.

NACA RM A52L04a

DAMPING IN PITCH OF LOW-ASPECT-RATIO WINGS AT SUBSONIC AND SUPERSONIC SPEEDS. Murray Tobak. April 1953. ii, 107p. diagrs. (NACA RM A52L04a)

The concept of indicial functions is applied to the analysis of the short-period pitching mode of wings in subsonic and supersonic flight. The effects on the rotary-damping-moment coefficient of changes in Mach number, aspect ratio, plan form, frequency, and thickness are investigated and the results compared with the results of a series of experiments for low-aspect-ratio wing-body combinations. The experimental results, obtained over the Mach number ranges 0.6 to 0.9 and 1.2 to 1.9 were in good agreement with the results of theoretical computations and confirmed the theoretical predictions of the existence of ranges of supersonic Mach number and center-of-gravity positions over which dynamic instability may be expected. The occurrence at high subsonic Mach numbers of small-amplitude self-sustained oscillations is noted and a hypothesis advanced for its explanation.

NACA RM A53D10

WIND-TUNNEL INVESTIGATION OF THE VORTEX WAKE AND DOWNWASH FIELD BEHIND TRIANGULAR WINGS AND WING-BODY COMBINATIONS AT SUPERSONIC SPEEDS. J. Richard Spahr and Robert R. Dickey. June 1953. 92p. diagrs., photos., tabs. (NACA RM A53D10)

An investigation has been made to observe visually the vortex wake behind triangular wings of aspect ratios from 0.67 to 4 in combination with a pointed cylindrical body at Mach numbers of 1.5 and 2.0, and to measure the downwash field associated with these vortex systems. An analytical method based on existing theories is applied to the prediction of these downwash distributions.

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NACA RM A53D27

AN EXPERIMENTAL INVESTIGATION AT SUBSONIC AND SUPERSONIC SPEEDS OF THE TORSIONAL DAMPING CHARACTERISTICS OF A CONSTANT-CHORD CONTROL SURFACE OF AN ASPECT RATIO 2 TRIANGULAR WING. David E. Reese, Jr. July 1953. 32p. diagrs., photos., tab. (NACA RM A53D27)

The results of an investigation of the torsional damping characteristics of a constant-chord control surface mounted on a triangular wing of aspect ratio 2 are presented. The effects of variations in control surface oscillation amplitude, angle of attack, and frequency were investigated at subsonic and supersonic Mach numbers. A cancellation technique for obtaining these data in forced-oscillation tests is described.

NACA RM A54D22

INVESTIGATION OF THE NORMAL FORCE ACCOMPANYING THRUST-AXIS INCLINATION OF THE NACA 1.167-(0)(03)-058 AND THE NACA 1.167-(0)(05)-058 THREE-BLADE PROPELLERS AT FORWARD MACH NUMBERS TO 0.90. Fred A. Demele and William R. Otey. June 1954. 31p. diagrs., photo., tab. (NACA RM A54D22)

Presented are results of an investigation of the normal force of two three-blade propellers, differing only in blade thickness-chord ratio. Data are included for several blade angles and angles of attack at Mach numbers to 0.90. The experimental normal force is compared with that calculated by a theoretical method developed herein.

NACA RM A55C28

EXPLORATORY INVESTIGATION OF THE LOW-SPEED STATIC STABILITY OF A CONFIGURATION EMPLOYING THREE IDENTICAL TRIANGULAR WING PANELS AND A BODY OF EQUAL LENGTH. Noel K. Delany. April 1955. 25p. diagrs., photos. (NACA RM A55C28)

Results are presented of an experimental investigation of the low-speed static-stability characteristics of a simplified model of an unusual configuration. The model had three identical triangular airfoils of low aspect ratio, two forming wings and one a vertical fin. The airfoils were radially disposed about a central body which had the same length as the airfoils. Results of a cursory investigation of elevator and rudder effectiveness and of the effects of changes in dihedral are also included.

#NACA RM A55D18a, by Triplett

NACA RM A55D27a

A COMPARISON AT MACH NUMBERS UP TO 0.92 OF THE CALCULATED AND EXPERIMENTAL DOWNWASH AND WAKE CHARACTERISTICS AT VARIOUS HORIZONTAL TAIL HEIGHTS BEHIND A WING WITH 45° OF SWEEPBACK. Jack D. Stephenson, Ralph Selan, and Angelo Bandettini. June 1955. 81p. diagrs., photos., tabs. (NACA RM A55D27a)

Results of downwash and dynamic-pressure surveys in the region of the tail of a wing-fuselage-tail model having a wing (of aspect ratio 5.5) swept back 45° are presented and discussed. A comparison of the downwash measured locally with the downwash calculated by two methods indicated that the effects of tail height and of partial stalling of the wing on downwash were not accurately predicted by either method.

NACA RM A56C01

THE EFFECTS OF BLOWING OVER VARIOUS TRAILING-EDGE FLAPS ON AN NACA 0006 AIRFOIL SECTION, COMPARISONS WITH VARIOUS TYPES OF FLAPS ON OTHER AIRFOIL SECTIONS, AND AN ANALYSIS OF FLOW AND POWER RELATIONSHIPS FOR BLOWING SYSTEMS. Jules B. Dods, Jr., and Earl C. Watson. June 1956. 145p. diagrs., photos., tab. (NACA RM A56C01)

The results are presented of a two-dimensional investigation conducted to determine the effect of blowing over various types of trailing-edge flaps on a wing having the NACA 0006 airfoil section and a drooped-nose flap. The position and profile of the trailing-edge flap, the nozzle height, and the location of the flap with respect to the nozzle were found to be important variables. Data from many investigations were used to make an evaluation of the effects of blowing on lift. An analysis was made of flow and power relationships for blowing systems.

NACA RM A56D02

THE EFFECT OF CONICAL CAMBER ON THE STATIC LONGITUDINAL, LATERAL, AND DIRECTIONAL CHARACTERISTICS OF A 45° SWEPTBACK WING AT MACH NUMBERS UP TO 0.96. Robert I. Sammonds and Robert M. Reynolds. July 1956. 64p. diagrs., tabs. (NACA RM A56D02)

The aerodynamic forces and static stability characteristics were measured for wing-body combinations having an aspect-ratio-3, 45° sweptback wing. The wing sections perpendicular to the quarter-chord line were NACA 64A006 with increased leading-edge radii. Tests were made both with and without conical camber, and with and without roughness strips, at Mach numbers up to 0.96 at a Reynolds number of 1.5 million, and at Reynolds numbers up to 8 million at a Mach number of 0.22.

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NACA RM A56D05

THE EFFECT OF FLUID INJECTION ON THE COMPRESSIBLE TURBULENT BOUNDARY LAYER - THE EFFECT ON SKIN FRICTION OF AIR INJECTED INTO THE BOUNDARY LAYER OF A CONE AT M = 2.7. Thorval Tendeland and Arthur F. Okuno. June 1956. 23p. diagrs. (NACA RM A56D05)

The effects of transpiration air flow on the average skin-friction coefficient and pressure drag of a conical model are presented. Air was injected into the turbulent boundary layer at several rates of flow through a truncated porous cone oriented at zero angle of attack to the airstream. The Mach number was 2.71 and the Reynolds number range was 6.25×10^6 to 8.56×10^6 per foot.

NACA RM A56D06

A HORIZONTAL-TAIL ARRANGEMENT FOR COUNTERACTING STATIC LONGITUDINAL INSTABILITY OF SWEPTBACK WINGS. George G. Edwards and Howard F. Savage. May 1956. 51p. diagrs., photos., tab. (NACA RM A56D06)

Horizontal-tail surfaces mounted on booms extending rearward from approximately the midsemispan of a sweptback wing were investigated as a means of improving static longitudinal stability. The results of exploratory wind-tunnel tests showing the longitudinal characteristics of a 45° sweptback wing and a fuselage in combination with these outboard tails are compared with those obtained using a conventional sweptback tail at Mach numbers up to 0.92. The outboard tails were very effective in preventing static longitudinal instability.

NACA RM A56D23

THE USE OF AREA SUCTION FOR THE PURPOSE OF IMPROVING THE LONGITUDINAL CHARACTERISTICS OF A THIN UNSWEPT-WING MODEL EQUIPPED WITH LEADING- AND TRAILING-EDGE FLAPS. David G. Koenig. July 1956. 52p. diagrs., photo., tabs. (NACA RM A56D23)

The increase in trailing-edge-flap lift increment obtained by applying porous area suction to the knees of full-span leading-edge flaps and part-span trailing-edge flaps was investigated, in the Ames 40- by 80-foot wind tunnel, on a model with an aspect-ratio-3 unswept wing with sharp leading edges. The wing section was a modified double wedge 4.2 percent thick. Most of the tests were made at a Reynolds number of 9.4×10^6 and a Mach number of 0.11.

NACA RM A56F12

ANALYSIS OF SOME PARAMETERS USED IN CORRELATING BLOWING-TYPE BOUNDARY-LAYER CONTROL DATA. Mark W. Kelly. September 1956. 19p. diagrs. (NACA RM A56F12)

A theoretical analysis of the limitations to the use of the jet momentum coefficient as a correlating parameter in blowing boundary-layer control research is presented. This analysis indicates that this parameter should be acceptable when the jet velocity is large compared to the local-stream velocity. However, when the jet velocity is of the same order as the local velocity, the correlating parameter should include a term involving the flow quantity and the ratio of the local velocity to free-stream velocity. Data are shown to substantiate this conclusion.

#NACA RM E8C23, by Doyle

#NACA RM E8I07, by Wyatt

NACA RM E51C16

INTERNAL FLOW AND BURNING CHARACTERISTICS OF 16-INCH RAM JET OPERATING IN A FREE JET AT MACH NUMBERS OF 1.35 AND 1.73. Eugene Perchonok and John M. Farley. May 21, 1951. 37p. diagrs., photos., tab. (NACA RM E51C16)

The effects of mass-flow ratio on the additive drag and normal-shock position of a single oblique-shock diffuser are presented. Also evaluated is the variation with operating condition of the velocity distribution at the combustion-chamber inlet. A comparison with connected-pipe data is included. Burner performance with a corrugated gutter-grid flame holder is discussed. It is shown that the total-pressure drop across the combustion chamber can be predicted with reasonable accuracy from the computed flame holder and combustion momentum pressure losses.

#NACA RM E51L03, by Medeiros, Hatch, and Dugan

#NACA RM E52A10, by Hatch and Medeiros

#NACA RM E52B15, by Medeiros and Hatch

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NACA RM E52C10

AERODYNAMICS OF SLENDER BODIES AT MACH NUMBER OF 3.12 AND REYNOLDS NUMBERS FROM 2 x 10^6 TO 15 x 10^6. II - AERODYNAMIC LOAD DISTRIBUTIONS OF SERIES OF FIVE BODIES HAVING CONICAL NOSES AND CYLINDRICAL AFTERBODIES. John R. Jack and Lawrence I. Gould. May 1952. 28p. diagrs., photos., tabs. (NACA RM E52C10)

The results of an investigation to determine the aerodynamic load distributions of a series of five bodies having conical or slightly blunted noses at a Mach number of 3.12 for a Reynolds number range of 2 x 10^6 to 14 x 10^6 and angles of attack from 0° to 9° are presented and compared with theoretical calculations. Comparison of the experimental pressure data with linear and second-order theories showed good agreement for low angles of attack. The conical pressures were predicted well by second-order theory for all angles of attack.

#NACA RM E52C14, by Hatch and Medeiros

NACA RM E52D18

EXPERIMENTAL INVESTIGATION OF AXIAL-FLOW COMPRESSOR STATOR BLADES DESIGNED TO OBTAIN HIGH TURNING ANGLES BY MEANS OF BOUNDARY-LAYER SUCTION. G. R. Costello, R. L. Cummings, and G. K. Serovy. June 1952. 22p. diagrs., photos., tab. (NACA RM E52D18)

In order to determine the practicability of using blade boundary-layer control to obtain high turning angles in a stator-blade row, a set of slotted stator blades, designed by a potential-flow method for a 45° turning angle with a low solidity using 1 percent boundary-layer bleed, was tested in a single-stage compressor. Several slot configurations were tested in order to reduce the large secondary flows produced by the original blades. In addition, a means of boundary-layer control was installed on the hub ahead of the stator blades to improve the entrance conditions. The overall performance of the stage was obtained for a range of weight flows at each of three speeds with and without hub suction. These results together with wake surveys indicate that, although design turning was obtained, the slots created large local pressure gradients which caused separation from the walls and greatly increased the secondary flows.

#NACA RM E52D22, by Medeiros and Hatch

NACA RM E52D25

INVESTIGATION OF PERFORMANCE OF SEVERAL DOUBLE-SHROUD EJECTORS AND EFFECT OF VARIABLE-AREA EXHAUST NOZZLE ON SINGLE EJECTOR PERFORMANCE. C. W. Ellis, D. P. Hollister, and H. D. Wilsted. July 1952. 25p. diagrs., photos. (NACA RM E52D25)

An investigation was made to determine briefly the characteristics of a double-shroud cooling-air ejector. Also, the performance of single-shroud ejector having a clamshell-type variable-area actuating nozzle was compared with that of an ejector having a conical nozzle. For the models investigated, the experimental results indicated that the differences in the variable-area and conical nozzle ejector performance are due primarily to flow restrictions in the cooling passage introduced by the clamshell protrusions, rather than the nonplanar and noncircular exit. The investigation of double-shroud-ejector performance, while not completely general in application, does indicate that an ejector of this type could be designed to operate satisfactorily, that is, with a ratio of tertiary to secondary air weight flow of about 0.2. In order to obtain such performance, the difference between the diameter ratios and spacing ratios of the two shrouds should be small.

NACA RM E53C17

DYNAMIC CHARACTERISTICS OF A SINGLE-SPOOL TURBOJET ENGINE. R. T. Craig, George Vasu, and R. D. Schmidt. August 1953. 50p. diagrs., tab. (NACA RM E53C17)

The linearized dynamic characteristics of a single-spool turbojet engine with variable exhaust-nozzle area are presented for a range of altitudes at a constant flight Mach number. The information was obtained by subjecting the engine to varied-size, independent variable step disturbances. Effects of step size, exhaust-nozzle area, engine speed, and flight altitude on the dynamic terms are presented. The regions of usefulness of the linearized first-order description of the engine are delineated.

NACA RM E53D02

CHARACTERISTICS OF A HYDRAULIC CONTROL DETERMINED FROM TRANSIENT DATA OBTAINED WITH A TURBOJET ENGINE AT ALTITUDE. George Vasu, William L. Hinde, and R. T. Craig. June 1954. 62p. diagrs., photo., tab. (NACA RM E53D02)

An analysis was conducted to determine pertinent characteristics of a hydraulic control for turbojet engines. A frequency-response analysis of transient data yielded the transfer function of the speed - fuel flow control. Studies with an analog computer substantiated the results of the frequency-response analysis and also indicated the existence of additional small lags not detectable by the frequency analysis. The schedule for the surge control was obtained from the response of engine variables to throttle burst accelerations from idle to full thrust. The investigation revealed some difficulties with the present control and therefore a modification of the control which

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more closely matches the engine surge characteristics for a broad range of engine and flight conditions is suggested.

NACA RM E53D08

PRELIMINARY EXPERIMENTAL INVESTIGATION OF TRANSPIRATION COOLING FOR AN AFTERBURNER WITH A SINTERED, POROUS STAINLESS-STEEL COMBUSTION-CHAMBER WALL. William K. Koffel. June 1953. 47p. diagrs., photos., tabs. (NACA RM E53D08)

The application of transpiration air-cooling to the combustion-chamber wall of an afterburner was investigated experimentally on a full-scale afterburner having a combustion-chamber wall fabricated from sintered, porous stainless-steel plates. The temperatures of the hot-gas surface of the porous wall were correlated in terms of the temperatures of the combustion gas and cooling air against the ratio of the cooling-air flux density normal to the porous wall to the mass flow of combustion gases per unit of combustion-chamber flow area.

NACA RM E53D09

INTERNAL PERFORMANCE CHARACTERISTICS OF VARIABLE-THROAT PLUG- AND VANED-TYPE CONVERGENT-DIVERGENT NOZZLES. H. George Krull, Fred W. Steffen, and Carl C. Ciepluch. June 1953. 34p. diagrs., photo. (NACA RM E53D09)

As part of an overall program for the experimental investigation of large-scale jet nozzles, the internal performance characteristics of three types of variable-throat convergent-divergent nozzles were obtained over a wide range of pressure ratios. The experimental results obtained with one of these nozzles were applied to a typical flight plan of a ram-jet missile. There were only small differences in peak thrust coefficient between the three types of variable-throat convergent-divergent nozzles. The peak thrust coefficients obtained with these nozzles approached or equaled those obtained with several fixed-geometry convergent-divergent nozzles from a previous investigation. There was little gain (1 percent or less) obtained in the peak thrust coefficient of a convergent-divergent plug-type nozzle when the sharp corner of a simple conical center plug was rounded. By proper matching of a variable-throat convergent-divergent nozzle to a typical flight plan of a ram-jet missile, a thrust coefficient of 0.95 was obtained over a flight Mach number range from 2.13 to 3.0. With the performance characteristics of the variable-throat nozzles investigated, this maximum thrust coefficient was obtained by matching the nozzle expansion ratio to the flight plan at the minimum flight Mach number and allowing the nozzle to operate underexpanded at the higher flight Mach numbers.

NACA RM E53D13

INVESTIGATION OF 16-INCH IMPULSE-TYPE SUPERSONIC COMPRESSOR WITH ROTOR TURNING PAST AXIAL DIRECTION. John J. Jacklitch, Jr., and Melvin J. Hartmann. July 1953. 29p. diagrs., photos. (NACA RM E53D13)

Performance data and characteristics are presented for a 16-inch impulse-type supersonic-compressor rotor (as a separate component and as a stage) with turning in the rotor passage beyond the axial direction. This experimental investigation was conducted with Freon-12 as the test medium. As a separate component, the rotor produced a total-pressure ratio of about 5.4 and an adiabatic efficiency of about 0.76. However, the diffusing stators reduced the stage performance much more than expected.

NACA RM E53D16

TURBINE DESIGN CONSIDERATIONS FOR TURBINE-PROPELLER ENGINE OPERATING OVER A RANGE OF FLIGHT CONDITIONS. Elmer H. Davison. June 1953. 20p. diagrs., tab. (NACA RM E53D16)

The turbine design requirements for turbine propeller engines were studied by investigating the turbine design requirements of a turbine for an engine with known compressor characteristics operating over a range of flight conditions from take-off up to speeds of 600 miles per hour at an altitude of 40,000 feet. It was concluded that the turbine design requirements for a turbine-propeller engine should be based on a consideration of the range of flight conditions over which the engine is to perform. Both constant- and variable-exhaust-nozzle-area operation resulted in efficient engine performance, and satisfactory turbine designs were obtainable for either mode of engine operation. The constant-exhaust-nozzle-area operation resulted in more severe turbine design requirements than variable-exhaust-nozzle-area operation. However, the variations in exhaust-nozzle area required for efficient engine operation were quite large.

#NACA RM SE53D17, by Hatch, Lucas, and Finger

NACA RM E54A08

EXPERIMENTAL INVESTIGATION OF ROTATING STALL AND BLADE VIBRATION IN THE AXIAL-FLOW COMPRESSOR OF A TURBOJET ENGINE. Merle C. Huppert, Howard F. Calvert, and André J. Meyer. April 1954. 24p. diagrs., tabs. (NACA RM E54A08)

A compressor-blade-vibration survey was conducted on a production turbojet engine incorporating an axial-flow compressor with a pressure ratio of approximately 7. Resistance wire strain gages were used to measure the vibratory stress in the first-stage rotor blades, and the flow fluctuations due to

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rotating stall were detected and measured by use of the constant-temperature hot-wire anemometer. The investigation was conducted with three different guide-vane assemblies and four jet-nozzle sizes. High vibratory stresses were measured in two distinct speed ranges. The cause of the high vibratory stresses in both speed ranges was determined to be resonant excitation due to rotating stall.

NACA RM E54C22

ANALYSIS OF FACTORS AFFECTING SELECTION AND DESIGN OF AIR-COOLED SINGLE-STAGE TURBINES FOR TURBOJET ENGINES. I - TURBINE PERFORMANCE AND ENGINE WEIGHT-FLOW CAPACITY. Richard J. Rossbach, Wilson B. Schramm, and James E. Hubbartt. May 1954. 50p. diagrs., tab. (NACA RM E54C22)

Turbine blade cooling not only permits higher turbine inlet temperatures for improving turbojet cycle performance but also permits large increases in the obtainable compressor pressure ratio and the engine weight-flow capacity by providing an independent control of the turbine-inlet temperature and the turbine blade stresses. These increases in the compressor pressure ratio and engine weight flow must be reflected into the turbojet-engine performance in order to evaluate accurately the advantages and design of air-cooled turbines. The compressor pressure ratios and the engine weight-flow capacity for turbojets equipped with single-stage air-cooled turbines have been computed and are presented herein for wide ranges in turbine design specifications. High aerodynamic limits are imposed upon each engine component to assure high turbine work and high component weight-flow capacities.

NACA RM E54C24

JET EFFECTS ON PRESSURE LOADING OF ALL-MOVABLE HORIZONTAL STABILIZER. Alfred S. Valerino. June 1954. 27p. diagrs., photo., tab. (NACA RM E54C24)

An investigation was conducted at Mach numbers 0.63, 1.5, and 1.8 to determine the effects of an exhaust jet on the pressure loadings of an all-movable, 45° sweptback horizontal stabilizer located in a region influenced by the jet, and the effects of the stabilizer on the drags of the boattail, base annulus, and secondary-flow passage. Results indicate that at pressure ratios of 1 to 9 the exhaust jet did not appreciably affect the pressure loadings of the stabilizer. The presence of the stabilizer resulted in large increases in the drags of the base annulus and secondary-flow passage.

#NACA RM E54C29, by Lucas and Filippi

NACA RM E54D01

EFFECT OF MECHANICALLY INDUCED SINUSOIDAL AIR-FLOW OSCILLATIONS ON OPERATION OF A RAM-JET ENGINE. E. E. Dangle, A. J. Cervenka, and Eugene Perchonok. June 1954. 24p. diagrs., tab. (NACA RM E54D01)

An experimental investigation conducted in a 16-inch ram-jet engine has shown the degree to which inlet flow pulsations influence the combustion efficiency and lean blow-out limit of a ram-jet combustor. It is shown that pulsed air flow affects combustion efficiency and lean blow-out limit depending upon flame-holder configuration, fuel-injector location, and frequency of flow pulsation. The influence of the combustor on inlet flow pulsations is also reported. Investigation has shown that a combustor may amplify or attenuate inlet pressure pulsations. The degree to which the combustor attenuates pressure pulsations is dependent upon the flame-holder pressure loss coefficient, while the degree to which a combustor amplifies pressure pulsations depends on the engine total-temperature ratio τ. As τ increases, the amount by which the combustor amplifies the pressure pulse also increases.

NACA RM E54D06

PUMPING AND DRAG CHARACTERISTICS OF AN AIRCRAFT EJECTOR AT SUBSONIC AND SUPERSONIC SPEEDS. Gerald C. Gorton. June 1954. 19p. diagrs. (NACA RM E54D06)

An investigation was conducted on a cylindrical-shroud ejector (diameter ratio of 1.2 and spacing ratio of 0.80) at free-stream Mach numbers of 0.1, 0.6, 1.6, and 2.0 for a wide range of weight-flow ratio and primary pressure ratio. The results indicate no effect of free-stream Mach number or angle of attack on the pumping characteristics. Boattail pressure-drag and base pressure-drag coefficients decreased with increasing primary pressure ratio, similar to conventional nozzles, and also decreased as weight-flow ratio was increased. The results also indicate that the internal geometry of the secondary passage at the exit station of the primary nozzle was critical in effecting a decrease in primary-nozzle mass-flow coefficient as the weight-flow ratio was increased to values greater than 0.10.

NACA RM E54D21

ANALYSIS OF FACTORS AFFECTING SELECTION AND DESIGN OF AIR-COOLED SINGLE-STAGE TURBINES FOR TURBOJET ENGINES. II - ANALYTICAL TECHNIQUES. Richard J. Rossbach. June 1954. 29p. diagrs. (NACA RM E54D21)

The design freedom provided by turbine cooling is a basis for improving both the turbine and overall engine performance. In order to explore the range of engine operation that can be made possible in this way, analytical techniques are developed herein to determine the design performance of single-stage air-cooled turbines operating over wide ranges in the turbine design specifications. In addition, analytical techniques are developed that utilize the turbine specifications and turbine performance to determine the design performance for both nonafterburning and afterburning engines.

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NACA RM E54D22

PERFORMANCE OF A SUPERSONIC ROTOR HAVING HIGH MASS FLOW. Ralph L. Schacht, Arthur W. Goldstein, and Harvey E. Neumann. July 1954. 34p. diagrs., photo., tab. (NACA RM E54D22)

Experimental investigation was made of a rotor designed for supersonic internal flow, which developed a pressure ratio of 5.3 at an equivalent air speed of 1480 feet per second and a flow of 31.5 pounds per frontal area. Some results were obtained on the effect of inlet Mach number, leading-edge sweep, casing pressure distribution, and accuracy of the approximation of axially symmetric internal flow.

NACA RM E54D23

PERFORMANCE OF MIXED-FLOW IMPELLER, MODEL MFI-1B, WITH DIFFUSER VANES AT EQUIVALENT IMPELLER SPEEDS FROM 1100 TO 1700 FEET PER SECOND. Walter M. Osborn. June 1954. 16p. diagrs., photo. (NACA RM E54D23)

An investigation was made of the performance characteristics of a mixed-flow impeller, model MFI-1B, in combination with a vaned diffuser. The peak pressure ratio and maximum efficiency at an equivalent speed of 1700 feet per second with a vane inlet angle of 66° were 5.39 and 0.733, respectively. An analysis of the data indicates that a pressure ratio of 6.0 and an efficiency of 0.72 can be obtained at an equivalent impeller speed of 1800 feet per second with a vane inlet angle of 69°.

NACA RM E54F16a

ANALYSIS OF FACTORS AFFECTING SELECTION AND DESIGN OF AIR-COOLED SINGLE-STAGE TURBINES FOR TURBOJET ENGINES. III - ENGINE DESIGN-POINT PERFORMANCE. James E. Hubbartt, Richard J. Rossbach, and Wilson B. Schramm. September 1954. 41p. diagrs., tab. (NACA RM E54F16a)

Turbine blade cooling permits engine design freedom which can be exploited to improve both the turbine and the overall turbojet-engine performance. The thrust and thrust specific fuel consumption for both nonafterburning and afterburning turbojet engines equipped with single-stage air-cooled turbines have been determined for wide ranges of coolant-flow ratios, turbine-inlet temperatures, and other turbine design specifications. The results of this analysis showed that the thrust of turbojet engines would be increased in excess of 300 percent for the nonafterburning engines and 100 percent for the afterburning engines as the turbine design specifications are varied over the range considered.

NACA RM E55C09

ANALYSIS OF FACTORS AFFECTING SELECTION AND DESIGN OF AIR-COOLED SINGLE-STAGE TURBINES FOR TURBOJET ENGINES. IV - COOLANT-FLOW REQUIREMENTS AND PERFORMANCE OF ENGINES USING AIR-COOLED CORRUGATED-INSERT BLADES. Henry O. Slone and James E. Hubbartt. May 1955. 45p. diagrs., photos., tab. (NACA RM E55C09)

Overall turbojet-engine performance may be improved by using turbine blade cooling to permit additional engine design freedom. Estimated minimum cooling requirements, related engine performance, and effects of factors influencing cooling were determined for engines equipped with single-stage turbines using air-cooled corrugated-insert blades. Wide ranges of turbine design specifications were considered for a flight Mach number of 2 at 50,000-ft altitude; however, the effects of flight Mach number and altitude were illustrated. The results showed that this blade may permit increases in turbine-inlet temperature to about 3000° and 3500° R for tip speeds of 1700 and 1100 ft/sec, respectively.

NACA RM E55D07a

COMBUSTION OF ALUMINUM BOROHYDRIDE IN A SUPERSONIC WIND TUNNEL. Edward A. Fletcher, Robert G. Dorsch, and Melvin Gerstein. June 1955. 72p. diagrs., photos., tabs. (NACA RM E55D07a)

The feasibility of adding heat to a supersonic airstream in the absence of flame holders was studied. Transient burning for periods of 3 to 10 milliseconds was achieved in a supersonic wind tunnel at nominal Mach numbers of 1.5, 2, 3, and 4. Steady burning was achieved for periods of 0.2 to 2 seconds at nominal Mach numbers of 1.5, 2, and 3. Burning and tunnel flow phenomena, including thermal choking, are described. Suggestions are made for possible applications of the results of this study.

NACA RM E55D21

MATCHING OF AUXILIARY INLETS TO SECONDARY-AIR REQUIREMENTS OF AIRCRAFT EJECTOR EXHAUST NOZZLES. Donald P. Hearth, Gerald W. Englert, and Kenneth L. Kowalski. August 1955. 39p. diagrs. (NACA RM E55D21)

The problem associated with matching secondary-air requirements of ejector exhaust nozzles and auxiliary inlets is analyzed for free-stream Mach numbers up to 2.0. A method for matching the components is presented. The analysis indicates that inlets located in the free stream supply higher pressure recovery than ejectors generally require for optimum net internal thrust at Mach numbers above about 1.4. Consequently, net-internal-thrust gains may be achieved by immersing the auxiliary inlet in a boundary layer where the inlet-momentum penalty is less.

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NACA RM E55D22

AN ANALYSIS OF RAM-JET-ENGINE TIME DELAY FOLLOWING A FUEL-FLOW DISTURBANCE. Fred A. Wilcox and Arthur R. Anderson. June 1955. 38p. diagrs., tabs. (NACA RM E55D22)

An analytical method of predicting ram-jet-engine time delay is presented and discussed. The total time delay is assumed to consist of the time for fluid propagation downstream from the fuel injector to the exhaust-nozzle throat plus the time for wave propagation upstream from the nozzle to the sensing station. The time delays of the complete engine as well as its individual components are evaluated theoretically for several rates of heat addition and compared with experimental values. Methods for the reduction of the total time delay are discussed.

NACA RM E55F07

A PRELIMINARY INVESTIGATION OF STATIC-PRESSURE CHANGES ASSOCIATED WITH COMBUSTION OF ALUMINUM BOROHYDRIDE IN A SUPERSONIC WIND TUNNEL. Robert G. Dorsch, John S. Serafini, and Edward A. Fletcher. August 1955. 12p. diagrs., photos. (NACA RM E55F07)

Static-pressure changes resulting from steady combustion of aluminum borohydride in a supersonic wind tunnel were studied. Static pressures were measured along the top wall of a 3.84- by 10-inch tunnel adjacent to the flame that filled the upper portion of the test section. Pressure increases of the order of 20 to 40 percent of the initial static pressure were measured during combustion. The magnitude of the pressure changes suggests that further use of aluminum borohydride to study the effects of heat addition on supersonic flow is warranted.

NACA RM E55I20a

A STUDY OF LIQUID BORIC OXIDE PARTICLE GROWTH RATES IN A GAS STREAM FROM A SIMULATED JET ENGINE COMBUSTOR. Paul C. Setze. April 1957. 41p. diagrs., photos., tab. (NACA RM E55I20a)

It was experimentally determined that the liquid boric oxide particles leaving a jet engine combustor, burning a boron-containing fuel, will have diameters of 1.0×10^{-5} to 2.0×10^{-5} centimeter. For this size range the particle heat-transfer and drag coefficients are essentially infinite. The results may be applied to any boron-containing fuel. Equations are developed that enable the calculation of the particle size-time history. A study of boric oxide deposition mechanisms is included, and suggestions for decreasing deposition rates given.

NACA RM E56A12

FABRICATION AND ENDURANCE OF AIR-COOLED STRUT-SUPPORTED TURBINE BLADES WITH STRUTS CAST OF X-40 ALLOY. Eugene F. Schum, Francis S. Stepka, and Robert E. Oldrieve. April 1956. 39p. diagrs., photos., tabs. (NACA RM E56A12)

A method of fabricating air-cooled, strut-supported turbine blades with struts cast of high-temperature alloy X-40 was developed, and the blade durability was determined in a modified turbojet engine. Thirty blades were investigated at root stress levels of 15,000, 27,000, and 35,000 psi at a turbine-inlet gas temperature of about 1650° F. Early failures at the root region of the blades at the two highest stress levels were eliminated by modifications to the blade structure and fabrication method. Details of the fabrication method and the stress-ratio factors for the blades are presented.

NACA RM E56C16

EXPERIMENTAL INVESTIGATION OF INTERFERENCE EFFECTS OF LATERAL-SUPPORT STRUTS ON AFTERBODY PRESSURES AT MACH 1.9. John L. Klann and Ronald G. Huff. May 1956. 13p. diagrs., tab. (NACA RM E56C16)

A series of single and double unswept, lateral-support struts were tested at Mach 1.9 on a cone-cylinder body at zero angle of attack. All strut-body interference effects were small beyond a length of eight body diameters. However, a nonreflected shock wave due to the presence of the support struts at the tunnel walls did affect afterbody pressures. Reduction of the leading-edge strut angle alleviated this disturbance.

NACA RM E56D04

INJECTION PRINCIPLES FOR LIQUID OXYGEN AND HEPTANE USING TWO-ELEMENT INJECTORS. Marcus F. Heidmann. June 1956. 30p. diagrs., photos., tab. (NACA RM E56D04)

The data from the 400-pound-thrust heptane-oxygen rocket engine are compared with data obtained with single elements in a 200-pound-thrust engine. The results show that, with injection methods that both mix and atomize propellants, the performance was comparable to that of a single element. With other injection methods, performance was not appreciably altered by using two elements, except in the case of interference between spray patterns of the same propellant where performance decreased substantially. High-frequency combustion instability, frequently encountered with single element, did not occur with the two-element injectors.

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NACA RM E56D13

EFFECT OF DESIGN OVER-ALL COMPRESSOR PRESSURE RATIO DIVISION ON ACCELERATION CHARACTERISTICS OF THREE HYPOTHETICAL TWO-SPOOL TURBOJET ENGINES. Richard E. Filippi and James F. Dugan, Jr. August 1956. 26p. diagrs. (NACA RM E56D13)

The engines, each with a compressor overall total-pressure ratio of 12 and a design inner-turbine-inlet temperature of 2500° R, were investigated at static sea-level conditions to determine the effect on transient performance of varying the design pressure ratio divisions 2-6, 3-4, and 4-3 between the outer and inner compressors. The transient considered was an acceleration from 40 to 100 percent design thrust. When the outer compressor of each engine reached design speed, the inner compressors were overspeeding, the maximum being only 1.7 percent over design mechanical speed. Acceleration times for the three engines were equal.

NACA RM E56D27a

INTERNAL PERFORMANCE CHARACTERISTICS OF SHORT CONVERGENT-DIVERGENT EXHAUST NOZZLES DESIGNED BY THE METHOD OF CHARACTERISTICS. H. George Krull and William T. Beale. July 1956. 17p. diagrs. (NACA RM E56D27a)

Internal performance data on a short exhaust nozzle designed by the method of characteristics were obtained over a range of pressure ratios from 1.5 to 22. The peak thrust coefficient was not affected by a shortened divergent section, but it occurred at lower pressure ratios due to reduction in expansion ratio. This nozzle contour based on characteristics solution gave higher thrust coefficients than a conical convergent-divergent nozzle of equivalent length. Abrupt-inlet sections permitted a reduction in nozzle length without a thrust-coefficient reduction.

NACA RM E56I25a

A STUDY OF INJECTION PROCESSES FOR LIQUID OXYGEN AND GASEOUS HYDROGEN IN A 200-POUND-THRUST ROCKET ENGINE. Carmon M. Auble. January 1957. 32p. diagrs., photos. (NACA RM E56I25a)

Characteristic velocities of six single-element injectors that separately varied propellant spreading and mixing were measured over a range of oxidant-fuel weight ratios of 2 to 7. Hydrogen inlet temperature was -320° F. Injectors that both mixed and spread the propellants had the highest characteristic-velocity efficiency. Spreading of either propellant produced about the same increment of efficiency. The increase in efficiency due to mixing was relatively small. With similar injectors, oxygen-hydrogen required about 0.2 to 0.5 of the combustor volume of oxygen-heptane for the same efficiency.

NACA RM E57E03

PROPELLANT VAPORIZATION AS A CRITERION FOR ROCKET-ENGINE DESIGN; EXPERIMENTAL EFFECT OF FUEL TEMPERATURE ON LIQUID-OXYGEN - HEPTANE PERFORMANCE. M. F. Heidmann. July 1957. 21p. diagrs., tabs. (NACA RM E57E03)

Characteristic exhaust velocity of a 200-pound-thrust rocket engine was evaluated for fuel temperatures of -90°, 40°, and 200° F with a spray formed by two impinging heptane jets reacting in a highly atomized oxygen atmosphere. Tests covered a range of mixture ratios and chamber lengths. The characteristic exhaust-velocity efficiency increased 2 percent for a 290° F increase in fuel temperature. This increase in performance can be compared with that obtained by increasing chamber length by about 1/2 inch. The result agrees with the fuel-temperature effect predicted from an analysis based on droplet-evaporation theory. Mixture ratio markedly affected characteristic exhaust-velocity efficiency, but total flow rate and fuel temperature did not.

NACA RM E57E13

INJECTION PRINCIPLES FOR LIQUID OXYGEN AND HEPTANE USING NINE-ELEMENT INJECTORS IN AN 1800-POUND-THRUST ROCKET ENGINE. Richard F. Neu. July 1957. 27p. diagrs., photos., tab. (NACA RM E57E13)

Characteristic velocity data were obtained from six 9-element injectors in an 1800-pound-thrust engine. The results are compared with data previously obtained from two-element injectors in a 400-pound-thrust engine to evaluate spray interference effects. The results paralleled closely the two-element injector results although the decrease in performance due to like propellant spray interference was about two-fifths that of the two-element study. High-frequency combustion instability, frequently encountered with single-element injectors but not present in two-element injectors, also did not occur with the nine-element injectors.

NACA RM E57E15

EXPLORATORY INVESTIGATION OF STATIC- AND BASE-PRESSURE INCREASES RESULTING FROM COMBUSTION OF ALUMINUM BOROHYDRIDE ADJACENT TO BODY OF REVOLUTION IN SUPERSONIC WIND TUNNEL. John S. Serafini, Robert G. Dorsch, and Edward A. Fletcher. October 1957. 49p. diagrs., photos., tabs. (NACA RM E57E15)

The pressure distribution, resulting from combustion of aluminum borohydride about a body of revolution, was experimentally investigated in a wind tunnel at a Mach number of 2.47. Stable and steady-state combustion runs of several seconds duration resulted in static-pressure increases of about 70 percent on the cylindrical surface. The base pressure increased from 1.37 inches of mercury prior to combustion to 4.98 inches of mercury during combustion.

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NACA RM E57E16

EXPLORATORY INVESTIGATION OF AERODYNAMIC EFFECTS OF EXTERNAL COMBUSTION OF ALUMINUM BOROHYDRIDE IN AIRSTREAM ADJACENT TO FLAT PLATE IN MACH 2.46 TUNNEL. Robert G. Dorsch, John S. Serafini, and Edward A. Fletcher. July 1957. 91p. diagrs., photos., tabs. (NACA RM E57E16)

Aerodynamic effects produced by the combustion of aluminum borohydride in a Mach 2.46 airstream adjacent to a flat plate were studied in the test section of the 1- by 1-foot tunnel. Static-pressure changes, total temperatures, and total pressures of the stream were measured during combustion. Static-pressure increases averaged about 60 percent of the free-stream value (3 in. Hg).

NACA RM E57I26

EFFECT OF FUEL-ORIFICE DIAMETER ON PERFORMANCE OF HEPTANE-OXYGEN ROCKET ENGINES. Richard J. Priem and Martin Hersch. February 1958. 20p. diagrs. (NACA RM E57I26)

Five rocket engines ranging from 50 to 800 pounds thrust were investigated to determine characteristic exhaust velocity as a function of chamber length for parallel-sheet, triplet, and parallel-jet injectors with various fuel-orifice diameters. Decreasing the fuel-orifice diameter increased engine performance for a fixed chamber length. The experimental results were compared with analytical studies based on propellant vaporization as the rate-controlling combustion process.

#NACA RM SL9B09, by Garrison

NACA RM L50C03a

SOME EXPERIMENTS ON THE FLUTTER OF WINGS WITH SWEEPBACK IN THE TRANSONIC SPEED RANGE UTILIZING ROCKET-PROPELLED VEHICLES. William T. Lauten, Jr., and J. M. Teitelbaum. May 18, 1950. 30p. diagrs., photos., tabs. (NACA RM L50C03a)

Nine pairs of wings of various angles of sweepback and aspect ratios have been tested using rocket propelled vehicles. Two pairs of wings failed in a vibration mode that is apparently composed of wing bending and body pitch. Two pairs of wings, 30° sweepback angle and 60° sweepback angle, fluttered at Mach numbers of 0.78 and 1.01, respectively, in a bending-torsion flutter mode.

NACA RM L50D10

FLIGHT MEASUREMENTS WITH THE DOUGLAS D-558-II (BUAERO NO. 37974) RESEARCH AIRPLANE. DETERMINATION OF THE AERODYNAMIC CENTER AND ZERO-LIFT PITCHING-MOMENT COEFFICIENT OF THE WING-FUSELAGE COMBINATION BY MEANS OF TAIL-LOAD MEASUREMENTS IN THE MACH NUMBER RANGE FROM 0.37 TO 0.87. John P. Mayer, George M. Valentine, and Geraldine C. Mayer. July 11, 1950. 27p. diagrs., photos., tab. (NACA RM L50D10)

Flight measurements of aerodynamic tail loads have been made on the Douglas D-558-II airplane from which the variation with Mach number of the wing-fuselage aerodynamic center, the static-longitudinal-stability parameter $(\partial C_M/\partial C_L)_{WF}$, the tail load per g, and the zero-lift wing-fuselage pitching-moment coefficient have been determined up to a Mach number of 0.87.

NACA RM SL51A03, by Carter, West, and Bryce

NACA RM SL51B21, by Carter

NACA RM L53D15a

LOAD DISTRIBUTIONS ASSOCIATED WITH CONTROLS AT SUPERSONIC SPEEDS. K. R. Czarnecki and Douglas R. Lord. May 1953. 21p. photo., diagrs. (NACA RM L53D15a)

The status of the control loads problem at the present time is discussed and some recent test results concerning the aerodynamic loads associated with various types of controls at supersonic speeds are presented. Experimental results are compared with theoretical predictions for unbalanced controls, for controls with varying amounts of balance, and for spoilers, on two- and three-dimensional wings.

NACA RM L53D29a

LOADS DUE TO FLAPS AND SPOILERS ON SWEPTBACK WINGS AT SUPERSONIC AND TRANSONIC SPEEDS. Alexander D. Hammond and F. E. West, Jr. June 1953. 17p. diagrs. (NACA RM L53D29a)

A summary is presented of available data of the loads on thin sweptback wings and their point of application which results from deflection of flaps and spoilers at high subsonic and transonic speeds. Presented also are the loads on a spoiler on a typical sweptback-wing configuration.

UNAVAILABLE; contains proprietary or obsolete information.

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NACA RM L54C04

ROCKET-POWERED MODEL INVESTIGATION OF LIFT, DRAG, AND STABILITY OF A BODY-TAIL CONFIGURATION AT MACH NUMBERS FROM 0.8 TO 2.3 AND ANGLES OF ATTACK BETWEEN ±6.5°. Warren Gillespie, Jr., and Albert E. Dietz. April 1954. 42p. diagrs., photos., tabs. (NACA RM L54C04)

A missile configuration having a body of fineness ratio 16.6, an unswept horizontal tail of aspect ratio 2.7, and a highly swept vertical tail was aeropulsed continuously in pitch during free flight with and without a sustainer rocket motor operating. The Mach number range covered by the test was 0.8 to 2.3 and the model angle of attack did not exceed ±6.5°. Zero-lift-drag and drag-due-to-lift data were obtained during coasting flight of the model. Normal-force, pitching-moment, and static-stability data were obtained with and without the rocket motor thrusting. Analysis of the data indicated that cross coupling between pitching and yawing motions may have occurred during certain portions of the flight.

NACA RM L54C16

EXPERIMENTAL EFFECTS OF PROPULSIVE JETS AND AFTERBODY CONFIGURATIONS ON THE ZERO-LIFT DRAG OF BODIES OF REVOLUTION AT A MACH NUMBER OF 1.59. Carlos A. de Moraes and Albin M. Nowitzky. April 1954. 32p. diagrs., photos. (NACA RM L54C16)

The present investigation was made at a free-stream Mach number of 1.59 to compare the afterbody drags of a series of conical boattailed models at zero angle of attack. Afterbody drags were obtained for both the power-off and the power-on conditions. Power-on drags were obtained as a function of afterbody fineness ratio, jet pressure ratio and divergence, and jet Mach number.

NACA RM L54C17a

EFFECTS OF SPOILER AILERONS ON THE AERODYNAMIC LOAD DISTRIBUTION OVER A 45° SWEPTBACK WING AT MACH NUMBERS FROM 0.60 TO 1.03. Joseph M. Hallissy, Jr., F. E. West, Jr., and George Liner. May 1954. 162p. diagrs., tabs. (NACA RM L54C17a)

An investigation was conducted with 73-percent-semispan inboard-spoiler ailerons, having heights of 4 percent of the local wing chord and located along the 70-percent wing-chord line of a 45° sweptback-wing—fuselage combination. The wing had an aspect ratio of 3.98, a taper ratio of 0.61, and NACA 65A006 airfoil sections parallel to the plane of symmetry. Test configurations included upper- and lower-surface spoilers, with and without a gap through the wing behind the spoiler. Chordwise pressure-distribution data were obtained at seven spanwise stations at Mach numbers from 0.60 (Reynolds number, 5.1×10^6) to 1.03 (Reynolds number, 6.2×10^6) for an angle-of-attack range that usually extended to 20° or higher. The effects of upper- and lower-surface spoilers on chordwise pressure distributions, wing normal forces, wing span-load distributions, and positions of center of pressure are shown. Spoiler load distributions are also shown.

NACA RM L54D20

INVESTIGATION AT HIGH SUBSONIC SPEEDS OF THE EFFECT OF ADDING VARIOUS COMBINATIONS OF MISSILES ON THE AERODYNAMIC CHARACTERISTICS OF SWEPTBACK AND UNSWEPT WINGS COMBINED WITH A FUSELAGE. H. Norman Silvers and William J. Alford, Jr. June 1954. 39p. diagrs., photo., tabs. (NACA RM L54D20)

An investigation was made at Mach numbers from 0.50 to about 0.94 of the effects of missiles attached in various combinations of two spanwise and two vertical locations on the longitudinal stability and performance characteristics of models with a 46.7° sweptback wing and a 3.5° sweptback wing combined with a fuselage.

NACA RM L54D27

TRANSONIC FLIGHT TEST OF A ROCKET-POWERED MODEL TO DETERMINE PROPULSIVE JET INFLUENCE ON THE CONFIGURATION DRAG. Carlos A. deMoraes. June 1954. 16p. diagrs., photo. (NACA RM L54D27)

The present investigation was conducted in the transonic Mach number range of 0.8 to 1.2. The Reynolds number based on body length varied from 23×10^6 to 43×10^6. The interference effects of the overexpanded propulsive jet were to decrease the boattail pressures (in the vicinity of the base) and the base pressure. At a Mach number of 1.075 the power-on drag was more than 24 percent higher than the power-off drag.

NACA RM L54D29

LOW-AMPLITUDE DAMPING-IN-PITCH CHARACTERISTICS OF TAILLESS DELTA-WING—BODY COMBINATIONS AT MACH NUMBERS FROM 0.80 TO 1.35 AS OBTAINED WITH ROCKET-POWERED MODELS. Charles T. D'Aiutolo. June 1954. 34p. diagrs., photos., tab. (NACA RM L54D29)

A flight test was conducted using three delta-wing—body combinations: an aspect-ratio-2 delta-wing—body combination with afterbody, an aspect-ratio-2 delta-wing—body combination with no afterbody, and an aspect-ratio-3 delta-wing—body combination with afterbody. All models incorporated NACA 63A006 airfoil sections. Data were obtained on the static and dynamic stability, drag characteristics, and the effects of aspect ratio on the damping in pitch between the Mach numbers of 0.80 and 1.35 corresponding to Reynolds number of 9×10^6 to 20×10^6. An application of the effect of dynamic instability on the performance of a full-scale airplane has been made from the data obtained from the flight-test models.

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NACA RM L55C29

EXPLORATORY TESTS OF TRANSPIRATION COOLING OF A POROUS 8° CONE AT M = 2.05 USING NITROGEN GAS, HELIUM GAS, AND WATER AS THE COOLANTS. Leo T. Chauvin and Howard S. Carter. June 1955. 22p. diagrs., photos., tab. (NACA RM L55C29)

The effectiveness of transpiration cooling on an 8° total-angle porous cone is presented for various coolant flow rates of nitrogen gas, helium gas, and distilled water. The tests were made at a Mach number of 2.05 and Reynolds number of 8×10^6. The heat transfer with nitrogen gas was in agreement with theory. At the same flow rate, helium gas reduced the heat transfer more than nitrogen gas. Cooling with distilled water gave a large reduction in the average wall temperature.

NACA RM L55D11

INVESTIGATION AT HIGH SUBSONIC SPEEDS OF THE EFFECTS OF VARIOUS UNDERWING EXTERNAL-STORE ARRANGEMENTS ON THE AERODYNAMIC CHARACTERISTICS OF A 1/16-SCALE MODEL OF THE DOUGLAS D-558-II RESEARCH AIRPLANE. H. Norman Silvers and Thomas J. King, Jr. July 1955. 59p. diagrs., photos., tab. (NACA RM L55D11)

An investigation of various external stores on a 1/16-scale model of the Douglas D-558-II research airplane has been made in the Langley high-speed 7- by 10-foot tunnel at Mach numbers from 0.40 to 0.96. All stores were located at the 0.61-semispan station. Three store sizes were investigated for a shape having a short cylindrical section between the forebody and the afterbody. Two store sizes were investigated for a shape having a long cylindrical center body. Pylon thicknesses of 7.6-, 6.2-, and 4.2-percent pylon chord were used with one of the stores.

NACA RM L55I21

FLIGHT MEASUREMENTS OF SECTION EFFICIENCY, THRUST, AND POWER OF A SUPERSONIC-TYPE PROPELLER AT MACH NUMBERS TO 0.9. Jerome B. Hammack and Thomas C. O'Bryan. January 1956. 38p. diagrs., photos., tab. (NACA RM L55I21)

Flight tests have been made on a supersonic-type propeller designed for a forward Mach number of 0.95 and advance ratio of 2.2. Power and thrust distributions, and section efficiency were determined over a range of forward Mach numbers to 0.9 in level flight. At an advance ratio of 2.2 and a forward Mach number of 0.9, blade section efficiencies were measured to be a maximum of 83 percent. Measured thrust distributions are smooth and uniform; such distributions are indicative of efficient operation. Power distributions which show section power absorption are also presented.

NACA RM L56C16

EFFECT OF WING CAMBER AND TWIST AT MACH NUMBERS FROM 1.4 TO 2.1 ON THE LIFT, DRAG, AND LONGITUDINAL STABILITY OF A ROCKET-POWERED MODEL HAVING A 52.5° SWEPTBACK WING OF ASPECT RATIO 3 AND INLINE TAIL SURFACES. Warren Gillespie, Jr. May 1956. 29p. diagrs., photos., tabs. (NACA RM L56C16)

The effect of wing camber and twist on the aerodynamic performance of a free-flight rocket-powered model was investigated at supersonic Mach numbers. The configuration tested had a 52.5° sweptback wing of aspect ratio 3, a body of fineness ratio 16.9, and inline tail surfaces. The warped wing was designed to have low drag at a wing lift coefficient of 0.3 and a Mach number of 1.46. Drag polars, normal force, pitching moment, static longitudinal stability, and wash effects at the tail were obtained. Comparisons are made with data from a similar model that had a flat wing.

NACA RM L56C21

JET EFFECTS ON BASE AND AFTERBODY PRESSURES OF A CYLINDRICAL AFTERBODY AT TRANSONIC SPEEDS. James M. Cubbage, Jr. May 1956. 50p. diagrs., photos. (NACA RM L56C21)

An investigation of the effects of jet nozzle geometry, size of base annulus, and base bleed upon the base and afterbody pressures of a cylindrical afterbody at transonic speeds has been conducted. Sonic and supersonic conical nozzles with jet-to-base diameter ratios from 0.25 to 0.85 were investigated with a cold jet at jet total-pressure ratios up to approximately 8.0 through a Mach number range from 0.6 to 1.25. Base pressure coefficients of about -0.55 were measured for the sonic nozzles at a Mach number of 1 or greater. The jet-to-base diameter ratio had a substantial effect on the base pressure obtained on the cylindrical afterbody of this investigation. Base bleed was beneficial in increasing the base pressure under certain conditions but had little or no effect at certain other conditions.

NACA RM L56C22

INVESTIGATION AT TRANSONIC SPEEDS OF THE EFFECTS OF INLET LIP STAGGER ON THE INTERNAL-FLOW CHARACTERISTICS OF AN UNSWEPT SEMIELLIPTICAL AIR INLET. Gene J. Bingham and Charles D. Trescot, Jr. May 1956. 31p. diagrs., photos., tab. (NACA RM L56C22)

An investigation has been made in the Langley transonic blowdown tunnel to study the effects of variations in inlet lip stagger from 0° to 60° on the internal-flow characteristics of an unswept semielliptical scoop-type air-inlet model without boundary-layer control. Tests were made at Mach numbers of 1.0, 1.2, and 1.4 through a mass-flow ratio range from about 0.3 to 0.9 at an angle of attack of 0°. Increases in total-pressure recovery with decreasing mass-flow ratio were effected for the 30° configuration at Mach numbers of 1.2 and 1.4. The maximum recovery (near normal shock) was obtained with the 30° stagger inlet at a mass-flow ratio of 0.63 ($M_O = 1.4$).

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NACA RM L56D03

LOW-SPEED WIND-TUNNEL RESULTS FOR A THIN ASPECT-RATIO-1.85 POINTED-WING—FUSELAGE MODEL WITH DOUBLE SLOTTED FLAPS. Albert E. Brown. July 1956. 31p. diagrs., tabs. (NACA RM L56D03)

Results are presented of a wind-tunnel investigation at low speeds of a thin aspect-ratio-1.85 pointed-wing—fuselage model equipped with double slotted flaps, including the effects of a straight and a delta horizontal tail on the static longitudinal stability and the effect of a delta vertical tail on the static lateral stability. Flap effectiveness increased with increase of flap deflection up to 52.5°. With a flap deflection of 52.5° the lift coefficient at an angle of attack of 0° was 0.66 and a maximum lift coefficient was 1.53. Most of the lift coefficient increment at an angle of attack of 0° held throughout the angle-of-attack range to near stall. Satisfactory location of the straight and delta horizontal tails was rearward and below the wing chord line extended. A delta vertical tail provided static directional stability of the model except at high lift coefficients and generally increased effective dihedral.

NACA RM L56D06

A SUMMARY OF NACA RESEARCH ON THE STRENGTH AND CREEP OF AIRCRAFT STRUCTURES AT ELEVATED TEMPERATURES. Richard R. Heldenfels and Eldon E. Mathauser. (Presented at Symposium on High-Speed Aerodynamics and Structures sponsored jointly by Air Research and Development Command, Bell Aircraft Corporation, Cornell Aeronautical Laboratory, and University of Buffalo, January 18-20, 1956, Buffalo, New York.) May 1956. 22p. diagrs. (NACA RM L56D06)

This paper summarizes some NACA research on the strength and creep of aircraft structural elements and components at elevated temperatures. Experimental data for aluminum-alloy columns, plates, stiffened panels, and multiweb box beams are presented for temperatures up to 600° F and compared with results predicted from materials data. Methods are described for predicting maximum strength from material stress-strain curves and creep lifetime from isochronous stress-strain curves. Some observations on the probable effect of creep on the design of aircraft structures are also included to illustrate the influence of design criteria on the weight of aircraft structures at elevated temperatures.

NACA RM L56D13

SOME EFFECTS OF WING FENCES ON THE LATERAL STABILITY DERIVATIVES OF A 60° DELTA WING OSCILLATING CONTINUOUSLY IN YAW. Donald R. Riley. July 1956. 29p. diagrs., photos., tab. (NACA RM L56D13)

From a wind-tunnel investigation made at low speed, results are presented which indicate some of the effects of wing fences on the lateral stability derivatives of a 60° delta-wing model oscillating continuously in yaw. Measurements were obtained for the rolling-moment and yawing-moment components in phase and out of phase with the model motion. The results indicate some of the effects of fence geometric characteristics, reduced frequency, oscillation amplitude, and angle of attack. The addition of wing fences provided large reductions in the magnitudes of the out-of-phase derivatives at high angles of attack and low reduced frequency by reducing the amount of separated flow on the wing surface. In addition, increases were obtained in the magnitudes of the in-phase derivatives.

NACA RM L56D19

THE EFFECT OF EXTERNAL STIFFENING RIBS ON THE ROLLING POWER OF AILERONS ON A SWEPT WING. Emily W. Stephens. October 1956. 15p. diagrs., photo., tab. (NACA RM L56D19)

An investigation, using rocket-powered models, was made to determine some effects on rolling effectiveness and drag of external ribs on swept wings. The Mach number range covered was from 0.6 to 1.6. The test wings were swept 45° at the quarter chord and had aspect ratios of 4.0, taper ratios of 0.6, NACA 65A006 airfoil sections parallel to the free stream, and one-half-span outboard flap-type ailerons of 30 percent chord. The results of the tests showed that stiffening the wings by the addition of fences increased the zero-lift rolling effectiveness and the reversal Mach number for the more flexible wings. It was indicated that the aerodynamic effects of adding fences would be small; however, a 10-percent increase in total drag coefficient was noted.

NACA RM L56D20a

FLIGHT MEASUREMENTS OF THE VIBRATORY BENDING AND TORSION STRESS ON A SUPERSONIC-TYPE PROPELLER FOR FLIGHT MACH NUMBERS UP TO 0.95. Thomas C. O'Bryan. July 1956. 22p. diagrs., photos., tab. (NACA RM L56D20a)

Vibratory stress measurements have been obtained in flight on a supersonic-type propeller for forward Mach numbers up to 0.95. Measured vibratory bending stresses were low and almost pure once-per-revolution stresses for Mach numbers up to approximately 0.82. There was no evidence of flutter during the flight program.

NACA RM L56D26

COMPARISON WITH THEORY OF LANDING IMPACTS OF A MODEL OF A SEAPLANE INCORPORATING A HYDRO-SKI WITH AND WITHOUT A SHOCK ABSORBER. Edward L. Hoffman. July 1956. 30p. diagrs., photo., tabs. (NACA RM L56D26)

Theoretical computations based on the application of planing data to impact conditions were compared with experimental data of calm- and rough-water landing impacts of a dynamic model of a seaplane incorporating a flat-bottom hydro-ski that could be mounted

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on a rigid strut and on a shock-absorber strut so that the ski translated normal to its keel without changing trim. A method was developed for obtaining an equivalent wave slope on which to base rough-water computations.

NACA RM L57A09

MEASUREMENT OF STATIC PRESSURE ON AIRCRAFT. William Gracey. April 1957. ii, 70p. diagrs. (NACA RM L57A09)

Existing data on the measurement of static pressure by means of static-pressure tubes and fuselage vents at subsonic, transonic, and supersonic speeds are presented. Static-pressure errors are given for isolated tubes and vents and for installations ahead of the fuselage nose, wing tip, and vertical tail fin, and on the fuselage. Various methods of calibrating installations in flight are briefly discussed.

NACA RM L57A30

EXPERIMENTAL DETERMINATION AT SUBSONIC SPEEDS OF THE OSCILLATORY AND STATIC LATERAL STABILITY DERIVATIVES OF A SERIES OF DELTA WINGS WITH LEADING-EDGE SWEEP FROM 30° TO 86.5°. William Letko. April 1957. 38p. diagrs., photos., tab. (NACA RM L57A30)

The static lateral stability of six delta wings was determined at subsonic speeds and, in addition, two of the wings having 82.5° and 75° sweep of the leading edge were oscillated in yaw about their vertical axis to determine the effects of frequency and amplitude on the combination lateral stability derivatives resulting from this motion. The results generally showed that large changes in the derivatives occurred with changes of frequency and amplitude at high angles of attack.

NACA RM L57E20

FLIGHT INVESTIGATION OF A SUPERSONIC PROPELLER ON A PROPELLER RESEARCH VEHICLE AT MACH NUMBERS TO 1.01. Jerome B. Hammack, Max C. Kurbjun, and Thomas C. O'Bryan. July 1957. 43p. diagrs., photos. (NACA RM L57E20)

The NACA propeller research vehicle, the McDonnell XF-88B airplane, is described. Results of flight investigation made with this vehicle to determine the aerodynamic characteristics of a supersonic propeller at the design Mach number of 0.95 and the design advance ratio of 2.2 are presented. At these design conditions the propeller efficiency was determined to be 79 percent. At the maximum test Mach number (M = 1.01) the propeller efficiency was measured to be 78 percent.

NACA RM L57F07

EFFECT OF FREQUENCY OF SIDESLIPPING MOTION ON THE LATERAL STABILITY DERIVATIVES OF A TYPICAL DELTA-WING AIRPLANE. Jacob H. Lichtenstein and James L. Williams. September 1957. 46p. diagrs., photos., tabs. (NACA RM L57F07)

An investigation has been made in the Langley stability tunnel at low speeds to determine the effect of frequency of sideslipping motion on the lateral stability derivatives of a typical 60° delta-wing airplane configuration. The results, for the various configurations tested, show that changes in the frequency of oscillation at low angles of attack had an appreciable effect on the yawing-moment derivatives and a negligible effect on the rolling-moment derivatives of the complete-model configuration and a negligible effect on the derivatives for the other configuration. Both the yawing- and rolling-moment derivatives underwent very large changes in magnitude because of the oscillatory motion at high angles of attack. Leading-edge radius had a pronounced bearing on the oscillatory stability derivatives for the wing alone in that a decrease in leading-edge radius considerably accentuated the effects due to oscillatory motion. The use of oscillatory sideslip derivatives instead of steady-state derivatives resulted in an increase in the calculated damping and stability for a typical delta-wing airplane at the high angles of attack.

NACA RM L57H02

A PRELIMINARY INVESTIGATION OF METHODS FOR IMPROVING THE PRESSURE-RECOVERY CHARACTERISTICS OF VARIABLE-GEOMETRY SUPERSONIC-SUBSONIC DIFFUSER SYSTEMS. Lowell E. Hasel and Archibald R. Sinclair. October 1957. 57p. diagrs., photos. (NACA RM L57H02)

An investigation has been initiated to study methods for improving the pressure-recovery characteristics of two-dimensional variable-geometry supersonic-subsonic diffuser systems. The pressure recovery of the basic configuration which had a relatively long supersonic diffuser varied from 0.71 to 0.21 over a Mach number range from 2.50 to 4.75. Incorporation of an injector at the end of the supersonic diffuser resulted in recoveries which varied from 0.65 to 0.56 over a Mach number range from 2.95 to 4.70. The results indicate that considerable improvement in the performance of new or existing supersonic wind tunnels can be obtained by modifying the diffuser.

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1300

BASIC CONSIDERATIONS IN THE COMBUSTION OF HYDROCARBON FUELS WITH AIR. Propulsion Chemistry Division. Edited by Henry C. Barnett and Robert R. Hibbard. Chap. I: ATOMIZATION AND EVAPORATION OF LIQUID FUELS. Charles C. Graves and Donald W. Bahr. Chap. II: FLOW AND MIXING PROCESSES IN COMBUSTION CHAMBERS. Wilfred E. Scull and William R. Mickelsen. Chap. III: IGNITION AND FLAMMABILITY OF HYDROCARBON FUELS. Frank E. Belles and Clyde C. Swett. Chap. IV: LAMINAR FLAME PROPAGATION. Gordon L. Dugger, Dorothy M. Simon, and Melvin Gerstein. Chap. V: TURBULENT FLAMES. Melvin Gerstein and Gordon L. Dugger. Chap. VI: FLAME STABILIZATION. Gordon L. Dugger and Melvin Gerstein. Chap. VII: DIFFUSION FLAMES. Richard S. Brokaw and Melvin Gerstein. Chap. VIII: OSCILLATIONS IN COMBUSTORS. Perry L. Blackshear, Jr., and Warren D. Rayle. Chap. IX: SMOKE AND COKE FORMATION IN THE COMBUSTION OF HYDROCARBON-AIR MIXTURES. Rose L. Schalla and Robert R. Hibbard. 1957. xi, 259p. diagrs., photos., tabs. (NACA Rept. 1300)

Basic combustion research is collected, collated, and interpreted as it applies to flight propulsion. The following fundamental processes are treated in separate chapters: atomization and evaporation of liquid fuels, flow and mixing processes in combustion chambers, ignition and flammability of hydrocarbon fuels, laminar flame propagation, turbulent flames, flame stabilization, diffusion flames, oscillations in combustors, and smoke and coke formation in the combustion of hydrocarbon-air mixtures. Theoretical background, basic experimental data, and practical significance to flight propulsion are presented.

NACA Rept. 1314

SUMMARY OF SCALE-MODEL THRUST-REVERSER INVESTIGATION. John H. Povolny, Fred W. Steffen, and Jack G. McArdle. 1957. ii, 14p. diagrs., photos. (NACA Rept. 1314. Supersedes TN 3664)

This report summarizes the results of a scale-model thrust-reverser investigation. Three basic types of thrust reversers, target, tail-pipe cascade, and ring cascade, were investigated. All three were found to have satisfactory reverse-thrust performance and thrust-modulation characteristics.

NACA Rept. 1319

INDUCED VELOCITIES NEAR A LIFTING ROTOR WITH NONUNIFORM DISK LOADING. Harry H. Heyson and S. Katzoff. 1957. iii, 88p. diagrs., photos., tab. (NACA Rept. 1319. Supersedes TN 3690; TN 3691)

A method is given for converting known uniformly loaded rotor induced velocities to correspond with arbitrary axisymmetric nonuniform disk load distributions. Numerical results for two specific distributions are given in chart form. Symmetry relations and relations between radial disk loading and wake velocities are developed. Experimental flow measurements are presented and compared with theory. Reasonable agreement is shown in the forward part of the flow when nonuniform loading is assumed, but far behind the rotor the flow is more like that of a wing.

NACA Rept. 1321

THEORETICAL CALCULATION OF THE POWER SPECTRA OF THE ROLLING AND YAWING MOMENTS ON A WING IN RANDOM TURBULENCE. John M. Eggleston and Franklin W. Diederich. 1957. ii, 19p. diagrs., tabs. (NACA Rept. 1321. Supersedes TN 3864.)

An analytical solution is derived for the power spectral density of the rolling- and yawing-moment coefficients of a wing subjected to random isotropic atmospheric turbulence. The theory considers the random variations of the turbulence in the spanwise as well as the flight-path direction. Horizontal, vertical, and side gust components are considered. Plots of the power spectra are presented.

NACA Rept. 1323

INVESTIGATION OF THE LAMINAR AERODYNAMIC HEAT-TRANSFER CHARACTERISTICS OF A HEMISPHERE-CYLINDER IN THE LANGLEY 11-INCH HYPERSONIC TUNNEL AT A MACH NUMBER OF 6.8. Davis H. Crawford and William D. McCauley. 1957. ii, 21p. diagrs., photos., tab. (NACA Rept. 1323. Supersedes TN 3706)

The aerodynamic heat transfer of a nonisothermal hemisphere-cylinder has been investigated at a Mach number of 6.8 and Reynolds numbers from 0.14×10^6 to 1.06×10^6 based on diameter and free-stream conditions. The experimental heat transfer was slightly less than that predicted by the Stine and Wanlass theory (NACA TN 3344) for an isothermal surface. For stations within 45° of the stagnation point the heat transfer could be correlated by a single relation between local Stanton and local Reynolds numbers.

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NACA Rept. 1326

FLIGHT AND ANALYTICAL METHODS FOR DETERMINING THE COUPLED VIBRATION RESPONSE OF TANDEM HELICOPTERS. John E. Yeates, Jr., George W. Brooks, and John C. Houbolt. 1957. iv, 31p. diagrs., photo., tabs. (NACA Rept. 1326. Supersedes TN 3852; TN 3849)

A discussion of flight-test and analysis methods for some selected helicopter vibration studies is presented. The use of a mechanical shaker in flight to determine the structural response is reported. Some results are presented to show the coupled response of a helicopter in flight for two different blade configurations. In addition a method is presented for calculating the natural coupled frequencies and mode shapes of vertical vibrations of tandem helicopters; certain forced excitations are also considered. Frequency response functions of cockpit deflection for various applied oscillating forces are given.

NACA Rept. 1329

FAR NOISE FIELD OF AIR JETS AND JET ENGINES. Edmund E. Callaghan and Willard D. Coles. 1957. ii, 18p. diagrs., photos. (NACA Rept. 1329. Supersedes TN 3590; TN 3591)

The effect of nozzle-exit shape was studied using a small (4-in. diam.) air jet. Circular, square, rectangular, and elliptical convergent nozzles and convergent-divergent and plug nozzles were investigated. At low jet pressure ratios (less than 2.2) the effect of nozzle shape on the sound field was negligible. At high jet pressure ratios all the nozzles exhibited discrete-frequency noises associated with shock formations in the jet. The convergent-divergent nozzle showed an elimination of such noises at its design pressure ratio. The acoustic power radiated by the engines and air jet was correlated by the Lighthill parameter. The free-field spectral distribution of the sound power was in good agreement for both engine and air jet.

NACA Rept. 1333

ATTENUATION IN A SHOCK TUBE DUE TO UNSTEADY-BOUNDARY-LAYER ACTION. Harold Mirels. 1957. iii, 19p. diagrs., tab. (NACA Rept. 1333. Supersedes TN 3278)

A method is presented for obtaining the attenuation of a shock wave in a shock tube due to the unsteady boundary layer along the shock-tube walls. It is assumed that the boundary layer is thin relative to the tube diameter and induces one-dimensional longitudinal pressure waves whose strength is proportional to the vertical velocity at the edge of the boundary layer. The method is shown to be in reasonably good agreement with existing experimental data.

NACA RM 58B11

LOCAL ISOTROPY IN TURBULENT SHEAR FLOW. Stanley Corrsin, Johns Hopkins University. May 1958. 15p. diagr. (NACA RM 58B11)

The mean strain rate in turbulent shear flow must tend to make the structure anisotropic in all parts of the spectrum. The argument is presented that, if the spectral energy transfer process destroys orientation, the Kolmogoroff notion of local isotropy can still be justified in spectral regions where the local transfer time is shorter than the characteristic time of the gross shear strain.

NACA RM E58A21

THEORETICAL PERFORMANCE OF LIQUID AMMONIA WITH LIQUID OXYGEN AS A ROCKET PROPELLANT. Sanford Gordon and Alan R. Glueck. May 1958. 84p. diagrs., tabs. (NACA RM E58A21)

Data were calculated for both equilibrium and frozen composition for chamber pressures of 300 and 600 lb/sq in. abs, pressure ratios from 1 to 1500, and oxidant-fuel ratios from 0.564 to 7.046. Parameters include specific impulse, specific impulse in vacuum, combustion and exit temperature, molecular weight, molecular-weight derivatives, characteristic velocity, coefficient of thrust, ratio of nozzle-exit area to throat area, specific heat at constant pressure, isentropic exponent, viscosity, thermal conductivity, Mach number, and equilibrium gas compositions. Maximum specific impulse for a chamber pressure of 600 lb/sq in. abs and an exit pressure of 1 atm (pressure ratio, 40.827) is 278.7 and 269.3 assuming equilibrium and frozen composition, respectively.

NACA RM E58B20

THEORETICAL ROCKET PERFORMANCE OF LIQUID METHANE WITH SEVERAL FLUORINE-OXYGEN MIXTURES ASSUMING FROZEN COMPOSITION. Sanford Gordon and Michael E. Kastner. May 1958. 44p. diagrs., tabs. (NACA RM E58B20)

Data were calculated for a chamber pressure of 600 pounds per square inch absolute, fluorine in oxidant from 0 to 100 percent, pressure ratios of 1 to 300, and a range of equivalence ratios. Parameters included are specific impulse, combustion and exit temperatures, molecular weight, characteristic velocity, coefficient of thrust, area ratio, specific heat, isentropic exponent, viscosity, thermal conductivity, and combustion compositions.

CURRENT NACA RESEARCH REPORTS

NACA TN 3924

DISCHARGE COEFFICIENTS FOR COMBUSTOR-LINER AIR-ENTRY HOLES. II - FLUSH RECTANGULAR HOLES, STEP LOUVERS, AND SCOOPS. Ralph T. Dittrich. April 1958. 56p. diagrs., tab. (NACA TN 3924)

Experimental discharge coefficients for various types of combustor-liner air-entry holes are presented as a function of a dimensionless flow parameter. In general, scoops and step louvers have higher discharge coefficients and wider flow ranges than flush holes. The effects of size or shape of a given type of hole are small. The proximity of multiple flush holes or the wall inclination of a convergent duct has a negligible effect on discharge coefficient.

NACA TN 4226

ANALYSIS OF HARMONIC FORCES PRODUCED AT HUB BY IMBALANCES IN HELICOPTER ROTOR BLADES. M. Morduchow and A. Muzyka, Polytechnic Institute of Brooklyn. April 1958. 37p. diagrs. (NACA TN 4226)

General explicit expressions are derived for the harmonic forces produced at the hub by an n-bladed unbalanced helicopter rotor. Imbalances due to property differences among the blades and to nonuniform spacing between the blades are considered. Numerical examples are given throughout to illustrate the order of magnitude of the results. For convenient reference, an analysis of the forces transmitted to the hub by a balanced rotor of n blades is also given.

NACA TN 4228

EFFECTS OF FIXING BOUNDARY-LAYER TRANSITION FOR AN UNSWEPT-WING MODEL AND AN EVALUATION OF POROUS TUNNEL-WALL INTERFERENCE FOR MACH NUMBERS FROM 0.60 TO 1.40. Louis S. Stivers, Jr., and Garth W. Lippmann. April 1958. 37p. diagrs. (NACA TN 4228)

Tests have been made in the Ames 2- by 2-foot transonic wind tunnel to determine the aerodynamic effects of fixing boundary-layer transition in a forward location on two unswept-wing models which differed only in size. The models had wings of aspect ratio 3.09 with sharp leading edges. The tests were made at Mach numbers from 0.60 to 1.40 and at Reynolds numbers from 1.5 to 3.45 million. The fixed-transition data were utilized to evaluate the interference of the porous walls of the Ames 2- by 2-foot transonic wind tunnel. The results demonstrated that the model size indicated to be necessary for small wall interference in NACA RM A55I21 is incorrect.

NACA TN 4235

OBSERVATIONS OF TURBULENT-BURST GEOMETRY AND GROWTH IN SUPERSONIC FLOW. Carlton S. James. April 1958. (i), 85p. diagrs., photos., tab. (NACA TN 4235)

Some aspects of the mechanics of boundary-layer transition have been deduced from a study of shadowgraphs of free-flight models at free-stream Mach numbers between 2.7 and 10. That part of the transition process between the first appearance of turbulence vortices and the end result of continuously turbulent flow is found to occur in supersonic flow in a manner closely similar to its observed occurrence in subsonic flow. Minute spots, or bursts, of turbulence form near the leading edge and are swept aft. The rates at which these bursts form and grow are found to vary gradually with Mach number, unit Reynolds number, and surface roughness.

NACA TN 4240

SOME MEASUREMENTS OF AERODYNAMIC FORCES AND MOMENTS AT SUBSONIC SPEEDS ON A RECTANGULAR WING OF ASPECT RATIO 2 OSCILLATING ABOUT THE MIDCHORD. Edward Widmayer, Jr., Sherman A. Clevenson, and Sumner A. Leadbetter. May 1958. 45p. diagrs., tabs. (NACA TN 4240. Supersedes RM L53F19)

Results are presented for a range of Mach number from 0.15 to 0.81, a range of reduced frequency from 0.15 to 1.32, and a range of Reynolds number from 0.60×10^6 to 9.21×10^6. A comparison of the measured aerodynamic forces and moments is made with some available published data. Comparisons are also made between the measured data and theoretical incompressible-flow coefficients obtained from the aspect-ratio theory of Reissner, the aspect-ratio theory of Lawrence and Gerber, and the two-dimensional-flow theory. Some experimental results pertaining to the influence of wind-tunnel-wall effects on nonsteady aerodynamic measurement are included.

NACA TN 4241

AN APPROXIMATE METHOD FOR DESIGN OR ANALYSIS OF TWO-DIMENSIONAL SUBSONIC-FLOW PASSAGES. E. Floyd Valentine. April 1958. 38p. diagrs., photo. (NACA TN 4241)

A method is developed for the design and analysis of two-dimensional subsonic-flow passages with isentropic nonviscous flow. The method is based on the relation between the pressure change across a stream tube and the centrifugal force resulting from the curvature of the flow. Precomputed charts can be drawn which eliminate subsequent calculation for a given upstream Mach number. The method is limited by the accuracy with which the radius of curvature of the streamlines can be determined.

CURRENT NACA RESEARCH REPORTS

NACA TN 4242

GENERAL SOLUTIONS FOR FLOW PAST SLENDER CAMBERED WINGS WITH SWEPT TRAILING EDGES AND CALCULATION OF ADDITIONAL LOADING DUE TO CONTROL SURFACES. E. B. Klunker and Keith C. Harder. May 1958. 55p. diagrs. (NACA TN 4242)

The slender-wing-type analysis is used to obtain general expressions for the surface pressure, lift, and rolling moment for cambered wings with swept trailing edges. These results are specialized to give the additional loading due to the deflection of trailing-edge control surfaces. The loading due to twist is also obtained for one particular form of twist.

NACA TN 4247

STUDY OF GROUND-REACTION FORCES MEASURED DURING LANDING IMPACTS OF A LARGE AIRPLANE. Albert W. Hall, Richard H. Sawyer, and James M. McKay. May 1958. 40p. diagrs., photo., tabs. (NACA TN 4247. Supersedes RM L55E12c)

Tests were conducted on a large bomber-type airplane to determine the ground-reaction forces imposed on the main landing gear under actual landing conditions. Data were obtained from 30 landings made at vertical velocities up to 8.4 feet per second and forward ground speeds from 81.0 to 119.5 knots. Vertical, drag, and side forces are presented. Results are presented of the effect of vertical velocity at contact on the vertical force and the variations of coefficient of friction with slip ratio during spin-up for both wet and dry concrete surfaces. A limited amount of side-force data indicating the nature of side-force variation with drift angle and vertical force is presented.

NACA TN 4248

SUMMARY OF EXPERIMENTAL HEAT-TRANSFER MEASUREMENTS IN TURBULENT FLOW FOR A MACH NUMBER RANGE FROM 0.87 TO 5.05. Maurice J. Brevoort and Barbara D. Arabian. May 1958. 43p. diagrs., photos., tab. (NACA TN 4248)

An axially symmetric annular nozzle was used to obtain essentially flat-plate data on turbulent heat-transfer coefficients and temperature-recovery factors. The test results of this paper are for Mach numbers 0.87, 1.62, 2.06, 3.03, 3.90, and 5.05 and for a Reynolds number range of 1×10^6 to 9.5×10^8. These results are presented in the form of Stanton number and recovery factor as a function of Reynolds number. The Stanton number shows a systematic variation with Mach number. The recovery factor appears to be independent of the Mach number in the range of these tests. Both Stanton number and recovery factor show a decrease with an increase in Reynolds number.

NACA TN 4251

AN EXPERIMENTAL INVESTIGATION OF WAKE EFFECTS ON HYDRO-SKIS. Ellis E. McBride and Lloyd J. Fisher. May 1958. 34p. diagrs., photos., tab. (NACA TN 4251)

Two combinations of hydro-skis were tested: two hydro-skis in tandem and three hydro-skis arranged with a single front hydro-ski. The results show that the rear hydro-ski in a tandem arrangement could have large increases in lift coefficient and small improvements in lift-drag ratio compared with a hydro-ski in undisturbed water over a limited speed range. The two rear hydro-skis in a three-hydro-ski arrangement would tend to have losses in efficiency compared with hydro-skis in undisturbed water, but the losses could apparently be prevented by carefully selecting the spacing.

NACA TN 4254

FLIGHT INVESTIGATION OF EFFECTS OF RETREATING-BLADE STALL ON BENDING AND TORSIONAL MOMENTS ENCOUNTERED BY A HELICOPTER ROTOR BLADE. LeRoy H. Ludi. May 1958. 23p. diagrs., photo. (NACA TN 4254)

The results of the investigation indicated that blade stall can produce large increases in periodic blade moments during high-speed flight and pull-up maneuvers. The results also indicated that the higher harmonics can contribute as much as the lower harmonics to increased vibration and increased periodic control loads in the highly stalled condition.

NACA TN 4261

ACOUSTIC, THRUST, AND DRAG CHARACTERISTICS OF SEVERAL FULL-SCALE NOISE SUPPRESSORS FOR TURBOJET ENGINES. Carl C. Ciepluch, Warren J. North, Willard D. Coles, and Robert J. Antl. April 1958. 48p. diagrs., photos. (NACA TN 4261)

An experimental investigation was conducted with an engine in the 10,000-pound-thrust class. The acoustic study was made with an outdoor thrust stand. Acoustic data are presented in terms of sound directionality, spectrum, and sound power. Aerodynamic properties of the suppressors were evaluated over a range of Mach numbers up to 0.5 in an altitude wind tunnel. The most efficient configurations from both acoustic and propulsive thrust considerations were a two-position mixing nozzle with ejector and a 12-lobe nozzle. At a Mach number of 0.5 the respective propulsive thrust losses were about 1 and 3 percent. Calculations indicate that these two configurations would reduce the noise heard during takeoff by 5 or 6 decibels.

CURRENT NACA RESEARCH REPORTS

NACA TN 4263

EFFECT OF PRIOR AIR FORCE OVERTEMPERATURE OPERATION ON LIFE OF J47 BUCKETS EVALUATED IN A SEA-LEVEL CYCLIC ENGINE TEST. Robert A. Signorelli, James R. Johnston, and Floyd B. Garrett. April 1958. 41p. diagrs., photos., tabs. (NACA TN 4263)

Buckets of S-816 alloy overtemperatured in service operation were evaluated in laboratory and engine tests. Some buckets were tested in the as-overtemperatured condition while others were heat-treated prior to testing. Results indicated that overtemperatured buckets did not fracture in abnormally short operating times, although life in stress-rupture tests was reduced. Cracks, particularly on the leading edge, developed after short operating times but did not propagate to fracture during several hundred hours of operation.

NACA TN 4265

COMPOSITION AND THERMODYNAMIC PROPERTIES OF AIR IN CHEMICAL EQUILIBRIUM. W. E. Moeckel and Kenneth C. Weston. April 1958. 39p. diagrs. (NACA TN 4265)

Charts have been prepared relating the thermodynamic properties of air in chemical equilibrium for temperatures to 15,000° K and for pressures from 10^{-5} to 10^{+4} atmospheres. Also included are charts showing the composition of air, the isentropic exponent, and the speed of sound. These charts are based on thermodynamic data calculated by the National Bureau of Standards.

NACA TN 4267

PRELIMINARY SURVEY OF PROPULSION USING CHEMICAL ENERGY STORED IN THE UPPER ATMOSPHERE. Lionel V. Baldwin and Perry L. Blackshear. Appendix D: HEAT TRANSFER AND FRICTION DRAG. James F. Schmidt. May 1958. 73p. diagrs., tabs. (NACA TN 4267)

Ram-jet cycles that use the chemical energy of dissociated oxygen for propulsion in the ionosphere are presented. After a review of the properties and compositions of the upper atmosphere, the external drag, recombination kinetics, and aerodynamic-heating problems of an orbiting ram jet are analyzed. The study indicates that the recombination ram jet might be useful for sustaining a satellite at an altitude of about 60 miles. Atmospheric composition and recombination-rate coefficients were too uncertain for more definite conclusions. The ram jet is a marginal device even in the optimistic view.

NACA TN 4268

DROPLET IMPINGEMENT AND INGESTION BY SUPERSONIC NOSE INLET IN SUBSONIC TUNNEL CONDITIONS. Thomas F. Gelder. May 1958. 56p. diagrs., photos. (NACA TN 4268)

The amount of water in cloud droplet form ingested by a full-scale supersonic nose inlet with conical center body was measured. Local and total water impingement rates on the cowl and center-body surfaces were also obtained. All measurements were made with a dye-tracer technique. Inlet angles of attack of 0° and 4.2°, droplet diameters from 11 to 20 microns, and ratios of inlet to free-stream velocity from 0.4 to 1.8 were studied. Measurements were confined to a free-stream Mach number of 0.237 and are extendable to other subsonic speeds by dimensionless impingement parameters.

NACA TN 4269

TRANSONIC DRAG OF SEVERAL JET-NOISE SUPPRESSORS. Warren J. North. April 1958. 34p. diagrs., photos. (NACA TN 4269)

One-fifth scale suppressors were tested at Mach numbers from 0.65 to 1.10 over a range of nozzle pressure ratios. Total and component drag coefficients are presented for the various models. Drag increases due to the suppressors are presented in terms of net thrust. Propulsive-thrust losses were calculated, and the results were converted into aircraft payload penalty.

NACA TN 4270

A PERFORMANCE ANALYSIS OF METHODS FOR HANDLING EXCESS INLET FLOW AT SUPERSONIC SPEEDS. Donald P. Hearth and James F. Connors. May 1958. 26p. diagrs., tab. (NACA TN 4270)

For the Mach 1.5 to 4.0 range, the following schemes were considered: normal- and oblique-shock spillage, bypass through an auxiliary exit, bypass to an ejector nozzle, and bypass through an auxiliary ram-jet engine. These methods were evaluated in terms of a thrust penalty for an assumed turbojet engine. Charts are presented for estimating these penalties for a range of mass flows and Mach numbers. Comparison of the various methods is also made on the basis of matching requirements for a hypothetical Mach 4.0 turbojet application.

CURRENT NACA RESEARCH REPORTS

NACA TN 4271

MAXIMUM THEORETICAL TANGENTIAL VELOCITY COMPONENT POSSIBLE FROM STRAIGHT-BACK CONVERGING AND CONVERGING-DIVERGING STATORS AT SUPERCRITICAL PRESSURE RATIOS. Thomas P. Moffitt. April 1958. 21p. diagrs. (NACA TN 4271)

The results of the investigation showed that converging stators are limited to exit tangential components of critical velocity ratios less than 1.714, while values up to the theoretical limit of 2.449 (corresponding to a Mach number of infinity) might be realized from converging-diverging stators. Unless design requirements are rigorous or unless extremely small blade exit angles as measured from the tangential are to be used, an approximate method of assuming uniform flow at the stator exit appears adequate in determining the maximum tangential velocity component possible from stators.

NACA TN 4274

MEASUREMENT OF THE EFFECT OF AN AXIAL MAGNETIC FIELD ON THE REYNOLDS NUMBER OF TRANSITION IN MERCURY FLOWING THROUGH A GLASS TUBE. Michel Bader and William C. A. Carlson. May 1958. 8p. diagrs. (NACA TN 4274)

Experiments were conducted to determine the effect of a 15,000 gauss axial magnetic field on the flow of mercury through a glass tube of 0.027-inch inside diameter. It was found that when only slight instabilities were present at Reynolds numbers from 5,000 to 8,000, the Reynolds number of transition could be increased by as much as 10 percent.

NACA TN 4276

AN APPROXIMATE ANALYTICAL METHOD FOR STUDYING ENTRY INTO PLANETARY ATMOSPHERES. Dean R. Chapman. May 1958. (i), 101p. diagrs., tab. (NACA TN 4276)

The complete pair of motion equations for entry into an exponential atmosphere is reduced to an ordinary, nonlinear differential equation of second order by introducing a certain mathematical transformation. This differential equation includes terms representing the gravity force, centrifugal force, lift force, drag force, and vertical acceleration. Solutions obtained for different types of entry are universal in the sense that a single solution determines the motion and heating of a vehicle of arbitrary weight, dimensions, and shape entering an arbitrary planetary atmosphere. Study is made of the decelerations, heating rates, and total heat absorbed for entry into Venus, Earth, Mars, and Jupiter.

BRITISH REPORTS

N-38730X*

Aeronautical Research Council (Gt. Brit.)
ON THE INTEGRAL EQUATIONS OF TWO-DIMENSIONAL SUBSONIC FLUTTER DERIVATIVE THEORY. D. E. Williams. 1958. 21p. ARC R & M 3057; ARC 17,931. Supersedes RAE Report Structures 181. (Ask for N-38730X*)

This note gives the result of an attempt to find an analytical solution of Poisson's integral equation - the equation which connects the downwash and the pressure distribution on an airfoil oscillating in two-dimensional subsonic compressible flow. A method is given for solving this problem and for solving the corresponding problem in incompressible flow (the solution of Birnbaum's integral equation).

N-48079*

Aeronautical Research Council (Gt. Brit.)
ON THE MINIMUM DRAG OF THIN LIFTING BODIES IN STEADY SUPERSONIC FLOWS. G. N. Ward. October 1, 1956. 6p. ARC 18,711; FM 2459. (Ask for N-48079*)

The problem of calculating the minimum drag for a thin body with a given mean surface which is sustaining a given lift in a steady supersonic flow is reduced to a two-dimensional harmonic problem. The minimum drag is determined from the momentum integral for the smallest closed characteristic surface which just contains the body, but it is not certain that this minimum value can always be attained by a real body. It is shown that any larger characteristic surface leads to a smaller minimum drag which cannot be attained by a real body with the given mean surface.

N-58036X, pt.1*

Aeronautical Research Council (Gt. Brit.)
MEASUREMENTS OF THE EFFECT OF SURFACE COOLING ON BOUNDARY LAYER TRANSITION ON A 15° CONE. PART 1. TESTS AT M = 2 AND 3 IN AN 8 IN. X 9 IN. WIND TUNNEL AT R. A. E./ BEDFORD. A. C. Browning, J. F. W. Crane, and R. J. Monaghan. 1958. 41p. diagrs., photos., tab. ARC CP 381. (Ask for N-58036X, pt.1*)

This was a steel cone, cooled internally by the circulation of cold alcohol. Results showed that when the ratio (surface temperature ahead of transition)/ (surface temperature for zero heat transfer) was reduced from 1.0 to 0.88, the transition RN at zero incidence was increased by a factor of about 1.8 for a local Mach number of 1.86 and by a factor of 1.24 to 1.43 for M = 2.81. The spread in the latter factor arose from alternative estimates of transition RN under zero heat transfer conditions, since at M = 2.81 this RN was dependent on stagnation pressure. Simultaneous records of transition position on the top and bottom generators of the cone were obtained in all cases, using the shadowgraph technique. Tests were also made at an incidence of 2°.

*AVAILABLE ON LOAN ONLY.

BRITISH REPORTS

CN-60231*

Royal Aircraft Establishment (Gt. Brit.)
THE TECHNIQUE OF WELDING ALUMINIUM AND ALUMINIUM ALLOY VESSELS FOR USE WITH CONCENTRATED HYDROGEN PEROXIDE (H.T.P.).
P. Bradley and G. A. C. Waite. November 1957. 26p. diagrs., photos., tabs. RAE Tech.Note RPD 157. (Ask for CN-60231*)

The fusion welding of vessels made in aluminum and aluminum alloys for use in contact with H.T.P. (concentrated hydrogen peroxide) is discussed with reference to the chemical properties of the liquid. The metallurgical aspects of welding various alloys are outlined and recommendations given on the selection of suitable filler metals. Fusion welding processes are described with particular reference to the inert gas shielded arc processes. Typical weld preparations and techniques that have been employed in the fabrication of vessels for use with H.T.P., using the inert gas shielded arc processes, are described in detail. Methods of testing and inspecting the welds are given together with radiographs and photomicrographs which illustrate the more common defects.

N-60232*

Royal Aircraft Establishment (Gt. Brit.)
MECHANICAL PROPERTIES AT TEMPERATURES UP TO 300° C OF ALUMINIUM ALLOYS D.T.D. 546 AND H.S. 10 AT HIGH RATES OF HEATING AND STRAINING. M. S. Binning and B. Angell. November 1957. 22p. diagrs., photo., tabs. RAE Tech.Note Met.278. (Ask for N-60232*)

Tensile tests at room temperature, 100°, 200°, and 300° C have been made on specimens cut from aluminum alloy sheets to D.T.D. 546 and H.S. 10, the former being clad and the latter unclad. Specimens were raised to test temperature by resistance heating in 30 seconds and then tested at straining rates such that the 0.2-percent proof stress was reached in approximately 10 seconds. The decrease in proof stress with temperature was found to be similar for both materials; at 300° C the 0.2-percent proof stresses had decreased to 32 percent of their room temperature values. Seam welded specimens of D.T.D. 546 were tested and the weld efficiencies found to be 69 percent, 83 percent, and 98 percent at room temperature, 200°, and 300° C, respectively. Welded specimens were heated in an electric furnace and took 10 minutes to reach test temperature.

N-60233*

National Gas Turbine Establishment (Gt. Brit.)
THE DEVELOPMENT OF HOT FLUIDISED BEDS FOR A LABORATORY THERMAL SHOCK TEST.
S. W. K. Shaw. February 1958. 33p. diagrs., photos., tabs. NGTE Memo. M.302.
(Ask for N-60233*)

A laboratory thermal shock test was required for studying the behavior and assessing the performance of useful and potentially useful materials for gas turbine blading. A method of rapidly cooling test specimens at a constant heat transfer coefficient had been developed using a fluidized bed as the cooling medium. This memorandum is concerned with the development of hot fluidized beds for rapidly heating the specimens. Five methods of heating fluidized beds were investigated, the most successful involving a spiral electric resistance heating element immersed in the bed. The critical mass flow to fluidize a granular material was found to decrease markedly and the maximum heat transfer coefficient to increase with temperature. Thermal shock tests on different shapes of test piece in brittle and ductile materials have shown this technique to be a reliable and reproducible means of studying thermal shock behavior.

CN-60234*

Aeronautical Research Council (Gt. Brit.)
NUMERICAL SOLUTION OF A SECOND ORDER LINEAR DIFFERENTIAL EQUATION WITH THE DEPENDENT COEFFICIENTS. A. W. Babister. March 20, 1957. 59p. tabs. ARC 19,139; Comp. 120; GCS 59. (Ask for CN-60234*)

It is shown that the linear differential equation

$$(a_2 + b_2\tau)\frac{d^2x}{d\tau^2} + (a_1 + b_1\tau)\frac{dx}{d\tau} + (a_0 + b_0\tau)\,x = 0$$

can be reduced to either of the standard forms

(1) $$z\frac{d^2y}{dz^2} + (c - z)\frac{dy}{dz} - \alpha y = 0$$

or

(2) $$z\frac{d^2y}{dz^2} + (2m + 2)\frac{dy}{dz} + (z - 2a) - 0$$

The general properties of the solutions of the second standard form are considered. Values of two independent solutions (together with their first derivatives with respect to z) are tabulated for the ranges

M : - 1.0(0.25)0, a : - 1.0(0.25)1.0, z : 0(9.2)6.0.

CN-60235*

Royal Aircraft Establishment (Gt. Brit.)
SOME NOTES ON THE INSTRUMENTATION FOR MEASUREMENT OF GROSS AND NETT THRUST IN FLIGHT ON THE FAIREY ER 103 AIRCRAFT.
D. R. Andrews. February 1958. 25p. diagrs., photos. RAE Tech.Note Aero 2548.
(Ask for CN-60235*)

Instrumentation is being prepared to study and compare various methods of measuring gross thrust and engine mass flow in flight in the Fairey ER103 aircraft. This note gives details of the various techniques to be used, of the instrumentation to be fitted, and the general manner in which the test program will be conducted.

*AVAILABLE ON LOAN ONLY.

BRITISH REPORTS

N-60236*

Aeronautical Research Council (Gt. Brit.)
THE GROUND EFFECT ON THE JET FLAP IN TWO DIMENSIONS. D. J. Huggett. December 5, 1957. 19p. diagrs., photos. ARC 19,713; FM 2621; S & C 3232; Perf.1609. (Ask for N-60236*)

This paper presents the results of the first part of an experimental investigation of the ground effect on simple jet flap airfoils. In this part of the work an airfoil having a 58.1° jet flap was tested under two-dimensional conditions. The pressure lift on the airfoil was measured, with the ground at fixed positions, for varying jet momentum coefficients. It was found that the effect of the ground on the pressure lift was very small up to a certain critical jet coefficient. On increasing the jet coefficient beyond the critical value a marked loss of pressure lift was observed. This critical value referred to is approximately the same as the jet coefficient at which the jet first hits the ground.

CN-60237*

Aeronautical Research Council (Gt. Brit.)
A MULTI-RANGE, LOW FREQUENCY BAND-PASS FILTER. J. B. Bratt, National Physical Laboratory. November 19, 1957. 14p. diagrs. ARC 19,669; 0.1363. (Ask for CN-60237*)

The band-pass filter described covers a frequency range from 16 c/s to 175 c/s in nine bands, the ratio of the upper to the lower frequency of each pass-band being 1.38. Response in the pass-band is flat within ±5 percent, and attenuation of the third harmonic of the lower frequency limit is 33 times. Two frequency selective RC valve amplifiers, modified to give zero output at frequencies of 0 and ∞ are employed, and a special feedback network enables change of pass-band to be made by switching two capacitors in each amplifier.

N-60238*

Aeronautical Research Council (Gt. Brit.)
THE GROUND EFFECT ON THE JET-FLAP IN TWO DIMENSIONS. II. PITCHING MOMENT AND DOWNWASH CHANGES ON A 58° FLAP AND FURTHER EXPERIMENTS, INCLUDING PITCHING MOMENT CHANGES ON A 31° FLAP. D. J. Huggett and A. J. Wilson, University of Southampton. February 19, 1958. 12p. diagrs. ARC 19,906; S & C 3251. (Ask for N-60238*)

In a previous paper the effect of the ground on a jet-flap airfoil was investigated. Since the completion of this report further work has been carried out with the same model (with the 58.1° flap). In addition to this similar tests have now been completed on a model having a 31.4° flap. The purpose of this present note is to give details of the results of all this work with special reference to the pitching moments and downwash, and the resulting effect on the stability of the hypothetical jet-flap aircraft.

N-60372*

Royal Aircraft Establishment (Gt. Brit.)
NOTES ON WIND TUNNEL PRESSURE MEASUREMENTS FROM THE OPERATOR'S POINT OF VIEW. J. S. Thompson and D. W. Holder. February 1958. 45p. diagrs. RAE Tech.Note Aero 2547. (Ask for N-60372*)

This note gives a brief description of the objects of pressure measurements in wind tunnels, explaining the various purposes for which they are needed and the special requirements of each. The series of appendixes give an assessment of the accuracy desirable for various applications.

CN-60373*

Royal Aircraft Establishment (Gt. Brit.)
THE EFFECT OF WEATHERING ON THE MECHANICAL PROPERTIES OF "DURESTOS." D. J. McCue. December 1957. 12p. diagrs., photos., tabs. RAE Tech.Note Chem.1324. (Ask for CN-60373*)

Tests on the influence of weather over a 2-year period on the mechanical properties of both vacuum and "no-pressure" molded Durestos have been made. The protection offered by coating "Durestos" with "R.A.E. furane" and "synthetic silver" finishes has also been investigated. The wet and dry tensile strengths, dry compressive strength and tensile Young's modulus are tabulated. There is a brief account of weight changes during exposure. The general effect of weather over 2 years is a 4-percent decrease in load-carrying capacity, but as the standard deviation of the properties is of this order it would be necessary to organize a more detailed program to obtain statistically significant results, even if a 2-percent deterioration per year were maintained. The coatings used here are of little value as protection.

N-60518*

Aeronautical Research Council (Gt. Brit.)
CALCULATION OF DERIVATIVES FOR A CROPPED DELTA WING WITH AN OSCILLATING CONSTANT-CHORD FLAP IN A SUPERSONIC AIR STREAM. J. Watson, National Physical Laboratory. 1958. 34p. diagrs., tabs. ARC R & M 3059; ARC 18,001. (Ask for N-60518*)

The lift, pitching moment, and hinge moment are derived for a delta wing with a trailing-edge flap of constant chord when the wing is at zero incidence in a supersonic airstream and the flap oscillates harmonically with small amplitude and low frequency. It is assumed that the wing is sufficiently thin and the amplitude of oscillation sufficiently small to permit the use of linearized theory. Expressions for the various control derivative coefficients are obtained for a particular delta wing of aspect ratio 1.8 and taper ratio 1/7. The investigation covers partial-span flaps. The derivatives are evaluated and tabulated for Mach numbers 1.1, 1.2, 1.4, 1.6, and 2.0. The theory is shown to apply without appreciable error, provided that the frequency parameter based on mean chord does not exceed 0.4.

BRITISH REPORTS

N-60519*

Aeronautical Research Council (Gt. Brit.)
SOME TESTS IN A SLOTTED-WALL TUNNEL WITH VARIOUS SLOT-ENTRY SHAPES. A. Chinneck and N. A. North. 1958. 11p. diagrs. ARC CP 377. (Ask for N-60519*)

Tests have been made in the NPL 9- by 3-inch high-speed tunnel to investigate the effect of slot-entry shape on the over-acceleration of the flow that occurs at supersonic speeds when the slots are of uniform width. It is shown that tapering the slot alleviates this over-acceleration, but a straight taper extending for as much as two tunnel heights does not eliminate it. A special slot-entry shape has been tested which does eliminate it and which produces an axial pressure variation of ±0.9 percent over an axial distance equal to one and one-half tunnel heights, at a free-stream Mach number of 1.15.

N-60739*

Aeronautical Research Council (Gt. Brit.)
AN INVESTIGATION AT LOW SPEED OF THE FLOW NEAR THE APEX OF THIN DELTA WINGS WITH SHARP LEADING EDGES. B. J. Elle. January 9, 1958. 32p. diagrs., photos. ARC 19,780; Perf. 1621; FM 2629. (Ask for N-60739*)

The results of some water- and wind-tunnel tests on sharp-edged delta wings of low aspect ratio are presented. The position of the center line of the spiral leading-edge vortex is determined as a function of incidence and apex angle and a comparison is made with the theoretical results of Brown and Michael. The effects of Reynolds number, leading-edge shape and secondary separation are discussed and the breakdown of the flow pattern at high incidence is described.

N-60740*

Aeronautical Research Council (Gt. Brit.)
THE VIBRATION OF CASCADE BLADES TREATED BY ACTUATOR DISC METHODS. D. S. Whitehead. July 26, 1957. 23p. diagrs. ARC 19,436; EA 594. (Ask for N-60740*)

This paper gives a theoretical method of calculating the aerodynamic forces on vibrating compressor and turbine blades subject to two fundamental limitations. These are firstly, that the time for the fluid to flow through the cascade must be small compared with the period of the vibration, and secondly, that adjacent blades must vibrate nearly in phase. This enables any kind of two-dimensional steady flow cascade data to be used. The methods given also allow the vibration forced by fluctuations in the incident flow to be calculated.

CN-60741*

Royal Aircraft Establishment (Gt. Brit.)
ELECTRICAL MATERIALS AND COMPONENTS FOR AIRCRAFT POWER EQUIPMENT OPERATING AT HIGH TEMPERATURES. D. B. McKenzie. December 1957. 13p. RAE Tech. Note EL 147. (Ask for CN-60741*)

This technical note describes the materials now available and in course of development which are suitable for use in components for operation at high ambient temperatures. The present and future developments of components for aircraft electrical-power distribution are described.

N-60742*

Royal Aircraft Establishment (Gt. Brit.)
VECTORIAL ANALYSIS OF FLIGHT FLUTTER TEST RESULTS. E. G. Broadbent and E. Violet Hartley. February 1958. 44p. diagrs. RAE Tech. Note Structures 233. (Ask for N-60742*)

A binary flexure-torsion analysis has been made to check theoretically a method for the prediction of flutter which depends on plotting vectorially the amplitudes of response relative to the exciting force and extracting the relevant damping rate. The results of this calculation are given in the form of graphs both of the vector plots themselves and of the estimated damping rate against forward speed. The estimated damping rates are compared with calculated values. The method has the advantage that in a flight flutter test damping can be estimated from continuous excitation records; the method is an extension of the Kennedy and Pancu technique used in ground resonance testing.

N-60751*

Royal Aircraft Establishment (Gt. Brit.)
THE THEORETICAL EVALUATION OF THE DOWNWASH BEHIND JET-FLAPPED WINGS. A. J. Ross. January 1958. 44p. diagrs., tab. RAE Report Aero 2599. (Ask for N-60751*)

The downwash behind jet-flapped wings of infinite and finite span has been evaluated, using the solutions given by Spence and Maskell for the flow in two and three dimensions respectively. The wing incidence and jet deflection are assumed to be small, and the displacement of the jet is taken into account by displacing the downwash field so that the relative distance between the jet and tailplane is correct. It is also assumed that the spanwise loading on the infinite wing is elliptic, and that the trailing vorticity is generated at one particular chordwise position. The wake is considered to be a flat sheet, and so the effect of the rolling up of the wake has been neglected. Charts are given for the functions required in the calculation of the downwash for four specific values of jet momentum coefficient.

BRITISH REPORTS

N-60752*

Ministry of Supply (Gt. Brit.)
THE DEVELOPMENT OF ALUMINIUM ALLOYS HAVING A HIGH YOUNG'S MODULUS. G. Meikle. March 1958. 26p. diagr., photos., tabs. MOS S & T Memo. 4/58. (Ask for N-60752*)

The aluminum-silicon alloy investigation was carried out in four sections, as follows: experimental casting, experimental rolling, heat treatment, and production rolling.

N-60753*

Royal Aircraft Establishment (Gt. Brit.)
SOME OBSERVATIONS ON THE FATIGUE BEHAVIOUR OF ALUMINIUM 7 PER CENT MAGNESIUM IN VARIOUS CONDITIONS OF HEAT TREATMENT. C. A. Stubbington. November 1957. 23p. diagrs., photos., tab. RAE Tech. Note Met. 279. (Ask for N-60753*)

Observations have been made on the qualitative and quantitative fatigue behavior of aluminum 7 percent magnesium in various conditions of heat treatment. The grain size of the material was varied by heat treatment and the effect of time at aging temperature for fine and coarse grain sizes examined. It was found that material in the extruded condition, having a small grain size, produced a steel type S-N curve but that the shape of this curve was altered to that typical of other aluminum alloys by any form of heat treatment, whether aging or solution treatment. Grain sizes appeared to be important in determining the fatigue properties of aluminum 7 percent magnesium, material in the extruded condition with fine grain size having higher fatigue endurances at 10^7 cycles and better fatigue ratios than solution treated material, in which grain growth had occurred, in all aged conditions. Cold working was found to improve the fatigue properties of solution treated aluminum 7 percent magnesium although the fatigue ratio of cold worked material was lower than that for extruded material with fine grain size. It was found that partial intercrystalline fatigue fracture could be observed in conditions of heat treatment in which, if the stress was unidirectional, the failure would be entirely transcrystalline and ductile.

MISCELLANEOUS

Errata on NACA Rept. 1032, by Stalder, Goodwin, and Creager. 1951.

Errata on NACA Rept. 1321, by Eggleston and Diederich. 1957.

Errata on NACA RM L57E03, by Emery. June 1957.

N-51987X

Advisory Group for Aeronautical Research and Development. FLIGHT LOADS MEASUREMENTS ON NACA RESEARCH AIRPLANES. De E. Beeler, NACA. (Presented at Fifth meeting of AGARD Structures and Materials Panel, April 29-May 3, 1957, Copenhagen, Denmark.) April-May 1957. vii, 35p. diagrs., photos. AGARD Report 109. (Ask for N-51987X)

Flight loads investigations are conducted primarily for the purpose of confirming wind-tunnel results by comparing the full-scale results with comparable wind-tunnel results as frequently as deemed necessary; assessing the maneuvering conditions required of the aircraft and determining the associated dynamic loading conditions for the maneuvers; and bringing to light loads problems as a result of conducting flight research. The research airplane program in the United States included, from the beginning, extensive programs on flight loads measurements. This report summarizes some of the results from these investigations for three aircraft: the X-1 rocket-powered airplane, the X-5 variable-sweep airplane, and the XF-92A delta-wing airplane.

CN-56082Y

Advisory Group for Aeronautical Research and Development. TITANIUM PRODUCTION DEVELOPMENTS INCLUDING METALLURGY AND ALLOYING. R. I. Jaffee. (Presented at 5th meeting of AGARD Structures and Materials Panel, April 25-27, 1957, Oslo, Norway.) April 1957. 89p. diagrs., photos., tabs. AGARD Report 94. (Ask for CN-56082Y)

The past, present, and future of the titanium industry are discussed in terms of costs and quantities of the metal produced. The nature and extent of present titanium ore reserves are described as are the relative merits and disadvantages of the present extractive metallurgical processes being used for primary metal production. Descriptions are given of the various methods in use for the melting, casting, and fabrication of titanium and its alloys. Techniques of descaling, finishing, joining, and machining are also reviewed. The physical, chemical, and mechanical properties of current commercial alloys are summarized. The principles applying to the physical metallurgy of titanium and its alloys are also described.

N-56216X

Advisory Group for Aeronautical Research and Development. STRAIN GAGE CALIBRATIONS AND FLIGHT LOADS TESTING TECHNIQUES. Norman A. Krause, Northrop Aircraft, Inc. (Presented at 5th meeting of AGARD Structures and Materials Panel, April 29-May 3, 1957, Copenhagen, Denmark.) April-May 1957. viii, 47p. diagrs., photos. AGARD Report 113. (Ask for N-56216X)

This paper deals with experiences with strain-gage systems during a number of comprehensive loads programs. Methods of installation and calibration of

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strain-gage systems are discussed. Flight maneuvers and methods of execution to obtain the desired data are outlined and typical test data shown. Techniques used in the handling and analysis of the data are discussed with examples of typical final results showing the concept of testing to 80 percent limit load and extrapolation to 100 percent limit load to determine critical load conditions and their magnitude. The use of automatic electronic equipment and other development programs which are improving the efficiency of conducting loads programs are discussed.

CN-60279*

Advisory Group for Aeronautical Research and Development. FLIGHT TESTING FOR INERTIAL COUPLING CHARACTERISTICS. C. H. Meyer, Grumman Aircraft Engineering Corp. (Presented at 10th meeting of AGARD Flight Test Techniques Panel, May 20-24, 1957, London.) May 1957. 6p. AGARD Report 124. (Ask for CN-60279*)

The quest for high-speed and high-altitude performance has led to low-drag configurations in which a large proportion of the total mass of the aircraft is concentrated in the fuselage. The effect of this has been to increase the yawing and pitching moments of inertia and to reduce rolling moment of inertia, resulting in increased roll instability and finally in roll divergence. The causes and effects of roll divergence are discussed and possible approaches to the practical solution of the problem in the design of aircraft for specific roles are considered.

N-60455

Advisory Group for Aeronautical Research and Development. AIRCRAFT HANDLING QUALITIES AND PILOT RESPONSE CHARACTERISTICS. Charles B. Westbrook and Duane T. McRuer, WADC. (Presented at 10th meeting of AGARD Flight Test Techniques Panel, May 20-24, 1957, London.) May 1957. v, 21p. diagrs., tabs. AGARD Report 125. (Ask for N-60455)

The evolution of handling qualities requirements in the United States Air Force is traced. It is shown that pilot opinion upon which "classical" handling qualities are based is in reality a subjective expression of the overall suitability of a pilot-airframe system. The research program of the U. S. Air Force to determine the dynamic characteristics of the human pilot is reviewed. The ultimate purpose of this program is the application of human response data and servo analysis techniques to the design of overall systems incorporating such elements as the airframe, control system, pilot, displays, etc. Some of the recent results of correlation work to these two approaches to handling qualities are given.

CN-60661

Advisory Group for Aeronautical Research and Development. FRENCH AND INTERNATIONAL STANDARDS ON QUALITY CONTROL. (Les normes Francaises et Internationales sur le Controle de la Qualite.) A. Pallez. (Presented at 6th meeting of AGARD Structures and Materials Panel, Paris, France, November 4-8, 1957.) November 1957. 8p. (French text.) AGARD Report 152. (Ask for CN-60661)

After defining quality control the author shows that, in order to arrive at a definition of quality, it is necessary to refer to values that can be measured, to set lower and upper limits for these values, and to indicate the method used for their measurement. The following French standards are then reviewed: (a) Standards of Terminology Relating to Statistics, Probability Calculations, Measurement Errors and Measuring Instruments; and (b) Standards Relating to Quality Control. The report ends with an account of the work being done on an international basis in this field.

N-60733

Advisory Group for Aeronautical Research and Development. HYPERSONIC FACILITIES IN THE AERODYNAMICS DEPARTMENT, ROYAL AIRCRAFT ESTABLISHMENT. P. A. Hufton. (Includes Appendix A: A NOTE ON MULTIPLE DIAPHRAGM SHOCK TUBES. G. A. Bird. Appendix B: A NOTE ON COMBUSTION DRIVEN SHOCK TUBES. G. A. Bird. Appendix C: SOME METHODS OF EVALUATING IMPERFECT GAS EFFECTS IN AERODYNAMIC PROBLEMS. G. A. Bird. Appendix D: DEVELOPMENT OF THE R. A. E. 6-INCH DIAMETER SHOCK TUBE. PART I: BURSTING OF DIAPHRAGMS AT 200 ATMOSPHERES. S. G. Cox.) (Presented at 11th meeting of AGARD Wind Tunnel and Model Testing Panel, July 8-12, 1957, Scheveningen, Holland.) July 1957. 91p. diagrs. AGARD Report 146. (Ask for N-60733)

In this report, a description is given of the hypersonic facilities at the Royal Aircraft Establishment, and the various problems leading to their development are discussed.

CN-60757

Advisory Group for Aeronautical Research and Development. RELATED FRENCH WORKS ON THE PRODUCTION AND DESIGN STUDIES OF TITANIUM ALLOY FITTINGS OF LARGE DIMENSIONS. (Travaux Francais relatifs a la Realisation et l'Etude de Ferrures de Grandes Dimensions en Alliages de Titane.) El Gammal. (Presented at 5th meeting of AGARD Structures and Materials Panel, Oslo, Norway, April 20-27, 1957.) April 1957. viii, 45p. diagrs., tabs. (French text.) AGARD Report 97. (Ask for CN-60757)

Production and design studies were carried out on "piano" wing fittings of the SO 4050 Vautoir II. It was possible by means of tests on cut-out samples to determine the following properties of various fittings: usual tensile properties, variation of these properties

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at low temperatures, fatigue strength, the effect of stress relieving heat treatments, and the strength of notched test pieces under constant load.

UNPUBLISHED PAPERS

CN-60520*

Laboratories for Research and Development, Franklin Institute. WEAR OF SLIDING SEAL MATERIALS ON CHROMIUM-PLATED STEEL AT SPEEDS TO 60,000 FPM. William W. Shugarts, Jr. Prepared for NACA under NACA Contract NAw-6492. August 30, 1957. i, 29p. diagrs., tabs. Laboratories for Research and Development, Franklin Inst. Final Report F-A1985. (Ask for CN-60520*)

A study was made of the wear and friction characteristics of various materials at high speeds. Six graphite-base materials, two ceramics, and molybdenum were run against chromium-plated steel at essentially room temperature, 6.0 cm Hg air pressure, and unit contact pressures ranging from 100 to 400 psi. Tests of the phenol-resin impregnated graphite were made at various conditions of pressure and moisture content with air, oxygen, or nitrogen as the atmosphere. Little difference in the wear characteristics was found between the various impregnants used in graphite. The ceramics showed much higher wear than the graphites under comparable conditions. Increased oxygen and moisture in the test chamber caused accelerated wear.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification May 16, 1958.

NACA RM A52E22

FORCES AND MOMENTS ON POINTED AND BLUNT-NOSED BODIES OF REVOLUTION AT MACH NUMBERS FROM 2.75 TO 5.00. David H. Dennis and Bernard E. Cunningham. August 1952. 47p. diagrs., photo., tabs. (NACA RM A52E22)

Results of tests to determine the aerodynamic forces and moments on bodies of revolution at angles of attack from 0° to 25° are presented and compared with theory. Cones and ogives of fineness ratios 3 to 7 and two blunt-nosed body shapes with fineness ratios 3 and 5 were tested at Mach numbers from 2.75 to 5.00. Reynolds numbers were from 0.5 million to 6.4 million, depending on Mach number and body fineness ratio.

NACA RM A54E06

INVESTIGATION OF A FLOW DEFLECTOR AND AN AUXILIARY SCOOP FOR IMPROVING OFF-DESIGN PERFORMANCE OF NOSE INLETS. Warren E. Anderson and Richard Scherrer. July 1954. 32p. diagrs., photos. (NACA RM A54E06)

Flow deflectors and auxiliary scoops for improving off-design performance of nose inlets were investigated at low angles of attack and at Mach numbers from 0 to 1.50. Net performance based on effective-thrust ratios showed that both the deflector and auxiliary scoop can be advantageous for some flight applications.

NACA RM A56E23

EFFECT OF CAMBER ON THE DRAG OF A BODY OF REVOLUTION. Robert R. Dickey. October 1956. 8p. diagrs., tabs. (NACA RM A56E23)

The effect of camber on the drag of a body of revolution was investigated by measuring the drag, at transonic speeds, of two bodies that differed only in the amount of camber. It was found that the addition of a small amount of camber had a negligible effect on the minimum foredrag of the model tested.

NACA RM E7L02

INVESTIGATION OF EFFECTS OF SEVERAL FUEL-INJECTION LOCATIONS ON OPERATIONAL PERFORMANCE OF A 20-INCH RAM JET. W. H. Sterbentz, E. Perchonok, and F. A. Wilcox. June 8, 1948. 39p. diagrs., photos. (NACA RM E7L02)

Presents the results of an investigation conducted in the NACA Cleveland altitude wind tunnel to determine the effects of several fuel-injection locations on the operational performance of a 20-inch ram jet. The combustion effects of the several fuel-injection locations are analyzed in terms of ram-jet combustion-chamber-inlet variable of fuel-air ratio, velocity, and pressure. Combustion efficiency varies with combustion-chamber-inlet velocity and fuel-air ratio for various fuel-injection locations investigated. Combustion-chamber-inlet static pressure over the range investigated had little effect on combustion efficiency.

#NACA RM SE50E01, by Finger, Cohen, and Stewart.

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DECLASSIFIED NACA RESEARCH REPORTS

NACA RM E50F16

ALTITUDE-TEST-CHAMBER INVESTIGATION OF PERFORMANCE OF A 28-INCH RAM-JET ENGINE. I - COMBUSTION AND OPERATIONAL PERFORMANCE OF FOUR COMBUSTION-CHAMBER CONFIGURATIONS. W. L. Jones, T. B. Shillito, and J. G. Henzel, Jr. August 23, 1950. 53p. diagrs., photos. (NACA RM E50F16)

An altitude-test-chamber investigation of a 28-inch-diameter ram-jet engine at a simulated flight Mach number of approximately 2.0 for altitudes of 40,000 to 50,000 feet was conducted at the NACA Lewis laboratory. Three different flame holders, varying in the number and size of the annular gutters, in conjunction with several fuel-injection systems were investigated. The combustion efficiency for the flame-holder fuel-injection system that provided the best overall operational fuel-air-ratio range (0.03 to 0.075) was over 0.9 at a fuel-air ratio of about 0.065 for the altitude range investigated.

NACA RM E50H21

ALTITUDE-TEST-CHAMBER INVESTIGATION OF PERFORMANCE OF A 28-INCH RAM-JET ENGINE. II - EFFECTS OF GUTTER WIDTH AND BLOCKED AREA ON OPERATING RANGE AND COMBUSTION EFFICIENCY. T. B. Shillito, W. L. Jones, and R. W. Kahn. November 6, 1950. 58p. diagrs. (NACA RM E50H21)

Altitude-test-chamber investigation of effects of flame-holder blocked area and gutter width on performance of 28-inch-diameter ram jet at simulated flight Mach number of 2.0 for altitudes from 40,000 to 55,000 feet was conducted at NACA Lewis laboratory. Ten flame holders investigated covered gutter widths from 1.00 to 2.50 inches and blocked areas from 40.5 to 62.0 percent of combustion-chamber area. Gutter width did not appreciably affect combustion efficiency. Increase in blocked area from 40 to 62 percent resulted in 5 to 10 percent increase in combustion efficiency. Increasing gutter width resulted in improvement in fuel-air-ratio operating range.

NACA RM E50J20

ALTITUDE-TEST-CHAMBER INVESTIGATION OF PERFORMANCE OF A 28-INCH RAM-JET ENGINE. III - COMBUSTION AND OPERATIONAL PERFORMANCE OF THREE FLAME HOLDERS WITH A CENTER PILOT BURNER. Thomas B. Shillito, George G. Younger, and James G. Henzel, Jr. February 6, 1951. 30p. diagrs. (NACA RM E50J20)

An altitude-test-chamber investigation of combustion performance of 28-inch-diameter ram-jet engine with a can-type center pilot burner was conducted for simulated flight Mach number of 2.0 at altitudes from 45,000 to 55,000 feet. Three different flame holders were used with a fixed fuel-injection system. The performance of the best pilot-burner configuration over the comparable range of fuel-air ratios was approximately the same as for the best configurations without a pilot burner, which were previously investigated, but the pilot burner had a lean limit of combustion at a fuel-air ratio of 0.02 compared with 0.03 for the configurations without a pilot burner.

#NACA RM SE51B02, by Lewis Laboratory Fuels Panel.

NACA RM E51D11

ALTITUDE-TEST-CHAMBER INVESTIGATION OF PERFORMANCE OF A 28-INCH RAM-JET ENGINE. IV - EFFECT OF INLET-AIR TEMPERATURE, COMBUSTION-CHAMBER-INLET MACH NUMBER, AND FUEL VOLATILITY ON COMBUSTION PERFORMANCE. Robert W. Kahn, Shigeo Nakanishi, and James L. Harp, Jr. July 1951. 27p. diagrs. (NACA RM E51D11)

Altitude-chamber investigation of 28-inch-diameter ram-jet engine was conducted to determine effects of inlet-air temperature, combustion-chamber-inlet Mach number and pressure, and fuel density and volatility on combustion performance. Results indicated that increasing inlet-air temperature extended operable range of fuel-air ratios, permitted operation at lower combustion-chamber pressures, and increased combustion efficiency; raising combustion-chamber-inlet Mach number increased minimum operational combustion-chamber-outlet pressure, lowered combustion efficiency, and reduced lean limit of combustion; and Diesel fuel decreased combustion efficiency 20 to 30 percent below that obtained with heptane for range of fuel-air ratios investigated.

NACA RM E52E14

PRELIMINARY INVESTIGATION OF EFFECT OF ANGLE OF ATTACK ON PRESSURE RECOVERY AND STABILITY CHARACTERISTICS FOR A VERTICAL-WEDGE-NOSE INLET AT MACH NUMBER OF 1.90. L. Abbott Leissler and Donald P. Hearth. August 1952. 11p. diagrs., photos. (NACA RM E52E14)

A preliminary investigation of an inlet consisting of a vertical wedge compression surface was conducted at a Mach number of 1.90 and at angles of attack from 0° to 10°. With a symmetrical cowling, pressure recovery and stability characteristics comparable to a conical inlet were observed; however, twin-duct flow interaction was observed. Modification of the inlet by cutting back the lower cowl lip and by perforating the wedge centerbody resulted in relatively constant maximum pressure recovery up to 10° angle of attack. These modifications also eliminated the twin-duct instability and increased the stable subcritical range of the inlet.

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NACA RM E52L26

FREE-JET ALTITUDE INVESTIGATION OF A 20-INCH RAM-JET COMBUSTOR WITH A RICH INNER ZONE OF COMBUSTION FOR IMPROVED LOW-TEMPERATURE-RATIO OPERATION. Arthur M. Trout and Carl B. Wentworth. May 1953. 28p. diagrs., photo. (NACA RM E52L26)

An investigation of the altitude performance of a 20-inch-diameter high-temperature-ratio ram-jet combustor which had been redesigned to provide good combustor efficiency over a wide range of temperature ratios was conducted at zero angle of attack in a free-jet facility at a Mach number of 3.0. Configurations investigated incorporated a cylindrical control sleeve which confined the injected fuel at low overall fuel-air ratios to about 40 percent of the engine air flow. This provided an optimum fuel-air mixture over a portion of the flame holder when the overall fuel-air ratio was about 0.02. The configurations with the control sleeve operated with good combustor efficiency at fuel-air ratios as lean as 0.015, whereas the original engine had a lean blowout limit at a fuel-air ratio of about 0.03. The control sleeve had little effect upon the high-fuel-air-ratio performance of the engine.

NACA RM E53E08

INVESTIGATION OF LIQUID FLUORINE - LIQUID AMMONIA PROPELLANT COMBINATION IN A 100-POUND-THRUST ROCKET ENGINE. Edward A. Rothenberg and Howard W. Douglass. July 1953. 31p. diagrs., photos., tabs. (NACA RM E53E08)

The experimental performance of the liquid fluorine - liquid ammonia propellant combination was evaluated in 100-pound-thrust rocket engines operating at a chamber pressure of 300 pounds per square inch absolute. Several injector configurations were investigated. The maximum experimental specific impulse value was 270 pound-seconds per pound at 29 weight percent fuel and was obtained with a two-oxidant-on-one-fuel impinging-jet injector in a chamber of 50 inches characteristic length. The theoretical maximum, based on equilibrium composition expansion through the nozzle, is 311 pound-seconds per pound at 24 weight percent fuel.

NACA RM E53E20

A PRELIMINARY INVESTIGATION AT MACH NUMBER 1.91 OF AN INLET CONFIGURATION DESIGNED FOR INSENSITIVITY TO POSITIVE ANGLE-OF-ATTACK OPERATION. Milton A. Beheim. July 1953. 18p. diagrs., photos. (NACA RM E53E20)

A preliminary investigation of an inlet utilizing half of a conventional conical-centerbody supersonic diffuser with a flat plate as the upper surface was conducted at a Mach number of 1.91 and at angles of attack from -5° to 14°. High pressure recovery and critical mass-flow ratio were maintained at positive angles of attack. Various geometries of the flat plate were included in the investigation.

NACA RM E53E26

THE EFFECT OF INITIAL RATE OF SUBSONIC DIFFUSION ON THE STABLE SUBCRITICAL MASS-FLOW RANGE OF A CONICAL SHOCK DIFFUSER. J. C. Nettles. July 1953. 23p. diagrs. (NACA RM E53E26)

Experimental pressure recovery, mass-flow ratio, drag, and diffuser-discharge Mach number are presented for five nacelle-type conical spike inlets with the same supersonic compression and various subsonic-diffuser area variations. Stable mass-flow range is presented for free-stream Mach numbers of 1.5, 1.8, and 2.0. The effect of angle of attack on stable range is presented for zero to 9° at a Mach number of 2.0. Reducing the initial rate of subsonic diffusion was effective in improving the mass-flow range that could be achieved without pulsation. The diffuser with 3.5 hydraulic diameters of zero diffusion length at the entrance to the subsonic diffuser could be throttled for a range of 0.45 percent of maximum mass-flow ratio without oscillation.

NACA RM E54E05

ENGINE PERFORMANCE OF ALLOY 73J TURBINE BLADES CAST TO PREDETERMINED GRAIN SIZES. James R. Johnston, Charles A. Gyorgak, and John W. Weeton. July 1954. 27p. diagrs., photos., tab. (NACA RM E54E05)

The suitability of 73J alloy for turbine blade use and the effect of controlled grain size on engine performance of the alloy were investigated. The blades were cast to produce controlled grain sizes; classed fine, medium, and coarse. The blades were operated in a turbojet engine. Results of the engine test indicated that (1) engine life of 73J alloy blades is superior to S-816, (2) medium-grain blades have the longest life, coarse-grained, intermediate life, and fine-grained, shortest life, (3) grain sizes were uniform and consistent, and the grains in the fine-grained blades were unusually small for cast material.

NACA RM E54E10

DESIGN AND EXPERIMENTAL INVESTIGATION OF LIGHTWEIGHT BASES FOR AIR-COOLED TURBINE ROTOR BLADES. John C. Freche and Roy A. McKinnon. July 1954. 27p. diagrs., photos., tab. (NACA RM E54E10)

A design and experimental investigation was conducted on lightweight bases for air-cooled turbine rotor blades. Base designs which utilized forming and brazing techniques in their manufacture were developed, and samples of the designs were tested statically. Several samples were also endurance-tested in a turbojet engine. The most successful sample withstood engine operation at rated test-blade tip speed for 15 hours at coolant-flow ratios of 0.05 and 0.03. This base weighed 45 percent less than a comparable cast base.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM E54E25

COOLING CHARACTERISTICS OF A TRANSPIRATION-COOLED AFTERBURNER WITH A POROUS WALL OF BRAZED AND ROLLED WIRE CLOTH. William K. Koffel. August 1954. 68p. diagrs., photos., tabs. (NACA RM E54E25)

Cooling data from this experimental afterburner are successfully correlated over a range of Reynolds number based on the distance downstream of the leading edge of the porous wall. Calculations based on the correlation indicate that the combustion-chamber cooling-air requirements for an exhaust-gas temperature of 3700° R are only 16 percent of the air required for conventional forced-convection cooling. The cooling-air requirements were nearly independent of flight condition, but close control of cooling-air pressure is required at high flight speeds.

NACA RM E54E27

PRELIMINARY WIND-TUNNEL INVESTIGATION OF TWO TYPES OF JET-EXIT CONFIGURATIONS FOR CONTROL OF AIRCRAFT. Gerald W. Englert and L. Abbott Leissler. August 1954. 20p. diagrs. (NACA RM E54E27)

A swiveled converging nozzle and a biconvex circular arc vane mounted in a shroud placed directly downstream of a convergent nozzle were studied, on a typical interceptor airplane, with the jet control surfaces deflected 0° and approximately 10°. The nozzle pressure ratio was varied from jet-off to 10. Normal forces obtained by swiveling the nozzle could be calculated quite closely from trigonometric relations. Some discrepancies were found between experimental and calculated values of the forces on the vanes. Changing the free-stream Mach number from 1.5 to 1.7 had no effect on internal performance.

NACA RM E55H29a

EFFECT OF HIGH ROTOR PRESSURE-SURFACE DIFFUSION ON PERFORMANCE OF A TRANSONIC TURBINE. James W. Miser, Warner L. Stewart, and Daniel E. Monroe. November 1955. 35p. diagrs., photos., tabs. (NACA RM E55H29a)

The subject turbine was investigated to determine the effect of high rotor pressure-surface diffusion on turbine performance. A comparison of the subject turbine with the most efficient transonic turbine in the present series of investigations showed that the efficiency of the subject turbine was almost as high, the suction-surface diffusion parameter was about the same, and the solidity was reduced by 36 percent. Because the loss per blade increased greatly with an increase in pressure-surface diffusion, the latter is also considered to be an important design consideration.

NACA RM E56E09a

AN ANALOG STUDY OF A SHOCK-POSITION DIFFUSER CONTROL ON A SUPERSONIC TURBOJET ENGINE. David Novik. August 1956. 27p. diagrs. (NACA RM E56E09a)

Shock position was assumed to be controlled by air bleed through a diffuser-exit bypass door operated by a second-order servomotor. Pressure disturbance resulting from changes in bypass-door position had a negligible effect on controlled engine speed, whereas a disturbance in engine speed had a large effect on diffuser pressure and could impose severe requirements on diffuser control response. The controlled diffuser response improved with faster servomotor response and smaller diffuser dead time and lag. The effect of diffuser dead time on diffuser response was greater than the effect of diffuser lag.

NACA RM E56E24

PERFORMANCE OF INCONEL 739 BUCKETS IN J33-9 TURBOJET ENGINE. C. A. Gyorgak and J. R. Johnston. October 1956. 19p. diagrs., photos., tabs. (NACA RM E56E24)

Investigation of the performance of Inconel 739 (a nickel-base alloy of low critical-element content) buckets in a J33-9 engine showed that Inconel 739 had an engine life at least equivalent if not superior to S-816 buckets operated at 1500° F. Inconel 739 buckets had a small scatter in life and exhibited lower total elongation than S-816. Bucket life was less than that predicted on the basis of stress-rupture considerations alone. The failure mechanism was probably influenced by fatigue.

NACA RM E56G31

ANALYTICAL INVESTIGATION OF SINGLE-STAGE-TURBINE EFFICIENCY CHARACTERISTICS IN TERMS OF WORK AND SPEED REQUIREMENTS. Warner L. Stewart. October 1956. 45p. diagrs. (NACA RM E56G31)

This report uses a work-speed parameter in describing single-stage full-admission turbine efficiency characteristics. The range of this parameter considered covers that used in turbojet engine applications as well as that being encountered in such applications as turbopump and accessory drives. Efficiency types considered are (a) total or aerodynamic efficiency, (b) rating efficiency, used in jet engine applications, and (c) static efficiency, used in turbopump and accessory drive applications. Velocity diagram types considered include zero exit whirl, impulse, and those corresponding to maximum values of efficiency.

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NACA RM E56J19

ANALYSIS OF EFFICIENCY CHARACTERISTICS OF A SINGLE-STAGE TURBINE WITH DOWNSTREAM STATORS IN TERMS OF WORK AND SPEED REQUIREMENTS. William T. Wintucky and Warner L. Stewart. January 1957. 28p. diagrs. (NACA RM E56J19)

One-dimensional mean-section flow and blade specific losses proportional to average specific kinetic energy are assumed in the analysis. Range of the work-speed parameter λ considered includes low to moderate blade speeds with high specific work outputs, where critical turbojet, turbopump, and accessory-drive turbines are encountered. A diffusion factor of 0.5 limits the loading on the downstream stators. Turbine efficiencies considered are total or aerodynamic, rating, and static. Efficiencies of velocity-diagram types at impulse and that corresponding to values of maximum efficiency are presented and compared to indicate in what range of λ downstream stators are beneficial as well as the attending improvements in efficiency.

NACA RM E57B15

BONDED LEAD MONOXIDE FILMS AS SOLID LUBRICANTS FOR TEMPERATURES UP TO 1250° F. Harold E. Sliney and Robert L. Johnson. May 1957. 25p. diagrs., photos., tabs. (NACA RM E57B15)

Friction, wear, and endurance properties of PbO coatings, bonded to steel surfaces, were studied. The coatings were ceramic films containing PbO as the primary component. They functioned effectively on dry-film lubricants from 70° to 1250° F. The coatings prevented galling and excessive wear of the metal surfaces over the entire temperature range studied, but friction was much lower from 500° to 1250° F than at room temperature. Improved lubrication at the higher temperatures was apparently associated with the formation of glazed wear tracks on the coated surfaces. The methods of formulating and applying the coatings are described.

NACA RM E57F12

ANALYSIS OF TWO-STAGE-TURBINE EFFICIENCY CHARACTERISTICS IN TERMS OF WORK AND SPEED REQUIREMENTS. Warner L. Stewart and William T. Wintucky. August 1957. 45p. diagrs., tabs. (NACA RM E57F12)

A work-speed parameter, similar to that used previously for single-stage turbines, is used in analyzing the effect of mean-section velocity-diagram variations on two-stage-turbine efficiency characteristics. The range of this parameter is that considered of interest for turbojet, turbopump, and accessory-drive turbines. The principal assumption limits flow across any blade row to impulse conditions. The results of the analysis are compared with those obtained for the single-stage turbine to indicate the effects and advantages of multistaging.

NACA RM E57K22b

ANALYTICAL INVESTIGATION OF MULTISTAGE-TURBINE EFFICIENCY CHARACTERISTICS IN TERMS OF WORK AND SPEED REQUIREMENTS. Warner L. Stewart. February 1958. 18p. diagrs. (NACA RM E57K22b)

An analytical investigation of the interacting effects of turbine specific work output, rotor blade speed, stage number, and efficiency is presented. The correlating parameter used is a work-speed parameter, defined as the ratio of the mean-section blade speed squared to the specific work output. Major assumptions include equal stage work and blade speed, no reheat effect, and impulse conditions as the lower limit on rotor reaction. The results of the analysis include both stage and overall efficiency characteristics. Efficiency results presented include those based on turbine total-pressure and static- to total-pressure ratios.

NACA RM E57L05

ANALYSIS OF TWO-STAGE COUNTERROTATING TURBINE EFFICIENCIES IN TERMS OF WORK AND SPEED REQUIREMENTS. William T. Wintucky and Warner L. Stewart. March 1958. 33p. diagrs., tabs. (NACA RM E57L05)

A work-speed parameter previously reported is used to correlate efficiencies based on a one-dimensional mean-section, velocity-diagram analysis. Range covered includes turbojet, turbopump, and accessory-drive turbines. It is assumed that the blade specific losses are proportional to the average specific kinetic energy of the flow. Limits of the analysis are positive reaction and impulse across either or both rotors. Efficiencies are slightly higher than the conventional two-stage turbine because of the elimination of the interstage stator. Varying the rotor speed ratio has no effect on the general level of efficiencies but does change the impulse limits and the work split at which maximum efficiencies occur.

NACA RM H55E26

FLIGHT MEASUREMENTS OF THE LATERAL RESPONSE CHARACTERISTICS OF THE CONVAIR XF-92A DELTA-WING AIRPLANE. Euclid C. Holleman. August 1955. 37p. diagrs., tabs. (NACA RM H55E26)

Rudder pulse maneuvers were performed with the XF-92A 60° delta-wing airplane at 30,000 feet over a Mach number range of 0.52 to 0.92. Tests were conducted with and without a wing fence. Representative data were analyzed to give airplane stability derivatives and frequency responses.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM L50E17a

A PRELIMINARY FLIGHT INVESTIGATION OF THE EFFECT OF SNAKING OSCILLATIONS ON THE PILOTS' OPINIONS OF THE FLYING QUALITIES OF A FIGHTER AIRPLANE. *Arnold R. Beckhardt*, John A. Harper, and William L. Alford. September 26, 1950. 31p. diagrs., photos., tabs. (NACA RM L50E17a)

Results of tests in a typical low-wing, high-speed fighter showed that, in general, the pilots' perception of the snaking oscillation is mainly dependent on the transverse acceleration which the oscillation produces. In this airplane, an amplitude of ±0.02g was sometimes perceptible to the pilot, but an amplitude of ±0.025g was always perceptible and was considered unsatisfactory for a long flight while an amplitude of ±0.08g was considered very unsatisfactory. The effect of the snaking oscillation on the efficiency of the airplane as a gun platform and the results of a check on the present service requirements for lateral stability are also presented. A brief discussion of the design characteristics of the test apparatus used to vary the damping in yaw is also presented.

NACA RM L51E03

REVIEW OF THE MAXIMUM-LIFT CHARACTERISTICS OF THIN AND SWEPT WINGS. John G. Lowry and Jones F. Cahill. June 5, 1951. 10p. diagrs. (NACA RM L51E03)

A summary is presented of available data on maximum lift coefficients of thin and swept aircraft wings without fuselages or high-lift devices at Mach numbers up to 2.4. Data are presented to provide indications of the effects of plan form, Reynolds number, airfoil section, thickness, and rate of pitch.

NACA RM L51E14a

DIVISION OF LOAD AMONG THE WING, FUSELAGE, AND TAIL OF AIRCRAFT. *John P. Mayer and* Clarence L. Gillis. May 29, 1951. 14p. diagrs. (NACA RM L51E14a)

Results are presented for the division of load among the wing, fuselage, and tail for several aircraft configurations at subsonic and supersonic speeds.

NACA RM L51E17

FREE-FLIGHT-TUNNEL INVESTIGATION OF THE DYNAMIC LATERAL STABILITY AND CONTROL CHARACTERISTICS OF A HIGH-ASPECT-RATIO BOMBER MODEL WITH SELF-SUPPORTING FREE-FLOATING FUEL TANKS ATTACHED TO THE WING TIPS. Charles V. Bennett and Robert B. Cadman. August 1951. 12p. diagrs., tab. (NACA RM L51E17)

The results are presented of an experimental investigation conducted in the Langley free-flight tunnel to determine the dynamic lateral stability and control characteristics of a high-aspect-ratio bomber model with self-supporting, free-floating fuel tanks attached to the bomber wing tips.

NACA RM L51K14a

AERODYNAMIC CHARACTERISTICS AT SUPERSONIC SPEEDS OF A SERIES OF WING-BODY COMBINATIONS HAVING CAMBERED WINGS WITH AN ASPECT RATIO OF 3.5 AND A TAPER RATIO OF 0.2. EFFECT AT $M = 1.60$ OF NACELLE SHAPE AND POSITION ON THE AERODYNAMIC CHARACTERISTICS IN PITCH OF TWO WING-BODY COMBINATIONS WITH 47° SWEPTBACK WINGS. Lowell E. Hasel and John R. Sevier, Jr. January 1952. 31p. diagrs., photos., tabs. (NACA RM L51K14a)

An investigation has been conducted in the Langley 4- by 4-foot supersonic pressure tunnel to determine the effect of a series of nacelles on the aerodynamic characteristics in pitch of a sweptback-wing - body combination. Nacelle shape and position were varied on a configuration with a 6-percent-thick wing having an aspect ratio of 3.5, a taper ratio of 0.2, and 47° of sweep at the quarter chord. Submerged nacelles were tested on this wing-body combination and also on a similar configuration with a wing having a thickened root section. Lift, drag, and pitching-moment results are presented at a Mach number of 1.60 and a Reynolds number of 2.7×10^6 based on the wing mean aerodynamic chord.

NACA RM L51K15a

AERODYNAMIC CHARACTERISTICS AT SUPERSONIC SPEEDS OF A SERIES OF WING-BODY COMBINATIONS HAVING CAMBERED WINGS WITH AN ASPECT RATIO OF 3.5 AND A TAPER RATIO OF 0.2. EFFECTS OF SWEEP ANGLE AND THICKNESS RATIO ON THE STATIC LATERAL STABILITY CHARACTERISTICS AT $M = 1.60$. M. Leroy Spearman and John H. Hilton, Jr. January 1952. 31p. diagrs., tabs. (NACA RM L51K15a)

An investigation has been made to determine the lateral stability characteristics at $M = 1.60$ of 4-percent-thick wings having quarter-chord sweep angles of 10.8°, 35°, and 47° and of 47° sweptback wings having thickness ratios of 4, 6, and 9 percent. The effects of the installation of a nacelle on the 6-percent-thick 47° sweptback wing were also determined. Tests were made through an angle-of-yaw range from -2° to 10° at an angle of attack of 5° and through an angle-of-attack range from -2° to 13° at angles of yaw of 0° and 5°.

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NACA RM L51K16a

AERODYNAMIC CHARACTERISTICS AT SUPERSONIC SPEEDS OF A SERIES OF WING-BODY COMBINATIONS HAVING CAMBERED WINGS WITH AN ASPECT RATIO OF 3.5 AND A TAPER RATIO OF 0.2. EFFECTS OF SWEEP ANGLE AND THICKNESS RATIO ON THE AERODYNAMIC CHARACTERISTICS IN PITCH AT M = 1.60. Ross B. Robinson and Cornelius Driver. January 1952. 27p. diagrs., photos., tabs. (NACA RM L51K16a)

An investigation has been made to determine the longitudinal characteristics at M = 1.60 of 4-percent-thick wings having quarter-chord sweep angles of 10.8°, 35°, and 47°, and of 47° sweptback wings having thickness ratios of 4, 6, and 9 percent. One thickened root, 6-percent-thick wing of 47° sweepback and a horizontal canard surface in combination with the 6-percent-thick 47° sweptback wing were also investigated. These tests were made through an angle-of-attack range of -2° to 13° at a Reynolds number of 2.7×10^6 based on the wing mean aerodynamic chord.

NACA RM L52E05b

A PROPOSED RAM-JET CONTROL SYSTEM OPERATED BY USE OF DIFFUSER PRESSURE RECOVERY. Maxime A. Faget. September 1952. 19p. diagrs. (NACA RM L52E05b)

A ram-jet fuel-control system which effects direct control of the thrust coefficient by maintaining a desired ratio between the measured total pressure and the diffuser exit pressure is described. A method for scheduling the thrust coefficient for any desired variation with Mach number is also described.

NACA RM L52E08

FREE-FLIGHT-TUNNEL INVESTIGATION OF THE DYNAMIC LATERAL STABILITY AND CONTROL CHARACTERISTICS OF A HIGH-ASPECT-RATIO BOMBER MODEL WITH A SWEPTBACK-WING FIGHTER MODEL ATTACHED TO EACH WING TIP. Charles V. Bennett and Peter C. Boisseau. September 1952. 17p. diagrs., tabs. (NACA RM L52E08)

The results are presented of an experimental investigation conducted in the Langley free-flight tunnel to determine the dynamic lateral stability and control characteristics of a high-aspect-ratio bomber model with a sweptback fighter model attached to each wing tip with freedom in roll. The outboard aileron of each fighter was operated automatically in response to the relative bank angle between the bomber and fighter to supply restoring moments to keep the fighter alined with the bomber wing. The effects of a variation in restoring moment and of the longitudinal position of the fighter models with respect to the bomber model were studied.

NACA RM L52E09

AERODYNAMIC CHARACTERISTICS AT SUPERSONIC SPEEDS OF A SERIES OF WING-BODY COMBINATIONS HAVING CAMBERED WINGS WITH AN ASPECT RATIO OF 3.5 AND A TAPER RATIO OF 0.2. EFFECTS OF SWEEP ANGLE AND THICKNESS RATIO ON THE AERODYNAMIC CHARACTERISTICS IN PITCH AT M = 2.01. Ross B. Robinson. July 1952. 27p. diagrs., photo., tabs. (NACA RM L52E09)

An investigation has been made to determine the aerodynamic characteristics in pitch at M = 2.01 of wings having quarter-chord sweep angles of 10.8°, 35°, and 47° for a thickness ratio of 4 percent and thickness ratios of 4, 6, and 9 percent for a quarter-chord sweep angle of 47°. One thickened root, 6-percent-thick wing at 47° sweepback and a horizontal canard surface in combination with the 6-percent-thick 47° sweptback wing were also investigated. These tests were made through an angle-of-attack range of -2° to 13° at a Reynolds number of 2.2×10^6 based on the wing mean aerodynamic chord.

NACA RM L52E23

AERODYNAMIC CHARACTERISTICS AT SUPERSONIC SPEEDS OF A SERIES OF WING-BODY COMBINATIONS HAVING CAMBERED WINGS WITH AN ASPECT RATIO OF 3.5 AND A TAPER RATIO OF 0.2. EFFECTS OF SWEEP ANGLE AND THICKNESS RATIO ON THE STATIC LATERAL STABILITY CHARACTERISTICS AT M = 2.01. Clyde V. Hamilton. August 1952. 37p. diagrs., tabs. (NACA RM L52E23)

An investigation has been made to determine the static lateral stability characteristics at M = 2.01 of 4-percent-thick wings having quarter-chord sweep angles of 10.8°, 35°, and 47° and of 47° sweptback wings having thickness ratios of 4, 6, and 9 percent and one additional 6-percent-thick wing with a thickened root section. The effects of the installation of nacelles on the 6-percent-thick 47° sweptback wing were also determined. Tests were made through an angle-of-yaw range from -4° to 8° at angles of attack of 0° and 5.3° and through an angle-of-attack range from -2° to 13° at angles of yaw of 0° and 5°.

NACA RM L52F03

AERODYNAMIC CHARACTERISTICS AT SUPERSONIC SPEEDS OF A SERIES OF WING-BODY COMBINATIONS HAVING CAMBERED WINGS WITH AN ASPECT RATIO OF 3.5 AND A TAPER RATIO OF 0.2. EFFECT AT M = 2.01 OF NACELLE SHAPE AND POSITION ON THE AERODYNAMIC CHARACTERISTICS IN PITCH OF TWO WING-BODY COMBINATIONS WITH 47° SWEPTBACK WINGS. Cornelius Driver. July 1952. 27p. diagrs., photos., tab. (NACA RM L52F03)

An investigation has been made to determine the effect of varying the nacelle shape and position on the longitudinal stability characteristics of a wing-body combination with a 6-percent-thick wing having an aspect ratio of 3.5, a taper ratio of 0.2, and 47° of

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sweep at the quarter chord. Submerged nacelles were tested on this wing-body combination and on a similar configuration with a wing having a thickened root section. These tests were conducted at a Mach number of 2.01 and a Reynolds number of 2.2×10^6 based on the wing mean aerodynamic chord.

NACA RM L53E01

A STUDY OF VISUAL INTERCEPTION ATTACKS ON A NONMANEUVERING AIRPLANE TARGET. Donald C. Cheatham, Charles W. Mathews, and John A. Harper. July 1953. 97p. diagrs., photos., tabs. (NACA RM L53E01)

A study and evaluation of interception runs made by an experienced pilot flying a Grumman F9F-3 airplane against a nonmaneuvering airplane target are presented. Included are the control procedures and tracking characteristics displayed by the interceptor pilot, the effect of interceptor turning limitations, data pertaining to interceptor control operation, and evaluations applied to automatic control apparatus.

NACA RM L53E07a

EFFECTS OF A SERIES OF INBOARD PLAN-FORM MODIFICATIONS ON THE LONGITUDINAL CHARACTERISTICS OF TWO 47° SWEPTBACK WINGS OF ASPECT RATIO 3.5, TAPER RATIO 0.2, AND DIFFERENT THICKNESS DISTRIBUTIONS AT MACH NUMBERS OF 1.61 AND 2.01. Morton Cooper and John R. Sevier, Jr. July 1953. 43p. diagrs., photos., tabs. (NACA RM L53E07a)

Tests of a series of inboard plan-form modifications to two 47° sweptback wings of aspect ratio 3.5 and taper ratio 0.2 were conducted in the Langley 4- by 4-foot supersonic pressure tunnel at Mach numbers of 1.61 and 2.01. One wing had 6-percent-thick hexagonal airfoil sections of constant thickness ratio along the span; the other wing had the same sections outboard of the 40-percent-semispan station but with thickness linearly increasing to 12 percent at the model center line.

NACA RM L53E08b

A STUDY OF THE AERODYNAMIC LOADS ON SWEPTBACK WINGS AT TRANSONIC SPEEDS. Claude V. Williams and Richard E. Kuhn. June 1953. 14p. diagrs. (NACA RM L53E08b)

A study of the aerodynamic loads on sweptback wings at transonic speeds has been made and was concerned with an analysis of the effects of thickness-ratio, geometric-twist, and sideslip-angle variations. The study indicates that wing thickness ratio has an important effect on the variation of the spanwise center-of-pressure location with increasing Mach number.

NACA RM L54B17a

A WIND-TUNNEL INVESTIGATION OF THE FIRST-ORDER VIBRATORY STRESSES ON A FULL-SCALE SUPERSONIC-TYPE PROPELLER OPERATING IN AN ASYMMETRIC AIR FLOW. Atwood R. Heath, Jr., and Robert L. O'Neal. November 1954. 28p. diagrs., photo. (NACA RM L54B17a)

An investigation of the first-order, 1xP, vibratory-stress characteristics of a three-blade supersonic-type propeller of 12-foot diameter operating in an asymmetric air flow has been made on the NACA 6,000-horsepower propeller dynamometer in the Langley 16-foot transonic tunnel. The investigation covered a blade-angle range from 19.7° to 46.3°, a rotational-speed range from 1,300 to 2,100 rpm, and a forward Mach number range from 0.20 to 0.94. Comparisons of calculated and measured maximum 1xP stress locations and resonant frequencies are given, as well as the 1xP resonant stresses expected for the propeller installed on a hypothetical airplane.

NACA RM SL54D13a, by Queijo.

NACA RM L54E05

A WIND-TUNNEL INVESTIGATION OF THE USE OF SPOILERS FOR OBTAINING STATIC LONGITUDINAL STABILITY OF A CANARD-MISSILE MODEL IN REVERSE FLIGHT. Herman S. Fletcher. June 1954. 15p. diagrs., tab. (NACA RM L54E05)

Results are presented of a wind-tunnel investigation made to determine the effect of five spoilers of different heights on the stability in reverse flight of a canard-missile model that is stable in normal flight without spoilers. The spoilers had total heights that varied from 10 to 50 percent of the wing chord and were attached perpendicular to the forward edge of the leading surface so that they protruded equal distances above and below the surface of the wing along the entire span.

NACA RM L54E17

AN EXPERIMENTAL INVESTIGATION OF TWO-DIMENSIONAL, SUPERSONIC CASCADE-TYPE INLETS AT A MACH NUMBER OF 3.11. Edward Offenhartz. August 1954. 29p. diagrs., photos. (NACA RM L54E17)

A preliminary investigation of two-dimensional supersonic cascade-type inlets at a free-stream Mach number of 3.11 has been conducted at the Langley Aeronautical Laboratory. Two cascade-type inlets utilizing different methods of internal-flow compression were designed and tested. In one inlet (designated cascade inlet) the passages were contoured to generate coalesced compressions; whereas those of the other inlet (designated stepped-cascade inlet) were contoured to generate noncoalesced compressions. Pressure and Mach number distributions as well as shadowgraphs are presented for both inlets. With mass-flow ratios of 1, the maximum values of total-pressure recovery attained at 0° angle of attack were 0.43 and 0.45 for the cascade and stepped-cascade inlets, respectively.

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NACA RM L54E25

AERODYNAMIC CHARACTERISTICS OF SEVERAL TIP CONTROLS ON A 60° DELTA WING AT A MACH NUMBER OF 1.61. Douglas R. Lord and K. R. Czarnecki. August 1954. 44p. diagrs., photos., tabs. (NACA RM L54E25)

An investigation has been made at a Mach number of 1.61 and a Reynolds number of 4.2×10^6 to determine the control effectiveness characteristics of seven tip controls on a 60° delta wing. Pressure-distribution measurements were made at angles of attack from 0° to 15° for control deflections from -30° to 30°. Integrated-pressure-distribution results are presented in the form of wing lift, bending-moment, and pitching-moment coefficients and control hinge-moment coefficients. The variations of control effectiveness with control deflection, wing angle of attack, hinge-line location, and control size and location are discussed as well as the effect of chordwise fences at the wing-control parting line and theoretical predictions.

NACA RM L54G22a

LOW-SPEED MEASUREMENT OF STATIC STABILITY AND DAMPING DERIVATIVES OF A 60° DELTA-WING MODEL FOR ANGLES OF ATTACK OF 0° TO 90°. Donald E. Hewes. September 1954. 30p. diagrs., photo., tab. (NACA RM L54G22a)

Measurements of the static stability, control characteristics, and damping derivatives of a 60° delta-wing model were made for a range of angles of attack of 0° to 90°. Tests were made with no vertical tails, and with 60° delta tails added on the top and bottom of the fuselage. Most of the tests were made at a Reynolds number of 830,000.

NACA RM L54G27

LOW-SPEED MEASUREMENTS OF ROLLING AND YAWING STABILITY DERIVATIVES OF A 60° DELTA-WING MODEL. Joseph L. Johnson, Jr. December 1954. 17p. diagrs., tab. (NACA RM L54G27)

Contains results of an investigation in the Langley free-flight tunnel to determine the low-speed rolling and yawing stability derivatives of a 60° delta-wing model from 0° to 30° angle of attack. The derivatives were measured by the free-to-damp oscillation technique and by the steady-roll technique.

#NACA RM SL54G27, by Johnson.

NACA RM L55E11

EXPERIMENTAL FLUTTER RESULTS FOR CANTILEVER-WING MODELS AT MACH NUMBERS UP TO 3.0. W. J. Tuovila and John Locke McCarty. June 1955. 13p. diagrs., tab. (NACA RM L55E11)

Experimental flutter tests have been made at Mach numbers up to 3.0 using cantilever wing models with 0° to 60° sweepback and 45° and 60° delta-wing models. The effects of high Mach number and center-of-gravity location on the flutter trends are indicated. For wings with center-of-gravity location ahead of the midchord and with small sweep angles, the stiffness requirements to prevent flutter at a given altitude are determined essentially at transonic speeds. For wings with rearward center-of-gravity locations and high sweep angles, the stiffness requirements continue to increase with increase in Mach number. Shifting the center-of-gravity location forward reduces the stiffness requirements to prevent flutter, particularly for wings of low sweep angle.

NACA RM L55E16a

A DISCUSSION OF RECENT WIND-TUNNEL STUDIES RELATING TO THE PROBLEM OF ESTIMATING VERTICAL- AND HORIZONTAL-TAIL LOADS. Richard E. Kuhn, Joseph M. Hallissy, Jr., and Ralph W. Stone, Jr. July 1955. 20p. diagrs., photos. (NACA RM L55E16a)

Some of the effects of angle of attack, sideslip, Mach number, and airplane configuration on the loads on the vertical tail and, to a lesser extent, the loads on the horizontal tail are discussed. Also the division of load between the exposed vertical tail and the fuselage is considered. It is shown that at high angles of attack large rolled-up vortices from the wing and fuselage appear in the flow in the region of the tail assembly and cause large changes in both vertical- and horizontal-tail loads.

NACA RM L55E17

INVESTIGATION OF THE EFFECTS OF BODY INDENTATION AND OF WING-PLAN-FORM MODIFICATION ON THE LONGITUDINAL CHARACTERISTICS OF A 60° SWEPT-WING–BODY COMBINATION AT MACH NUMBERS OF 1.41, 1.61, AND 2.01. John R. Sevier, Jr. July 1955. 37p. diagrs., tab. (NACA RM L55E17)

An investigation has been made in the Langley 4- by 4-foot supersonic pressure tunnel to determine the effects of body indentation and of inboard wing-plan-form modification on the longitudinal characteristics of wing-body combinations. Tests were made at Mach numbers of 1.41, 1.61, and 2.01, and at a Reynolds number of 3.7×10^6 per foot. Results indicated that, by properly contouring the fuselage, an increase in maximum lift-drag ratio up to 20 percent could be realized at a Mach number of 1.41 (the design Mach number for one of the bodies); above this Mach

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number, the improvement rapidly decreased. At the higher Mach numbers, 1.61 and 2.01, improvements in maximum lift-drag ratio up to 17 percent were obtained for the combinations by means of increasing the local wing chords over the inboard portion of the wing and thereby reducing the thickness ratio. At a Mach number of 1.41, this method was generally ineffective for increasing the maximum lift-drag ratio.

NACA RM L55E20

A THEORETICAL INVESTIGATION OF A COMPENSATING NETWORK WITH APPLICATION TO ROLL CONTROL SYSTEMS FOR AUTOMATIC INTERCEPTORS. Windsor L. Sherman. July 1955. 64p. diagrs., tab. (NACA RM L55E20)

A theoretical analysis of an airplane automatic control system incorporating a compensating network, a device which cancels airplane dynamics, is presented. The transfer function of this type of control system is derived and applied to the analysis of roll control systems. An analog-computer study was made to evaluate the effects of limiting the control-surface rate and displacement and of incomplete compensation on the response of the roll control systems. Results are presented as time histories of the airplane lateral and control-surface motions.

NACA RM L55E23

AN EXPERIMENTAL INVESTIGATION AT A MACH NUMBER OF 2.01 OF THE EFFECTS OF BODY CROSS-SECTION SHAPE ON THE AERODYNAMIC CHARACTERISTICS OF BODIES AND WING-BODY COMBINATIONS. Harry W. Carlson and John P. Gapcynski. July 1955. 29p. diagrs., tabs. (NACA RM L55E23)

An experimental investigation has been performed to determine the effect of changes in body cross-section shape on the aerodynamic characteristics of bodies and wing-body combinations. A series of 13 bodies having a given length and given longitudinal distribution of cross-sectional area but various cross-section shapes were tested at a Mach number of 2.01. The bodies were tested alone and in combination with a 47° sweptback wing having a 6-percent-thick hexagonal section.

NACA RM L55E23a

SUMMARY AND ANALYSIS OF HORIZONTAL-TAIL CONTRIBUTION TO LONGITUDINAL STABILITY OF SWEPT-WING AIRPLANES AT LOW SPEEDS. Robert H. Neely and Roland F. Griner. August 1955. ii, 133p. diagrs., tabs. (NACA RM L55E23a)

Available wind-tunnel data on the low-speed horizontal tail contributions to the static longitudinal stability of high-speed airplane configurations incorporating unswept and sweptback wings are summarized and analyzed. Air-flow characteristics behind wings and wing-body combinations are described and are related to the downwash at specific tail locations for unseparated and separated flow conditions. The effects of various tail-position parameters, wing parameters, stall-control devices, trailing-edge flaps, and ground interference on the air-flow characteristics and tail contribution are analyzed and demonstrated. An attempt has been made to summarize certain data by empirical correlation or theoretical means in a form useful for design. The experimental data herein were obtained mostly at Reynolds numbers greater than 4×10^6 and at Mach numbers less than 0.25.

NACA RM L55E27a

SIMULATOR STUDIES OF THE ATTACK PHASE OF AN AUTOMATICALLY CONTROLLED INTERCEPTOR. I - PRELIMINARY STUDIES OF THE LATERAL AND LONGITUDINAL CONTROL SYSTEMS. Albert A. Schy, Ordway B. Gates, Jr., and C. H. Woodling. II - SOME RESULTS OF A STUDY PERFORMED ON THE TYPHOON COMPUTER. Windsor L. Sherman and Leonard Sternfield. August 1955. 24p. diagrs. (NACA RM L55E27a)

The attack phase of the automatically controlled interceptor is studied in two parts. Part I is a limited simulation conducted to specify the lateral and longitudinal control systems for an automatic interceptor. The results are presented as Nyquist plots and time histories of the airplane variables. Part II uses the control systems developed in Part I, together with a dynamically perfect guidance system, to study the effect of the nonlinear terms in the complete equations of motion and nonlinear aerodynamics on the airplane response. The results are presented as time histories of the airplane and control surface motions.

NACA RM L56A26

A TRANSONIC WIND-TUNNEL INVESTIGATION OF STORE AND HORIZONTAL-TAIL LOADS AND SOME EFFECTS OF FUSELAGE-AFTERBODY MODIFICATIONS ON A SWEPT-WING FIGHTER AIRPLANE. Joseph M. Hallissy, Jr., and Louis Kudlacik. April 1956. 79p. diagrs., photos. (NACA RM L56A26)

An investigation has been conducted to determine: (a) pressure loads on a large store-pylon installation and the effect of the store on drag and stability, (b) span loading and hinge moments on a swept horizontal tail at 0° and 5° sideslip, and (c) transonic drag-rise reduction by afterbody enlargement. The model investigated had a wing of 40° sweep, aspect ratio 3.43, taper ratio 0.578, and NACA 64A010 airfoil sections perpendicular to the quarter-chord line. Tests were made at a Reynolds number of 5×10^6, at Mach numbers from 0.8 to 1.03, and at angles of attack to 17°.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM L56E01

A SEMIEMPIRICAL PROCEDURE FOR ESTIMATING WING BUFFET LOADS IN THE TRANSONIC REGION. T. H. Skopinski and Wilber B. Huston. September 1956. 22p. diagrs., tab. (NACA RM L56E01)

Wing buffeting data obtained from a flight loads investigation of two jet-propelled swept-wing airplanes were analyzed together with some published wind-tunnel results on two unswept-wing models to study the effects of Mach number and reduced frequency on the wing buffet loads. As a result of this analysis, a semiempirical procedure for a rough estimation of wing buffet loads has been derived which was based on simplified assumptions for the response of a linear single degree of freedom system. The procedure appeared to correlate the data from wings of various thickness ratios, stiffness, and size in the Mach number range from about 0.65 to 1.0.

NACA RM L56E10

EFFECT OF BLADE-SECTION CAMBER ON AERODYNAMIC CHARACTERISTICS OF FULL-SCALE SUPERSONIC-TYPE PROPELLERS AT MACH NUMBERS TO 1.04. Julian D. Maynard, John M. Swihart, and Harry T. Norton, Jr. October 1956. 79p. diagrs., photos., tab. (NACA RM L56E10)

This paper contains the results of an investigation of the aerodynamic characteristics of two full-scale supersonic-type propellers in the Langley 16-foot transonic tunnel with a 6,000-horsepower propeller dynamometer. The tests covered a range of blade angles at forward Mach numbers up to 1.04, and a few tests were made at lower speeds for low and negative blade angles. A brief analysis of the results is presented to show the effects of blade-section camber on propeller performance and stall-flutter characteristics. Stall flutter was also encountered at low and negative blade angles where the propeller might be used as a brake.

NACA RM L56E14

INVESTIGATION OF UNSTEADY FLOW PAST FOUR NACA 6-PERCENT-THICK AIRFOIL SECTIONS. Charles L. Ladson and Walter F. Lindsey. July 1956. 17p. diagrs. (NACA RM L56E14)

An investigation of the intensity of root-mean-square pressure pulsations and root-mean-square normal-force-coefficient fluctuations has been conducted on two NACA high-lift airfoils and two NACA 6-series airfoils. Data were obtained at angles of attack from 0° to 8° and over a Mach number range from 0.6 to 1.0. The corresponding Reynolds number range was from 1.6×10^6 to 2.1×10^6.

NACA RM L56E16

BLOWING OVER THE FLAPS AND WING LEADING EDGE OF A THIN 49° SWEPT WING-BODY-TAIL CONFIGURATION IN COMBINATION WITH LEADING-EDGE DEVICES. H. Clyde McLemore and Marvin P. Fink. July 1956. 57p. diagrs., photo. (NACA RM L56E16)

An investigation was conducted in the Langley full-scale tunnel to determine the effects on the low-speed aerodynamic characteristics of boundary-layer control by blowing over half- and full-span trailing-edge flaps of a large-scale wing-body-tail model in conjunction with several leading-edge-flow control devices, including leading-edge blowing. The wing and horizontal tail have an aspect ratio of 3.5, taper ratio of 0.3, 49° of sweep at the leading edge, and NACA 65A006 airfoil sections parallel to the plane of symmetry. The momentum coefficient range investigated was 0 to 0.16 for the trailing-edge blowing and 0 to 0.025 for the leading-edge blowing. Most of the tests were conducted at a Reynolds number of 5.20×10^6 corresponding to a Mach number of 0.08.

NACA RM L56E17

EFFECT OF WING HEIGHT AND DIHEDRAL ON THE LATERAL STABILITY CHARACTERISTICS AT LOW LIFT OF A 45° SWEPT-WING AIRPLANE CONFIGURATION AS OBTAINED FROM TIME-VECTOR ANALYSES OF ROCKET-PROPELLED-MODEL FLIGHTS AT MACH NUMBERS FROM 0.7 TO 1.3. Clarence L. Gillis and Rowe Chapman, Jr. September 1956. 70p. diagrs., photos., tabs. (NACA RM L56E17)

Lateral-stability flight tests were made over the Mach number range from 0.7 to 1.3 of models of three airplane configurations having 45° sweptback wings and tail surfaces. One configuration had a high wing; one, a low wing; and one, a high wing with 10° cathedral. The lateral oscillations resulting from intermittent yawing disturbances were interpreted in terms of typical full-scale airplane flying qualities and were further analyzed by the time-vector method to obtain lateral stability derivatives. Information was obtained on C_{Y_β}, C_{n_β}, C_{l_β}, C_{l_p}, $C_{n_r} - C_{n_{\dot{\beta}}}$, and $C_{l_r} - C_{l_{\dot{\beta}}}$. Comparisons were made with other experimental and theoretical results.

NACA RM L56E18

THE VARIATION WITH WING ASPECT RATIO OF FLAP EFFECTIVENESS ON THIN RECTANGULAR WINGS AT TRANSONIC SPEEDS. John G. Lowry and Robert T. Taylor. August 1956. 60p. diagrs., tabs. (NACA RM L56E18)

This paper presents the results of an investigation at transonic speeds to determine the effects of flap-chord ratio, wing aspect ratio, and wing thickness on the control effectiveness of full-span plain sealed flaps on 31 small-scale rectangular unswept wings.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM L56E28

A BRIEF SUMMARY OF EXPERIENCE IN BOOSTING AERODYNAMIC RESEARCH MODELS. Joseph G. Thibodaux, Jr. (Report is basis of talk presented at the thirtieth meeting of Bumblebee Aerodynamics Panel, Buffalo, New York, January 4, 1956.) July 1956. 21p. diagrs., photos. (NACA RM L56E28)

Single and multiple clusters of booster rockets in two-, three-, and four-stage combinations, and in tandem, wrap-around, underslung, and towing arrangements have been successfully used to propel various pilotless aircraft research model configurations. Results obtained with these unusual configurations along with some of the problems encountered and the factors responsible for choice of a particular configuration are briefly discussed.

NACA RM L56E30a

WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF WING THICKNESS ON THE STATIC LONGITUDINAL AND LATERAL STABILITY OF UNSWEPT WINGS OF ASPECT RATIO 3 AT HIGH SUBSONIC SPEEDS. William C. Hayes, Jr., and Edward C. Polhamus. August 1956. 43p. diagrs., photos. (NACA RM L56E30a)

An investigation was made to determine the effect of wing thickness on static longitudinal and lateral stability of a wing-fuselage combination at high subsonic speeds. The wings had an aspect ratio of 3, a taper ratio of 0.5, zero sweep of the half-chord line, and NACA 65A002, NACA 65A004, and NACA 65A006 airfoil sections parallel to the plane of symmetry. The variations of side force, yawing moment, and rolling moment with angle of sideslip were obtained as a continuous trace through the angle-of-sideslip range in order to detect any nonlinearities.

NACA RM L57F12

STATUS OF SPIN RESEARCH FOR RECENT AIRPLANE DESIGNS. Anshal I. Neihouse, Walter J. Klinar, and Stanley H. Scher. August 1957. ii, 98p. diagrs., photos., tabs. (NACA RM L57F12)

The status of spin research for recent airplane designs is presented in terms of the following major problem areas: interpretation of results of spin-model research, analytical spin studies, techniques involved in the measurement of various parameters in the spin, effectiveness of controls during spins and recoveries, influence of long noses, strakes, and canards on spin and recovery characteristics, and correlation of airplane and model spin and recovery characteristics.

NACA RM L57F26

COMPRESSIBILITY EFFECTS ON A HOVERING HELICOPTER ROTOR HAVING AN NACA 0018 ROOT AIRFOIL TAPERING TO AN NACA 0012 TIP AIRFOIL. Robert D. Powell, Jr. September 1957. 25p. diagrs. (NACA RM L57F26)

An investigation has been conducted on the Langley helicopter test tower to determine experimentally the effects of compressibility on the hovering performance and the blade pitching moments of a helicopter rotor having an NACA 0012 tip airfoil and an NACA 0018 root airfoil. Data are presented for blade-tip Mach numbers from 0.33 to 0.88. Experimental drag-divergence data are compared to unpublished two-dimensional data for the NACA 0012 airfoil section.

NACA RM L57G11a

THEORETICAL DETERMINATION OF LOW-DRAG SUPERCAVITATING HYDROFOILS AND THEIR TWO-DIMENSIONAL CHARACTERISTICS AT ZERO CAVITATION NUMBER. Virgil E. Johnson, Jr. September 1957. 29p. diagrs. (NACA RM L57G11a)

Two new low-drag hydrofoils for operation at zero cavitation number are derived by the application of the Tulin-Burkart linearized theory. The two-dimensional lift-drag ratios of these two hydrofoils operating at design angle of attack are shown to be, theoretically, about 45 and 80 percent greater than the Tulin-Burkart configuration. A simplified calculation of the location of the upper cavity streamline for arbitrary configurations is also presented.

NACA RM L57I16

THEORETICAL AND EXPERIMENTAL INVESTIGATION OF ARBITRARY ASPECT RATIO, SUPERCAVITATING HYDROFOILS OPERATING NEAR THE FREE WATER SURFACE. Virgil E. Johnson, Jr. December 1957. 94p. diagrs., photos. (NACA RM L57I16)

The existing two-dimensional theory for the characteristics of supercavitating hydrofoils operating at zero cavitation number is modified to include the effects of camber, aspect ratio, and depth of submersion. For a comparison with the theory, two aspect-ratio-1 hydrofoils, a flat plate and one with a cambered lower surface, were tested by operating them near the water surface so that their upper surfaces were completely ventilated. The data obtained verified the theory to within 3 percent. Some experimental data are also presented for the models operating at nonzero cavitation number for both air and water-vapor-filled cavities.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Secret. Effective date of declassification April 15, 1958.

NACA RM E52B28

CALCULATION OF INTERNAL PRESSURES IN THE FUEL TUBE OF A NUCLEAR REACTOR. B. M. Rosenbaum and G. Allen. July 1952. 32p. tabs. (NACA RM E52B28)

General procedures for computing internal pressures in fuel tubes of nuclear reactors are developed, and the effects on the pressure of varying neutron flux, fissioning material, operating time, and operating temperature are discussed. An account of chemical interactions between the many fission-product elements and the resulting effect on the total pressure completes the discussion. These general methods are illustrated by calculations applied to a system consisting of 90 percent enriched U^{235} in the form of UO_2 packed into a hollow metal cylinder or "pin," operating at a flux of 8×10^{14} per sec per cm^2 at 2000° F.

NACA RM E52L22

EFFECT OF DRAWBAR UPSTREAM LOCATION ON AIR VELOCITY DISTRIBUTION AT THE INLET FACE OF REACTOR SEGMENT DESIGNED BY THE GENERAL ELECTRIC COMPANY. T. F. Nagey and E. W. Sams. January 1953. 11p. diagrs. (NACA RM E52L22)

The results of flow tests on a drawbar for the General Electric reactor segment test in the MTR are reported. The drawbar is a T-shaped obstruction located as close to the upstream face of the reactor test segment as possible without serious flow distortion; the drawbar is required for instrumentation leads and segment insertion and removal in the MTR. The effect of drawbar upstream distance on velocity distribution across the segment face is evaluated for several Reynolds numbers.

NACA RM E53B05

EFFECT OF CAPTURE ON THE SLOWING-DOWN LENGTH OF NEUTRONS IN HYDROGENOUS MIXTURES CONTAINING URANIUM. H. C. Volkin and L. Soffer. April 1953. 4p. tab. (NACA RM E53B05)

Fermi's derivation for the slowing-down length of neutrons in hydrogenous media has been generalized to include capture while retaining the assumption of infinite mass for the nonhydrogen nuclei. Both the capture and the no-capture formulas have been applied to a mixture of uranium-235 and water with the ratio of hydrogen to uranium nuclei chosen as 25. Results show that capture reduced the calculated L_f^2 by 9.5 percent. A further calculation using the total mean free path in the no-capture formula gave an L_f^2 differing by 3.9 percent from that given by the capture formula.

NACA RM E53B26

COMPARISON OF CALCULATED AND MEASURED THERMAL DISTORTIONS IN A REACTOR CONTROL ROD FOR TEMPERATURE PATTERNS SIMULATING TWO REACTOR OPERATING CONDITIONS. Tibor F. Nagey. April 1953. 18p. diagrs., tabs. (NACA RM E53B26)

The results of a simplified theoretical analysis of the calculated distortion of a stainless-steel-clad silver-cadmium control rod under the influence of several temperature patterns are compared with the measured distortions for the same temperature patterns. The calculated distortion for a temperature variation simulating reactor operation with 50-percent shim-rod insertion agreed with the measured values for about the first 60 percent of rod length, measured from the fixed end. The calculated distortion for temperature variation simulating reactor operation with shim rod removed agreed with measured values over the entire length of rod.

NACA RM E53L18

FORCED-CONVECTION HEAT-TRANSFER CHARACTERISTICS OF MOLTEN FLINAK FLOWING IN AN INCONEL X SYSTEM. Milton D. Grele and Louis Gedeon. February 1954. 23p. diagrs., photos., tab. (NACA RM E53L18)

Heat-transfer characteristics of Flinak (NaF-KF-LiF, 11.4-42.0-46.5 mole percent) flowing through an electrically heated test section were investigated. Average heat-transfer coefficients were about 40 percent of the values given by the McAdams correlation line. Similar results were obtained by another investigator using an Inconel test section. The low values may be due to a scale formation and some intergranular penetration found on the inner surface of the tube.

National Advisory Committee for Aeronautics

Research Abstracts and Reclassification Notice

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CURRENT NACA RESEARCH REPORTS

NACA Rept. 1325

AVERAGE PROPERTIES OF COMPRESSIBLE LAMINAR BOUNDARY LAYER ON FLAT PLATE WITH UNSTEADY FLIGHT VELOCITY. Franklin K. Moore and Simon Ostrach. 1957. iii, 12p. diagrs., tabs. (NACA Rept. 1325. Supersedes TN 3886)

The time-average characteristics of boundary layers over either an insulated or isothermal flat plate in nearly quasi-steady flow are determined. Time averages are found without specifying plate velocity explicitly except that it is positive and has an average value. The time average quasi-steady terms are compared to steady flow values at the corresponding average velocity and the effects of the frequency dependent averages are discussed. The special case of harmonic velocity variation is considered, and it is found that large amplitudes accentuate the importance of the frequency-dependent terms. Oscillating the wall to increase the heat-transfer rate is not advantageous if the power to oscillate the plate is accounted for, unless the Prandtl number is in a certain range.

NACA Rept. 1338

NEAR NOISE FIELD OF A JET-ENGINE EXHAUST. Walton L. Howes, Edmund E. Callaghan, Willard D. Coles, and Harold R. Mull. Appendix B: CORRELATION COMPUTER. Channing C. Conger and Donald F. Berg. 1957. ii, 35p. diagrs., photos., tab. (NACA Rept. 1338. Supersedes TN 3763 and TN 3764)

Surveys of sound pressures and longitudinal and lateral cross correlations, both overall and in frequency bands, are presented for a fixed operating condition. The dependence on jet velocity and the effect on a stiff plate are shown. Sound-pressure data with afterburning are included. The distribution of acoustic sources according to frequency was found. The physical significance of cross correlation is outlined. The extent of positive correlation increased downstream, but was relatively independent of jet velocity and filter-band width. Sound pressures were increased on the plate, but correlation was unaffected.

NACA RM A58D17

DATA FROM FLOW-FIELD SURVEYS BEHIND A LARGE-SCALE THIN STRAIGHT WING OF ASPECT RATIO 3. William T. Evans. June 1958. 13p. diagrs. (NACA RM A58D17)

The wing section was a modified double wedge, 4.2 percent thick. Surveys were made in the Ames 40- by 80-foot wind tunnel at angles of attack from 8° to 30°. The dynamic pressure was 20 lb/sq ft and the Reynolds number 8.5×10^{6}. Limited force data with and without a horizontal tail are included. Longitudinal instability and loss of control effectiveness above the stall were traced to a region of high downwash and low dynamic pressure above and behind the wing.

NACA RM E58D11

COMPATIBILITY OF METALS WITH LIQUID FLUORINE AT HIGH PRESSURES AND FLOW VELOCITIES. Harold W. Schmidt. July 1958. 15p. diagrs., photo., tab. (NACA RM E58D11)

Nickel, stainless steel, brass, and aluminum were evaluated for compatibility with liquid fluorine at flow velocities up to approximately 400 ft/sec and pressures up to 1500 lb/sq in. gage. Configurations were varied to produce severe turbulence and impact effects. Two rotating-vane flowmeters were also tested. None of the metals exhibited any measurable physical or chemical changes. In a run made with Teflon, fluorine reacted violently.

NACA TM 1435

ELLIPTIC FUNCTIONS AND INTEGRALS WITH REAL MODULUS IN FLUID MECHANICS. (Les Fonctions et Intégrales Elliptiques a Module Réel en Mécanique des Fluides). Robert Legendre. June 1958. 113p. diagrs. (NACA TM 1435. Translation of Office National d'Études et de Recherches Aéronautiques, Publication 71, 1954)

The usefulness of the Schwarz transformation and elliptic functions in defining flows outside and inside polygons is discussed and illustrated. The mathematical properties and physical significance of the elliptic integrals of the first, second, and third kinds and of the elliptic functions are examined, together with their relations to the theta and zeta functions. Applications of the various functions are made to the calculation of wing profiles, of compressor profiles, and to the study of the vibration of airplane wings and of compressor vanes.

CURRENT NACA RESEARCH REPORTS

NACA TM 1436

STATISTICAL STUDY OF TURBULENCE - SPECTRAL FUNCTIONS AND CORRELATION COEFFICIENTS. (Étude statistique de la turbulence. Fonctions spectrales et coefficients de corrélation.) Francois N. Frenkiel. July 1958. 116p. diagrs., tabs. (NACA TM 1436. Translation of Office National d'Études et de Recherches Aéronautiques. Rapport Technique no. 34, 1948)

An extensive discussion is given of various possible correlation functions for homogeneous and isotropic turbulence. The logical consequence of each of several choices of such correlation functions is examined in detail.

NACA TN 3786

HANDBOOK OF STRUCTURAL STABILITY. PART VI - STRENGTH OF STIFFENED CURVED PLATES AND SHELLS. Herbert Becker, New York University. July 1958. iii, 82p. diagrs., tab. (NACA TN 3786)

A comprehensive review of failure of stiffened curved plates and shells is presented. Panel instability in stiffened curved plates and general instability of stiffened cylinders are discussed. The loadings considered for the plates are axial, shear, and the combination of the two. For the cylinders, bending, external pressure, torsion, transverse shear, and combinations of these loads are considered. When possible, test data and theory were correlated.

NACA TN 4080

SOME EFFECTS OF VANES AND OF TURBULENCE IN TWO-DIMENSIONAL WIDE-ANGLE SUBSONIC DIFFUSERS. Carl A. Moore, Jr., and Stephen J. Kline, Stanford University. June 1958. iii, 139p. diagrs., photos., tabs., film suppl. available on request. (NACA TN 4080)

Tests on two aspects of the behavior of wide-angle, plane-walled, two-dimensional diffusers with essentially incompressible flow have been conducted. A thorough study of the flow mechanism has been made using dye injection in a water table. The four regimes of flow found are delineated on graphs in terms of the three important parameters. Test data from large and small water-table units are given. Data are also presented which demonstrate means for producing efficient diffusers with total included angles up to 45° by use of simple, short, flat vanes.

NACA TN 4134

STALL PROPAGATION IN A CASCADE OF AIRFOILS. Anthony R. Kriebel, Barry S. Seidel, and Richard G. Schwind, Massachusetts Institute of Technology. June 1958. 122p. diagrs., photos., tabs. (NACA TN 4134)

An experimental investigation of stall propagation in a stationary circular cascade in which high-speed schlieren and interferometer photography is used is described. This investigation suggests an analytical approach to the study of stall propagation which is valid only for an isolated blade row in an infinite flow field but which is not restricted to small unsteady perturbations or to an assumed simplified cascade geometry. Conditions necessary for the existence of the assumed type of stall cells are described and equations are derived for the velocity of stall-cell propagation.

NACA TN 4186

HEAT TRANSFER IN ISOTROPIC TURBULENCE DURING THE FINAL PERIOD OF DECAY. D. W. Dunn and W. H. Reid, Johns Hopkins University and Ballistic Research Laboratories, U. S. Army. June 1958. 68p. diagrs., tabs. (NACA TN 4186)

The problem of heat transfer in isotropic turbulence with a constant mean temperature gradient is considered during the final period of decay. The Reynolds and Péclet numbers are then very small, and all triple correlation terms can be neglected in the equations for the double correlations. On this basis it is found that the temperature field ultimately becomes independent of the initial conditions on the temperature and has characteristics determined only by the mean temperature gradient, the physical properties of the fluid, and the characteristics of the turbulence. Detailed analytical and numerical results are obtained for the asymptotic state.

NACA TN 4187

HIGH-SPEED HYDRODYNAMIC CHARACTERISTICS OF A FLAT PLATE AND 20° DEAD-RISE SURFACE IN UNSYMMETRICAL PLANING CONDITIONS. Daniel Savitsky, R. E. Prowse, and D. H. Lueders, Stevens Institute of Technology. June 1958. 93p. diagrs., photos., tabs. (NACA TN 4187)

The results of an investigation made to obtain the wetted areas, the three components of planing forces, and the three components of moments acting on a 0° and a 20° dead-rise surface in high-speed, unsymmetrical planing conditions are presented. Hydrodynamic data were obtained for trim angles between 6° and 30°, roll angles between -15° and 15°, yaw angles between 0° and 20°, mean wetted-length—beam ratios up to 7.7, load coefficients up to 49.0, and speed coefficients up to 18.0.

CURRENT NACA RESEARCH REPORTS

NACA TN 4237

GENERAL INSTABILITY OF STIFFENED CYLINDERS. Herbert Becker, New York University. July 1958. 26p. diagrs., tab. (NACA TN 4237)

Theoretical buckling stresses are determined in explicit form for circular cylinders with circumferential and axial stiffening. The loadings are axial compression, radial pressure, hydrostatic pressure, and torsion. Analyses were confined to moderate-length and long cylinders. Derivation of a form of Donnell's equation applicable to orthotropic cylinders is presented in this report.

NACA TN 4238

NORMAL COMPONENT OF INDUCED VELOCITY FOR ENTIRE FIELD OF A UNIFORMLY LOADED LIFTING ROTOR WITH HIGHLY SWEPT WAKE AS DETERMINED BY ELECTROMAGNETIC ANALOG. Walter Castles, Jr., Howard L. Durham, Jr., and Jirair Kevorkian, Georgia Institute of Technology. June 1958. 33p. diagrs., photos., tabs. (NACA TN 4238)

Values of the normal component of induced velocity throughout the entire field of a uniformly loaded rotor at high speed are presented in the form of charts and tables. Many points were found by an electromagnetic analog, details of which are given. Comparisons of computed and analog values for the induced velocity indicate that the latter are sufficiently accurate for engineering purposes.

NACA TN 4243

AN EXPERIMENTAL STUDY OF THE TURBULENT BOUNDARY LAYER ON A SHOCK-TUBE WALL. Paul B. Gooderum. June 1958. 63p. diagrs., photos., tab. (NACA TN 4243)

Interferometric measurements were made of the density profiles of an unsteady turbulent boundary layer on the flat wall of a shock tube. The investigation included both subsonic and supersonic flow (Mach numbers of 0.50 and 1.77) with no pressure gradient and with heat transfer to a cold wall. Velocity profiles and average skin-friction coefficients were calculated. Effects on the velocity profile of surface roughness and flow length are examined.

NACA TN 4244

ON SOLUTIONS FOR THE TRANSIENT RESPONSE OF BEAMS. Robert W. Leonard. June 1958. 65p. diagrs., tabs. (NACA TN 4244)

Williams type modal solutions of the elementary and Timoshenko beam equations are presented for the response of several uniform beams to a general applied load. Example computations are shown for a free-free beam subject to various concentrated loads at its center. Discussion includes factors influencing the convergence of modal solutions and factors to be considered in a choice of beam theory. Results obtained by two numerical procedures, the traveling-wave method and Houbolt's method, are also presented and discussed.

NACA TN 4245

FLUTTER ANALYSIS OF RECTANGULAR WINGS OF VERY LOW ASPECT RATIO. Robert W. Fralich and John M. Hedgepeth. June 1958. 24p. diagrs. (NACA TN 4245)

This flutter analysis employs slender-body aerodynamic theory and thin-plate theory. The spanwise variation of wing deflection is assumed to be given by a parabola, and the chordwise variation is allowed complete freedom. The results show the variation of flutter speed and mode shape with aspect ratio. Comparisons are made with additional results obtained by approximating the chordwise deflection shape by use of parabolic or cubic curves. The analysis shows that the cubic approximation gives good results for a ratio of chord to semispan less than 3.

NACA TN 4246

FURTHER INVESTIGATION OF FATIGUE-CRACK PROPAGATION IN ALUMINUM-ALLOY BOX BEAMS. Herbert F. Hardrath and Herbert A. Leybold. June 1958. 23p. diagrs., tabs. (NACA TN 4246)

Results are presented for several designs of built-up box beams tested at one load level. Stress redistribution during the tests was studied to aid in interpreting the results. Parameters which varied were the material of construction, mode of connecting stringers to cover skins, ratio of stringer area to skin area, and location of rivets with respect to line of crack propagation.

NACA TN 4250

EFFECT OF THE PROXIMITY OF THE WING FIRST-BENDING FREQUENCY AND THE SHORT-PERIOD FREQUENCY ON THE AIRPLANE DYNAMIC-RESPONSE FACTOR. Carl R. Huss and James J. Donegan. June 1958. 45p. diagrs. (NACA TN 4250)

The results are presented in the form of preliminary design charts which give a comparison between the dynamic-response factors of the semirigid case and the airplane longitudinal short-period case and between the dynamic-response factors of the semirigid case and the steady-state value of the airplane longitudinal short-period response. These charts can be used to estimate the first-order effects of the addition of a wing-bending degree of freedom on the short-period dynamic-response factor and on the maximum dynamic-response factor when compared with the steady-state response of the system.

CURRENT NACA RESEARCH REPORTS

NACA TN 4252

EXPERIMENTAL INVESTIGATION OF AN IMPULSE-TYPE SUPERSONIC COMPRESSOR ROTOR HAVING A TURNING OF 73° AT THE MEAN RADIUS. James R. Sterrett. June 1958. 35p. diagrs., photos., tabs. (NACA TN 4252)

An impulse rotor with guide vanes was designed and tested in Freon-12. The rotor had an inlet and exit hub-tip ratio of 0.575 and 0.75, respectively. The blade-passage design was based on a two-dimensional vortex-flow theory modified to account partially for three-dimensional compressions. The rotor achieved an overall pressure ratio of 7.2 near design speed with an equivalent weight flow of 28.6 lb/sec of air per square foot of frontal area.

NACA TN 4253

DESIGN AND TESTS OF A SIX-STAGE AXIAL-FLOW COMPRESSOR HAVING A TIP SPEED OF 550 FEET PER SECOND AND A FLAT OPERATING CHARACTERISTIC AT CONSTANT SPEED. Willard R. Westphal and John W. Maynard, Jr. June 1958. 57p. diagrs., photos., tabs. (NACA TN 4253)

The six-stage axial-flow compressor was designed for a constant power input per pound of flow with a design specific weight flow of 21.3 pounds per second per square foot of frontal area at atmospheric discharge with a stagnation-pressure ratio of 3.25 and an inlet hub-tip radius ratio of 0.7. Several configurations having different blade setting angles and solidities were tested. The tests showed that the design flow, pressure ratio, and flat stagnation-pressure ratio as a function of weight flow were obtained at a peak efficiency of 82.8 percent.

NACA TN 4257

RESULTS OF AN EXPERIMENTAL INVESTIGATION OF SMALL VISCOUS DAMPERS. Milton A. Silveira, Domenic J. Maglieri, and George W. Brooks. June 1958. 49p. diagrs., photos. (NACA TN 4257)

Experimental results on the damping characteristics of small viscous dampers are presented. Several types of fluid-displacement and viscous-shear dampers for varying physical and fluid properties were tested. Descriptions of test devices are also presented.

NACA TN 4258

A NUMERICAL METHOD FOR EVALUATING WAVE DRAG. Maurice S. Cahn and Walter B. Olstad. June 1958. 13p. diagrs., tabs. (NACA TN 4258)

A numerical method for evaluating Von Kármán's wave-drag equation was developed and applied to four analytical bodies of revolution. It was concluded that the numerical method will yield results well within the accuracy of linearized theory. The method may be set up easily for a desk calculator or an electronic computer.

NACA TN 4264

INTERNAL CHARACTERISTICS AND PERFORMANCE OF SEVERAL JET DEFLECTORS AT PRIMARY-NOZZLE PRESSURE RATIOS UP TO 3.0. Jack G. McArdle. June 1958. ii, 107p. diagrs., photos., tabs. (NACA TN 4264)

Several model jet deflectors (devices which change the direction of resultant jet thrust) were tested in quiescent air. The deflectors (swiveled nozzles, auxiliary nozzles, and mechanical deflectors) were designed to be adaptable to conventional turbojet exhaust systems and produced side force as high as 43 percent of the undeflected jet thrust. Analytical expressions relating the performance of each type deflector with significant design variables are also presented.

NACA TN 4266

STUDIES OF OH, CO, CH, AND C_2 RADIATION FROM LAMINAR AND TURBULENT PROPANE-AIR AND ETHYLENE-AIR FLAMES. Thomas P. Clark. June 1958. 23p. diagrs., photos. (NACA TN 4266)

OH, CO, CH, and C_2 radiations from propane-air and ethylene-air flames were isolated with a monochromator, and the variation of emitter intensity with equivalence ratio was determined. The ratio of C_2 and CH radiation intensities was found to be a good index of the equivalence ratio in the flame. Turbulent open flames burning on tubes were found to become leaner near the base, but appeared to be burning at the metered equivalence ratio in the turbulent brush. The amount of radiation given off by the flame per unit rate of fuel consumption decreased with increasing average gas-flow velocities and Reynolds numbers, but this decrease could not be accounted for by admixing of the secondary air with the turbulent flame brush.

NACA TN 4272

USE OF THE COANDA EFFECT FOR OBTAINING JET DEFLECTION AND LIFT WITH A SINGLE FLAT-PLATE DEFLECTION SURFACE. Uwe H. von Glahn. June 1958. 49p. diagrs., tabs. (NACA TN 4272)

Performance characteristics similar to those for a flap immersed in an airstream were obtained in quiescent air for nozzle-deflection-plate configurations using the Coanda effect for achieving jet deflection and vertical lift. With a simple flat-plate deflection surface the optimum ratio of lift to undeflected thrust follows a sine function with plate deflection angle. Because of jet detachment from the deflection plate, the configurations studied were limited to specific deflection angles depending on nozzle height. An empirical relation was derived for predicting the required plate length in terms of nozzle height for achieving optimum performance at a given deflection-plate angle and pressure ratio.

CURRENT NACA RESEARCH REPORTS

NACA TN 4273

ON PAIRS OF SOLUTIONS OF A CLASS OF INTERNAL VISCOUS FLOW PROBLEMS WITH BODY FORCES. Simon Ostrach and Lynn U. Albers. June 1958. 21p. diagrs., tabs. (NACA TN 4273)

In previous analyses of fully developed combined forced- and natural-convection flows, a few examples were presented of two distinct states of flow and heat transfer which were obtained for a given set of conditions if the frictional heating was taken into account. This report discusses these pairs of solutions in greater detail and shows how the solutions are affected by systematic variations of the basic physical parameters. It is also shown that a critical set of parametric values exists beyond which no fully developed solutions can be found.

NACA TN 4275

DYNAMIC STABILITY OF VEHICLES TRAVERSING ASCENDING OR DESCENDING PATHS THROUGH THE ATMOSPHERE. Murray Tobak and H. Julian Allen. July 1958. (i), 35p. diagrs. (NACA TN 4275)

An analysis is given of the oscillatory motions of vehicles which traverse ascending and descending paths through the atmosphere at high speed. The specific case of a skip path is examined in detail, and this leads to a form of solution for the oscillatory motion which should recur over any trajectory. The distinguishing feature of this form is the appearance of the Bessel rather than the trigonometric function as the characteristic mode of oscillation.

NACA TN 4278

APPLICATION OF STATISTICAL THEORY TO BEAM-RIDER GUIDANCE IN THE PRESENCE OF NOISE. II - MODIFIED WIENER FILTER THEORY. Elwood C. Stewart. June 1958. (i), 48p. diagrs., tabs. (NACA TN 4278. Supersedes RM A55E11a)

An application has been made of Newton's modification of Wiener filter theory to optimize a beam-rider guidance system operating in the presence of glint noise. Results indicate that when the operation of the system is restricted to practical linear ranges, the minimum error attained from this theory closely approaches that for the Wiener theory. The system transfer functions and error performance against noise are given. Requirements on control deflection rates, circuit voltages, and servoenergy are discussed.

NACA TN 4283

FULL-SCALE WIND-TUNNEL TESTS OF A 35° SWEPTBACK-WING AIRPLANE WITH BLOWING FROM THE SHROUD AHEAD OF THE TRAILING-EDGE FLAPS. William H. Tolhurst, Jr. July 1958. 40p. diagrs., photos., tabs. (NACA TN 4283)

Data are presented showing the effect of flap position relative to the blowing nozzle on the air-flow requirements for boundary-layer control on flaps deflected from 45° to 75° at a Reynolds number of 7.5×10^{6}. A direct comparison of shroud blowing and flap blowing is shown for a plain flap configuration. Also presented are data showing the effect on the air-flow requirements of spacers in the nozzle, discontinuities on the flap upper surface, and of sealing the slot when the flap was in the single-slotted flap configuration.

NACA TN 4289

BOUNDARY-INDUCED DOWNWASH DUE TO LIFT IN A TWO-DIMENSIONAL SLOTTED WIND TUNNEL. S. Katzoff and Raymond L. Barger. June 1958. 31p. diagrs. (NACA TN 4289)

A solution has been obtained for the complete tunnel-interference flow for a lifting vortex in a two-dimensional slotted tunnel. Curves are presented for the longitudinal distribution of tunnel-induced downwash angle for various values of the boundary openness parameter and for various heights of the vortex above the tunnel center line. Some quantitative discussion is given of the use of these results in calculating the tunnel interference for three-dimensional wings in rectangular tunnels with closed side walls and slotted top and bottom.

NACA TN 4290

A FUSELAGE ADDITION TO INCREASE DRAG-RISE MACH NUMBER OF SUBSONIC AIRPLANES AT LIFTING CONDITIONS. Richard T. Whitcomb. June 1958. 38p. diagrs., photos., tab. (NACA TN 4290)

The addition of fuselage volume on the top of the forward portion of the fuselage for the purpose of increasing the drag-rise Mach number of subsonic airplanes at lifting conditions is investigated. The additions have been designed on the basis of the area rule and other important considerations to provide greater practicability of application compared with shapings previously investigated. The addition increased the drag-rise Mach number by an increment of approximately 0.03 for a configuration having a wing with moderate thickness and 35° of sweepback at a lift coefficient of 0.3. A lesser increase was obtained for a configuration with a thicker wing. The additions increase the nonlinearities of the variations of pitching moment with lift.

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NACA TN 4291

AN EVALUATION OF EFFECTS OF FLEXIBILITY ON WING STRAINS IN ROUGH AIR FOR A LARGE SWEPT-WING AIRPLANE BY MEANS OF EXPERIMENTALLY DETERMINED FREQUENCY-RESPONSE FUNCTIONS WITH AN ASSESSMENT OF RANDOM-PROCESS TECHNIQUES EMPLOYED. Thomas L. Coleman, Harry Press, and May T. Meadows. July 1958. ii, 74p. diagrs., photo., tabs. (NACA TN 4291)

Flight test measurements on a large swept-wing bomber airplane through rough air at altitudes of 5,000 and 35,000 feet are analyzed in order to determine the effects of airplane flexibility on wing bending and shear strains. For this purpose, the power spectra of the strain responses and the frequency-response functions for the strain responses to vertical gust disturbances are determined and compared with the strain responses for a quasi-rigid airplane. The measured power spectra and frequency-response functions are subject to distortion and statistical sampling errors from a variety of sources. A general analysis of the reliability of such results is presented and methods of estimating the distortions and sampling errors are developed. These methods are applied to the interpretation of the test results.

NACA TN 4292

LOCAL INSTABILITY OF THE ELEMENTS OF A TRUSS-CORE SANDWICH PLATE. Melvin S. Anderson. July 1958. 21p. diagrs., photo. (NACA TN 4292)

The charts presented give the compressive buckling coefficients for a single-truss-core and a double-truss-core sandwich plate. These charts cover a wide range of sandwich proportions and may be used for sandwiches with unequal faces. They apply to in-plane compressive loads acting parallel or perpendicular to the core direction or for various combinations of these loads.

NACA TN 4293

SPECIAL BODIES ADDED ON A WING TO REDUCE SHOCK-INDUCED BOUNDARY-LAYER SEPARATION AT HIGH SUBSONIC SPEEDS. Richard T. Whitcomb. June 1958. 48p. diagrs., photos. (NACA TN 4293)

The basic test configuration had a relatively thick 35° sweptback wing of aspect ratio 7.05 mounted on a contoured fuselage. Studies of the boundary-layer flow indicate that addition of the bodies resulted in a significant lessening of the separation on this configuration at high subsonic Mach numbers. Marked reductions in drag and pitch-up were associated with the improved flow. With an increase in sweep of the wing to 40°, the effectiveness of the added bodies in improving the drag and pitching-moment characteristics was increased.

NACA TN 4295

REFLECTION AND TRANSMISSION OF SOUND BY A SLOTTED WALL SEPARATING TWO MOVING FLUID STREAMS. Raymond L. Barger. June 1958. 14p. diagrs. (NACA TN 4295)

The acoustics problem discussed is related to the aerodynamic problem of determining the tunnel-wall interference on an oscillating airfoil in a slotted-throat wind tunnel in that the same boundary condition is involved with one of the two streams at the boundary having zero velocity. In the analysis the wall with discrete slots is replaced by an equivalent homogeneous boundary.

NACA TN 4296

COMPRESSIVE STRENGTH AND CREEP OF 17-7 PH STAINLESS-STEEL PLATES AT ELEVATED TEMPERATURES. Bland A. Stein. July 1958. 33p. diagrs., photos., tabs. (NACA TN 4296)

Compressive strength test results from room temperature to $1,000^{\circ}$ F and compressive creep test results from 700° F to $1,000^{\circ}$ F are presented for plates of 17-7 PH stainless steel, Condition TH 1,050, which were edge-supported in V-groove fixtures. Plate width-thickness ratios range from 15 to 60. Master curves are presented which show the combinations of average stress, temperature, and time which produce given amounts of creep strain or failure of the plates and which facilitate interpolation of the test results. The test results are compared with plate strengths and creep failure stresses determined from semiempirical approximations.

NACA TN 4298

EXPLORATORY WIND-TUNNEL INVESTIGATION TO DETERMINE THE LIFT EFFECTS OF BLOWING OVER FLAPS FROM NACELLES MOUNTED ABOVE THE WING. John M. Riebe and Edwin E. Davenport. June 1958. 19p. diagrs., tab. (NACA TN 4298)

An exploratory investigation, in which high-pressure air was blown over single and double slotted flaps from externally supported steel-pipe nacelles above the wing to simulate jet-engine exhaust, has been conducted on a model with a delta wing of aspect ratio 3. The jet-momentum-coefficient range was from 0 to 3.0 and the model angle of attack was 0°. Results of the limited investigation show that jet-circulation lift coefficients greater than the jet reaction alone were produced.

CURRENT NACA RESEARCH REPORTS

NACA TN 4299

EFFECTS OF FABRICATION-TYPE ROUGHNESS ON TURBULENT SKIN FRICTION AT SUPERSONIC SPEEDS. K. R. Czarnecki, John R. Sevier, Jr., and Melvin M. Carmel. July 1958. 15p. diagrs. (NACA TN 4299)

The results of this investigation indicate that the effects of both Reynolds number and Mach number can be correlated on the basis of changes in flow characteristics within the inner parts of the boundary layer. Consequently, increasing the unit Reynolds number has a detrimental effect and increasing Mach number has a powerful alleviating effect on drag due to surface roughness. The correlation of the effects of changes in roughness height or shape awaits a more comprehensive analysis than was attempted in this paper. Further investigation must be made of the effects of roughness sweep and possibly mutual interference effects.

NACA TN 4301

EFFECTS OF BOUNDARY-LAYER DISPLACEMENT AND LEADING-EDGE BLUNTNESS ON PRESSURE DISTRIBUTION, SKIN FRICTION, AND HEAT TRANSFER OF BODIES AT HYPERSONIC SPEEDS. Mitchel H. Bertram and Arthur Henderson, Jr. July 1958. 33p. diagrs. (NACA TN 4301)

Results are presented of an investigation to determine the effect of boundary-layer displacement and leading-edge bluntness on surfaces in hypersonic flow. The presence of the boundary layer and the blunt leading edge induce pressure gradients which in turn affect the skin friction and heat transfer to the surface. Methods for predicting these phenomena on two-dimensional surfaces are given and a brief review of recent three-dimensional results is presented.

NACA TN 4303

MEASUREMENTS AND POWER SPECTRA OF RUNWAY ROUGHNESS AT AIRPORTS IN COUNTRIES OF THE NORTH ATLANTIC TREATY ORGANIZATION. Wilbur E. Thompson. July 1958. 85p. diagrs. (NACA TN 4303)

Measurements of runway roughness obtained by a profile-survey method are presented. A variety of runway lengths or sections and degrees of roughness were measured. The results are presented as elevation profiles of the runways surveyed and in the form of power spectra.

NACA TN 4311

PRANDTL NUMBER EFFECTS ON UNSTEADY FORCED-CONVECTION HEAT TRANSFER. E. M. Sparrow and J. L. Gregg. June 1958. 14p. diagrs., tab. (NACA TN 4311)

An analysis is made for laminar forced-convection heat transfer on a flat plate with unsteady surface temperature. The deviation of the instantaneous heat-transfer rate from the quasi-steady value is computed. Results are obtained for Prandtl numbers in the range 0.01 to 10. The deviations from quasi-steady heat transfer increase markedly with increasing Prandtl number. The findings reported here should apply approximately in the entrance region of ducts and should also provide an upper bound on deviations from turbulent quasi-steady heat transfer.

NACA TN 4330

FLOW INDUCED BY A ROTOR IN POWER-ON VERTICAL DESCENT. Walter Castles, Jr., Georgia Institute of Technology. July 1958. 25p. diagrs., tabs. (NACA TN 4330)

Approximate equations are derived for the induced power required and blade loading of a lifting rotor operating in the power-on vertical-descent range. The approximate relations, which are based upon certain assumptions as to the nature of the flow pattern, yield, for the induced power variation, results which are in general agreement with available data.

NACA TN 4340

WIND-TUNNEL INVESTIGATION OF THE HIGH-SUBSONIC STATIC LONGITUDINAL STABILITY CHARACTERISTICS OF SEVERAL WING-BODY CONFIGURATIONS DESIGNED FOR HIGH LIFT-DRAG RATIOS AT A MACH NUMBER OF 1.4. Paul G. Fournier. July 1958. 42p. diagrs., photo., tab. (NACA TN 4340)

The Mach number range was 0.60 to 0.95 with a corresponding Reynolds number of 2.0×10^6 to 3.3×10^6 based on mean aerodynamic chord. The basic highly swept (approximately 60° at c/4) wing had a taper ratio of 0.167, an aspect ratio of 2.91, and thin NACA 65A-series airfoil sections. Other wings, of the same plan form, had twist and camber and twist. All bodies were of elliptical cross section; the basic body had a Sears-Haack area distribution and the others had indentation for a Mach number of 1.4. The maximum angle-of-attack range was from -2° to 22°.

CURRENT NACA RESEARCH REPORTS

NACA TN 4342

FLIGHT MEASUREMENTS OF THE VIBRATORY BENDING AND TORSIONAL STRESSES ON A MODIFIED SUPERSONIC PROPELLER FOR FORWARD MACH NUMBERS UP TO 0.95. Thomas C. O'Bryan. June 1958. 17p. diagrs., photos. (NACA TN 4342)

Vibratory bending stresses, measured in flight, on a modified supersonic propeller were low in relation to the strength of the material. The vibratory torsional stresses did not exceed ±1,000 pounds per square inch.

BRITISH REPORTS

N-5278Y*

Aeronautical Research Council (Gt. Brit.)
LOW-SPEED TESTS ON 45-DEG SWEPT-BACK WINGS. PART I. PRESSURE MEASUREMENTS ON WINGS OF ASPECT RATIO 5. J. Weber and G. G. Brebner. PART II. BALANCE AND PRESSURE MEASUREMENTS ON WINGS OF DIFFERENT ASPECT RATIOS. D. Küchemann, J. Weber, and G. G. Brebner. 1958. 89p. diagrs., tabs. ARC R & M 2882; ARC 13,655; ARC 14,139. Supersedes RAE Report Aero 2374 and RAE Report Aero 2419. (Ask for N-5278Y*)

Contains results of pressure measurements on three 45° sweptback wings with constant chord and AR = 5, over an angle-of-attack range up to 10°. Chordwise and spanwise lift distributions are given, mostly near the center where, on two of the wings, modifications had been made to the section shape. It was found that altering the thickness distribution in the center did not affect the loading but that approximately straight isobars could be obtained at values of C_L below about 0.1. By the incorporation of twist and camber in the central part the distortion of the lift distribution in the center could be avoided at one particular incidence, and thus the same chordwise distribution obtained over most of the span. The second part contains balance and pressure measurements on constant-chord wings of 45° sweepback and provides data on aspect ratio wings of 2, 3, 5, and infinity.

N-14283X*

Aeronautical Research Council (Gt. Brit.)
WIND-TUNNEL INTERFERENCE EFFECTS ON MEASUREMENTS OF AERODYNAMIC COEFFICIENTS FOR OSCILLATING AEROFOILS. W. P. Jones. 1958. 12p. diagrs., tabs. ARC R & M 2786. Supersedes ARC 13,411; FM 1478; S & C 2433; 0.894. (Ask for N-14283X*)

A theory is developed for estimating the effect of wind-tunnel walls on measured values of aerodynamic coefficients for two-dimensional airfoils oscillating in an incompressible fluid. The case of an airfoil describing translational and pitching oscillations in a wind tunnel of rectangular cross section is considered, and it is shown that the damping derivatives associated with the pitching degree of freedom are very sensitive to wall effects when the frequency parameter for the motion is small, and when the axis of oscillation is not at, or near, quarter chord. When the axis is at quarter chord, the pitching-moment damping derivative is hardly affected by the presence of the tunnel walls.

N-21486X*

Aeronautical Research Council (Gt. Brit.)
OSCILLATING WINGS IN COMPRESSIBLE SUBSONIC FLOW. W. P. Jones, National Physical Laboratory. 1957. 18p. diagrs., tab. ARC R & M 2855. Supersedes ARC 14,336; 0.961; S & C 2560. (Ask for N-21486X*)

The problem of estimating flutter and stability derivatives for wings of finite span describing simple harmonic oscillations in compressible flow is considered. It is shown that the problem can be reduced to a similar one for an equivalent wing in incompressible flow. The lateral dimensions of the equivalent wing are $\sqrt{(1 - M^2)}$ times those of the original wing and the frequency of oscillation is increased by the factor $(1 - M^2)^{-1}$ where M denotes the Mach number of the compressible flow. The mode of oscillation is different but related to that of the original wing and leads to a more complicated condition for tangential flow.

N-28100X*

Aeronautical Research Council (Gt. Brit.)
SOME ACTUATOR-DISC THEORIES FOR THE FLOW OF AIR THROUGH AN AXIAL TURBO-MACHINE. J. H. Horlock, University of Cambridge. 1958. 31p. diagrs., tab. ARC R & M 3030. Supersedes ARC 15,491; EA 271. (Ask for N-28100X*)

Using actuator-disk theory, simplified methods are given for the solution of the direct problem of the incompressible flow of air through an axial-flow turbomachine. Calculations based on these methods are compared with other approximate solutions to the flow through a model compressor stage.

N-38868X*

Aeronautical Research Council (Gt. Brit.)
LOW-SPEED-TUNNEL MODEL TESTS ON THE FLOW STRUCTURE BEHIND A DELTA-WING AIRCRAFT AND A 40 DEG SWEPT-WING AIRCRAFT AT HIGH INCIDENCES. D. A. Kirby and A. Spence. 1958. 18p. diagrs., tabs. ARC R & M 3078; ARC 17,946. Supersedes RAE Tech. Note Aero 2361. (Ask for N-38868X*)

In view of the possibility of trimming some swept-wing aircraft at incidences above the stall, there has been a desire to visualize the whole pattern of vortex sheets and separated flow starting from the stalling wing, and to follow it back beyond the tail plane. To supplement other methods a swiveling head has been used giving the velocity, pitch, and yaw, and results are given for a 48° delta (Javelin) and a 40° swept-wing aircraft (Swift without fences). Results have also been analyzed to show the effect of tail height.

BRITISH REPORTS

N-40041X*

Aeronautical Research Council (Gt. Brit.)
A COMPARISON OF THE MEASURED AND PREDICTED FLUTTER CHARACTERISTICS OF A SERIES OF DELTA WINGS OF DIFFERENT ASPECT RATIOS. H. Hall and E. W. Chapple. 1958. 8p. diagrs., photos., tab. ARC R & M 3071; ARC 18,206. Supersedes RAE Report Structures 180. (Ask for N-40041X*)

This report gives the results of tests to investigate the aerodynamic effects of aspect ratio on the flutter of delta wings that are virtually rigid but are flexibly supported at the root. A function representing the aerodynamic effects of aspect ratio on wing flutter speeds is derived from the experiments. Flutter calculations are made using this function as a correction to the derivatives obtained from two-dimensional theory, and there is good agreement between measured and calculated results. Calculations are also made using derivatives obtained from three-dimensional theory, but the agreement between measured and calculated results is poor.

N-44951X*

Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF WING TORSION ON AILERON-TAB FLUTTER. H. Hall. 1958. 19p. diagrs., tab. ARC R & M 3072; ARC 18,724. Supersedes RAE Report Structures 203. (Ask for N-44951X*)

This paper gives the results of an investigation into the effects of wing torsion in a ternary-type spring-tab flutter. The results presented are for a series of calculations on an idealized system having degrees of freedom in wing pitch, rotation of the control surface, and rotation of the tab; the pitching degree of freedom is spring restrained and is intended to represent wing torsion. The tab is restrained as a trim tab or pure aerodynamic servotab, but the results are expected to apply qualitatively to a spring tab. A comparison is made between these results and those of earlier investigations into a similar problem by Wittmeyer and Wittmeyer and Templeton, where the main surface mode considered was one of vertical translation to represent wing bending.

N-46414X*

Aeronautical Research Council (Gt. Brit.)
CALCULATION OF THE SHAPE OF A THIN SLENDER WING FOR A GIVEN LOAD DISTRIBUTION AND PLANFORM. J. H. B. Smith. 1958. 22p. diagrs. ARC CP 385. (Ask for N-46414X*)

The problem considered is that of finding the camber and twist for a swept wing of specified slender plan form which will produce the same chordwise lift distribution at each spanwise station as in two-dimensional flow past a flat plate, in conjunction with a uniform distribution of chord loading. Linearized inviscid potential flow theory is used and the results are valid only if $A^2 \mid 1 - M^2 \mid \ll 1$.

N-46611X*

Aeronautical Research Council (Gt. Brit.)
THE SAMPLING ERRORS OF ATMOSPHERIC TURBULENCE MEASUREMENTS. N. I. Bullen. 1958. 14p. diagrs., tabs. ARC R & M 3063; ARC 18,764. Supersedes RAE Report Structures 208. (Ask for N-46611X*)

Estimates of atmospheric turbulence from counting accelerometer records show a large scatter. The simple assumption of a random distribution of gusts is inconsistent with this scatter. A formula which takes account of the variations in gust density is given and the calculated sampling errors for 10 ft/sec gusts are found to be about four times those calculated on the basis of a random distribution.

N-47024X*

Aeronautical Research Council (Gt. Brit.)
SUPERSONIC BANGS. PART II. P. Sambasiva Rao. September 12, 1955. 22p. diagrs. ARC 17,842; FM 2295. (Ask for N-47024X*)

The nonlinear theory of supersonic bangs, obtained in part I for a body accelerating along a straight path, is extended to include curved paths. The basic theory remains the same. The important parameter, which appears in the theory, is the acceleration component along the ray, the rays being lines drawn from points on the flight path at an angle $\cos^{-1}(1/M)$ with the direction of motion. It is found that the only essential effect of the curvature of the path is in the modification of this acceleration component to include a term due to the transverse acceleration. With this modification the main results are formally the same as in part I. Finally, the theory is compared and contrasted with the recent work by Warren.

N-48160X*

Aeronautical Research Council (Gt. Brit.)
REGULARITIES IN CREEP AND HOT-FATIGUE DATA. PART I. A. Graham and K. F. A. Walles. 1958. 25p. diagrs., tabs. ARC CP 379. (Ask for N-48160X*)

Published experimental results are assembled to support a previously given theory of uniaxial deformation, and the theory is then used to analyze published data on the creep rupture and hot fatigue of engineering materials. The theory enables data for different times and temperatures to be classed together, thereby providing information over a much greater range of times than could practicably be covered by experiments at a single temperature. An underlying numerical pattern common to all the widely different Group VIII materials considered then shows through the experimental scatter.

BRITISH REPORTS

N-48178X*

Aeronautical Research Council (Gt. Brit.)
REGULARITIES IN CREEP AND HOT FATIGUE DATA. PART II. K. F. A. Walles and A. Graham. 1958. 141p. diagrs., tabs. ARC CP 380. (Ask for N-48178X*)

A previously given theory, which was extended in part I, suggests that (for a single form of loading) strain ϵ is related to stress σ, time t, and temperature T by a sum of terms of the form $C\sigma^{\beta}\emptyset^{\kappa}$ where $\emptyset = t(T' - T)^{-A}$ that the constant A is the same for all terms and a range of materials, and that the ratios β/κ take values from the sequence 2^n. In the present part II, the theory is compared with 103 sets of published creep rupture, creep rate, and hot-fatigue data relating mainly to alloys of the Fe, Ni, Cr, Co system of 44 different compositions. The results of all analyses are given in detail in the figures and tables. A statistical assessment of the extent of agreement of the theory with the data is given with reference to the number of free constants used.

N-48943X*

Aeronautical Research Council (Gt. Brit.)
THE WAVE DRAG OF NON-LIFTING COMBINATIONS OF THIN WINGS AND "NON-SLENDER" BODIES. L. M. Sheppard. 1958. 17p. diagrs. ARC R & M 3076; ARC 19,319. Supersedes RAE Tech. Note Aero 2496. (Ask for N-48943X*)

The methods of wave-drag estimation known as the area rule and transfer rule are restricted to non-lifting combinations of thin wings and slender bodies. The Lomax-Heaslet multipole method is applicable to configurations with "nonslender" fuselages, represented by an axial distribution of multipoles. However, it is not entirely satisfactory and an alternative multipole method is presented here. This is based upon the assumption, fundamental to the area rule and the transfer rule, that the effect on the wave drag of the interference velocity potential, due to the interaction between the exposed wing and the fuselage, is negligible. An investigation of the validity of this fundamental assumption based on existing theoretical and experimental results is given.

N-50134X*

Aeronautical Research Council (Gt. Brit.)
THE GEOMETRY OF WING SURFACES GENERATED BY STRAIGHT LINES AND WITH A HIGH RATE OF THICKNESS TAPER AT THE ROOT. D. Peckham. 1958. 17p. diagrs. ARC CP 383. (Ask for N-50134X*)

This note describes a way in which wings can be designed to have a high rate of thickness taper at the root, while still maintaining a surface shape generated by straight lines. The method can be most successfully applied to wings of parabolic arc section straight-tapered in plan form, in which case there is no change in airfoil section shape across the span. Other plan-form shapes, and wing-root airfoil section shapes, result in a variation of airfoil section shape across the span.

CN-57407X*

Aeronautical Research Council (Gt. Brit.)
THE CALIBRATION AT TRANSONIC SPEEDS OF A MK. 9A PITOT STATIC HEAD WITH AND WITHOUT FLOW THROUGH THE STATIC SLOTS. D. G. Mabey. 1958. 27p. diagrs., tab. ARC CP 384. (Ask for CN-57407X*)

The static pressure error of a standard Mark 9A pitot static head at transonic speeds has been measured in the R.A.E. (Bedford) 3-foot tunnel. The static error may be reduced slightly by sealing the drain hole. The effects of both flow through the drain hole and rate of altitude change were simulated and for a typical aircraft system the static error corresponding with a high rate of descent was found to be small.

N-58521X*

Aeronautical Research Council (Gt. Brit.)
TABLES OF AERODYNAMIC FLUTTER DERIVATIVES FOR THIN WINGS AND CONTROL SURFACES IN TWO DIMENSIONAL SUPERSONIC FLOW. I. T. Minhinnick and D. L. Woodcock. 1958. 44p. diagrs., tabs. ARC CP 382. (Ask for N-58521X*)

This report gives tables of the two-dimensional supersonic flutter derivatives for infinitesimally thin airfoils. Most of the values given are based on the published work of several authors but some have been specially calculated for this report. Only the derivatives giving the forces on wings and control surfaces due to wing motion are tabulated but it is shown how the remaining derivatives can be very easily obtained from those tabulated. The values tabulated are for control surface/wing chord ratios of 0(0.1), 0.6, and 1.0; for Mach numbers (M) given by $\lambda (= 1/M) = 0.3$ (0.1) 0.8, and for at least 11 values of the frequency parameter between 0 and 1.5.

N-60873*

Aeronautical Research Council (Gt. Brit.)
ACOUSTIC EFFECTS IN THE VIBRATIONS OF STRUCTURES. J. Foxwell and R. E. Franklin. August 29, 1957. 10p. diagrs. ARC 19,495; LA 41. (Ask for N-60873*)

It is shown that the response of a simple system can be considerably modified by the effects of an enclosed volume of air. The effects appearing in the simple one-dimensional model chosen do in fact appear in the case of a cylinder and this case will be dealt with in another paper. Broadly speaking it can be said that the effects are such that expected resonances may not occur and unexpected ones may be of significance. It is emphasized that no account is taken of structural damping; it is probable that although its effects may modify the amplitude of the resonances, the general characteristics of the problem will remain.

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N-60874*

Aeronautical Research Council (Gt. Brit.)
THE GENERATION OF SECONDARY VORTICITY IN THE FLOW OVER A HEMISPHERE DUE TO DENSITY GRADIENT AND SHEAR. W. R. Hawthorne and Moira E. Martin, University of Cambridge. May 26, 1955. 20p. diagrs., photos. ARC 17,654; FM 2257. (Ask for N-60874*)

When an inviscid fluid with a slight vertical variation of stagnation pressure and density flows over an obstacle lying on a horizontal plane a vorticity component in the direction of flow appears. An expression for this secondary vorticity is obtained on the assumption that the velocity and density gradients and gravitational effects are small enough for the flow to be regarded as a small perturbation of the potential flow about the obstacle. The obstacle is a hemisphere with its flat surface on the plane. It is, for instance, a hemispherical rock or hill standing in flat surroundings.

N-60875*

Aeronautical Research Council (Gt. Brit.)
ON HYDRODYNAMIC STABILITY IN UNLIMITED FIELDS OF VISCOUS FLOW. N. Curle, National Physical Laboratory. May 26, 1955. 16p. diagr., tab. ARC 17,653; FM 2256. (Ask for N-60875*)

The Orr-Sommerfeld equation is used to consider the stability of two-dimensional parallel flows. The analysis leads quite generally to a curve of neutral stability predicting a least critical Reynolds number. Application is made to a plane laminar jet, for which instability is shown to occur at a very low Reynolds number consistent with experiment.

N-60877*

Aeronautical Research Council (Gt. Brit.)
A NOTE ON THE VORTICITY DISTRIBUTION ON THE SURFACE AND IN THE WAKE OF SLENDER DELTA WINGS WITH LEADING EDGE SEPARATION. B. J. Elle. January 9, 1958. 19p. diagrs., photos. ARC 19,779; FM 2628; Perf. 1620. (Ask for N-60877*)

A description is given of the distribution of vorticity in the surface and in the wake of thin wings with high leading-edge sweep. The description, which is largely qualitative, is restricted to cases where spiral leading-edge vortex sheets occur. Although the delta wing is chosen as the basic plan form, the deductions are general and applicable to other types of wing. The conclusions are illustrated with experimental evidence from a water tunnel.

N-60878*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE EXTENSION OF EVVARD'S METHOD TO WINGS WITH "SUBSONIC" LEADING EDGES MOVING AT SUPERSONIC SPEEDS. G. J. Hancock, Queen Mary College. June 29, 1955. 25p. diagrs. ARC 17,716; FM 2268. (Ask for N-60878*)

Evvard's technique is applied to the problem of a thin finite wing moving at a supersonic speed when the leading edge is "subsonic" and is developed in two methods. The first method is one in which the relationship between the pressure loading and the integrals of the downwash over the wing surface is extended as far as possible and which has to be computed numerically. The other method is one in which approximations are made for the upwash fields in the neighborhood of the leading edge, leading to a series of standard integrals for the estimation of the pressure loading. The second method is applied to the pressure loading on a flat plate triangular wing and cropped delta wing, and the application to more general shapes is discussed.

N-60880*

Aeronautical Research Council (Gt. Brit.)
ON THE THEORY OF SOURCE-FLOW FROM AEROFOILS. L. C. Woods, University of Sydney, Australia. July 22, 1955. 17p. diagrs. ARC 17,766; FM 2280. (Ask for N-60880*)

An exact theoretical treatment of the influence of sources of fluid on and within two-dimensional airfoils is developed. In the case of a source placed within an airfoil the fluid is ejected through a duct, the shape of which is taken into account in the theory. The theory is given for incompressible flow but it could be extended to deal with linearized subsonic compressible flow. Formulas for the thrust, lift, and moment are derived from Blasius' theorem. The case of the "directed" source receives attention, and the influence of the angle of ejection is determined.

N-60884*

Royal Aircraft Establishment (Gt. Brit.)
AN INVESTIGATION OF THE EFFECTS OF THICKNESS, CAMBER AND NOSE RADIUS ON THE PERFORMANCE OF JET-FLAPPED AEROFOILS. J. A. Beasley. October 1957. 18p. diagrs., tab. RAE Tech. Note Aero 2534. (Ask for N-60884*)

Pressure distributions are calculated by Küchemann's method for six airfoils with jets blowing over deflected trailing-edge flaps. Some inaccuracy has been incurred by making approximations in the calculation but it has been possible to study qualitatively the efficacy of thickness, camber, and nose radius in preventing flow separation near the nose. The conclusions could thus be used to select airfoils suitable for use with jet flaps. The effects of jet deflection angle and of incidence are also discussed.

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N-60889*

Aeronautical Research Council (Gt. Brit.)
THE ABSOLUTE MEASUREMENT OF RATE OF FLOW OF LARGE QUANTITIES OF GAS. W. F. Cope, National Physical Laboratory. June 20, 1955. 4p. ARC 17,691; EA 415; FM 2421.
(Ask for N-60889*)

The accuracy of measurement of flow rates (from ±1 percent) for large quantities of gas has not changed for 40 years. The principal causes of error are temperature inequalities and velocity measurements in turbulence. An investigation with modern techniques seems not to exist and is overdue.

N-60892*

Royal Aircraft Establishment (Gt. Brit.)
IMPORTANCE OF SHAPE OF STRINGER SECTION IN PRESSURE-CABIN DESIGN. D. Williams. March 1958. 7p. RAE Tech.Note Structures 234.
(Ask for N-60892*)

It is shown that the effectiveness of the stringers in restricting the radial expansion of the cabin skin between frames depends upon the shape of the stringer cross section. Stringer sections in which the inward radial pull of the frames is offset from the shear center of the stringer section twist under the pull, so that the amount of stringer bending stiffness brought into action may well be only one-thousandth part of the potential stiffness. Channel, angle, and L sections in which the web and flanges of the l are at right angles, come under this category. Top-hat sections function admirably in this respect.

N-61282*

National Gas Turbine Establishment (Gt. Brit.)
FACTORS GOVERNING THE IGNITION DELAY OF GASEOUS FUELS. R. E. Miller. March 1958. 37p. diagrs., photo., tab. NGTE Report R.216.
(Ask for N-61282*)

The variation of ignition delay with temperature in a new laboratory apparatus has been investigated. In addition to temperature the concentrations of fuel (calor gas), oxygen, and steam have been varied and their effects measured. The effect of scale has been shown to be negligible by comparison with Mullins' data for calor gas in a 6-inch duct. The results have been compared with those found by other workers and found to differ considerably from those reported at NACA. A reason for this difference is suggested. Various views on the nature of spontaneous ignition are considered and it is found that all the observed facts can be explained in terms of a second-order kinetic law. It is pointed out that a reaction rate equation based on a detailed kinetic mechanism reduces to the simple second-order equation in certain cases.

N-61284*

Royal Aircraft Establishment (Gt. Brit.)
A STUDY OF FATIGUE CRACK FORMATION IN SILVER CHLORIDE. P. J. E. Forsyth. November 1957. 19p. diagrs. RAE Tech.Note Met.276.
(Ask for N-61284*)

Silver chloride specimens have been fatigued in reverse plane bending in order to observe the formation of defects and the propagation of cracks. The photolytic effect in this material has been utilized to reveal dislocations associated with the fatigue deformation. Observations have also been made on the slipband extrusion and intrusion and a possible model for the phenomena is discussed.

N-61285*

Royal Aircraft Establishment (Gt. Brit.)
SOME EXPERIMENTS ON THE SHEARING OF FINE METAL FOILS AT VERY HIGH SPEEDS. B. J. Brinkworth. December 1957. 21p. diagrs., photos. RAE Tech.Note Mech.Eng.250. (Ask for N-61285*)

Exploratory tests are described in which the work done in shearing fine aluminum and copper foils was measured at cutting speeds up to 120 ft per sec. The results indicate an increase in energy to fracture with increasing speed up to a point at which thermal softening is believed to predominate. Subsequently, the energy curve declines. Both the materials tested exhibit a marked size effect. From the results obtained and an examination of related work, hypothetical relations are put forward showing the anticipated variation of fracture energy over a wide range of speed.

N-61290*

Aeroplane and Armament Experimental Establishment (Gt. Brit.). A REDUCTION METHOD FOR THE FORWARD TAKE-OFF OF A SINGLE ROTOR HELICOPTER. M. C. Neale. December 20, 1957. 20p. diagrs. AAEE/Res/297. (Ask for N-61290*)

A method is given for reducing observed helicopter take-off performance measurements to standard conditions and for estimating the effect of changes in wind speed, engine power, all up weight, and climb speed. The correction for wind changes is obtained from a consideration of the relative air velocities during the different stages of take-off. By the use of charts, changes in the other variables are related to changes in the value of the thrust/weight ratio which are used with further charts to determine the corrected flight path.

N-61401*

Royal Aircraft Establishment (Gt. Brit.)
"WING FLOW" TESTS ON A CONRAD YAWMETER AT TRANSONIC SPEEDS. R. Rose. February 1958. 6p. diagrs. RAE Tech.Note Aero.2550.
(Ask for N-61401*)

This note describes some tests made on a Conrad differential pressure yawmeter at transonic speeds using the "wing-flow" technique. The differential

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pressure coefficient is linear with incidence up to at least 9°. The variation of sensitivity $\left(\text{defined as } \frac{\partial C_p}{\partial \beta}\right)$ with Mach number is small up to M = 1.10.

N-61402*

Aeronautical Research Council (Gt. Brit.)
UNSTEADY VISCOUS FLOW PAST A CIRCULAR CYLINDER. R. B. Payne, University of Manchester. November 26, 1957. 7p. diagrs. ARC 19,694; FM 2618. (Ask for N-61402*)

A numerical solution has been obtained for the starting flow of a viscous fluid past a circular cylinder at Reynolds numbers 40 and 100. The method used is the step-by-step forward integration in time of Helmholtz's vorticity equation. The advantage of working with the vorticity is that calculations can be confined to the region of nonzero vorticity near the cylinder. Besides the general features of the flow, including the formation of the eddies attached to the rear of the cylinder, the drag has been calculated. At R = 40 the drag on the cylinder decreases with time to a value very near that for the steady flow.

N-61403*

Aeronautical Research Council (Gt. Brit.)
DEPARTURE FROM DISSOCIATION EQUILIBRIUM IN A HYPERSONIC NOZZLE. K. N. C. Bray, University of Southampton. March 17, 1958. 30p. diagrs., tabs. ARC 19,983; FM 2656; EA 622, CF 433; TP 571. (Ask for N-61403*)

The flow of an ideal dissociating gas through a nearly conical nozzle has been examined. The results suggest that deviations from dissociation equilibrium will occur over a wide range of conditions and that lack of equilibrium may be expected in the working sections of hypersonic wind tunnels and shock tubes. Although the flow behind a normal shock wave in such a wind tunnel will not be greatly affected by it, the stand-off distance in front of a blunt model may be quite sensitive to deviations from equilibrium.

N-61408*

Aeronautical Research Council (Gt. Brit.)
THE THEORY OF DESIGN. H. L. Cox. (Reprint of lecture given at Mechanical Engineering Research Laboratory on April 26, 1957.) January 13, 1958. 19p. diagrs., photo. ARC 19,791; Strut. 2037. (Ask for N-61408*)

The topics discussed are: The first thing about design - Clerk Maxwell's lemma. The general theory of design - its limitation and its scope. State of pure dilation. Shell structures. The symmetrical three-load problem. A single central load on two fixed supports. A single central load supported on rollers. The stiffness of layouts. Classes of loading systems. Alternative loading.

N-61409*

Aeronautical Research Council (Gt. Brit.)
STRUCTURES OF MINIMUM WEIGHT: THE BASIC THEORY OF DESIGN APPLIED TO THE BEAM UNDER PURE BENDING. H. L. Cox. January 10, 1958. 9p. diagrs. ARC 19,785; Strut. 2036. (Ask for N-61409*)

At each end of the beam of length $2l$ the moment M is applied by means of a pair of concentrated loads $\pm M/2d$ acting in parallel lines 2d apart. It is first demonstrated that if $l/d > 4$ the optimum structure is appreciably lighter than a straight beam of constant depth 2d, and by synthesis of elementary substructures it is then shown that when $l/d > 20$ the optimum structure must weigh less than half the straight beam. By application of the basic theory of design due to Clerk Maxwell and A. G. M. Michell what is thought to be the true optimum structures is found and compared with a practical 14-bar framework. For values of $l/d > 10$ at least 35 percent of the weight of a parallel beam is unnecessary. A thin wing should not be continued as a parallel beam through the fuselage.

N-61410*

National Gas Turbine Establishment (Gt. Brit.)
A RESIDUAL FUEL COMBUSTION SYSTEM WITH SPRAY SEPARATION. J. A. Gardiner. April 1958. 28p. diagrs., photos. NGTE Memo. M. 303. (Ask for N-61410*)

The carbon/ash ratio control method of reducing fouling and corrosion associated with residual fuel oil in gas turbines is outlined. A special primary zone unit proves to be necessary for an adequate degree of control. This memorandum summarizes the development and performance of such a unit. This unit was proposed as the flame stabilizer of a balanced vortex combustion system, but the results suggest that it can be used in a "straight-through" arrangement. Test requirements throughout this work have been defined by reference to the Ruston and Hornsby T.A. gas turbine which is used at NGTE for research trials in the use of residual fuel oils.

N-61411*

Royal Aircraft Establishment (Gt. Brit.)
SOME CREEP AND TENSILE PROPERTIES OF A CORROSION RESISTING STEEL TO BRITISH STANDARDS SPECIFICATION S. 80, AT 22° C, 250° C, 400° C, AND 550° C. R. A. Whittaker. December 1957. 17p. diagrs. RAE Tech. Note Met. 280. (Ask for N-61411*)

Constant-load tensile creep tests and short-term tensile tests have been made on a hardened and tempered corrosion-resisting steel to B.S.S. S.80, at room temperature (22° C), 250° C, 400° C, and 550° C. At 22° C and 250° C the creep curves indicate a rapid increase in strain followed by a relatively small creep rate. The effect of applying 0.1 percent prestrain at room temperature prior to creep testing at 250° C is to reduce the amount of strain on loading by approximately 60 percent. The shape of the creep curves at 22° C and 250° C precludes the more usual

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types of assessment of properties but for comparative purposes table IV showing increase of strain with time is included. At 400° C and 550° C more "normal" types of creep curves have made possible a limited amount of engineering data.

CN-61541*

Royal Aircraft Establishment (Gt. Brit.)
QUADRATIC INTERPOLATION IN TAPPED-POTENTIOMETER-TYPE FUNCTION GENERATORS (WITH AN INTRODUCTORY SURVEY OF FUNCTION GENERATION). E. M. Deeley. December 1957. 34p. diagrs. RAE Tech. Note MS 43.
(Ask for CN-61541*)

A method is described for improving the accuracy of tapped-potentiometer function generators by using a form of quadratic interpolation. The possible extension of this method to generators of functions of two variables is discussed. A brief survey of methods of function generation is included.

N-61542*

Aeroplane and Armament Experimental Establishment (Gt. Brit.). SOME EXPERIMENTS WITH A MODEL JET FLAP IN A CENTRIFUGAL FIELD. D. A. Wilkinson. March 20, 1958. 14p. diagrs., photos. AAEE/Res/296. (Ask for N-61542*)

The possible application of the jet-flap principle to helicopter rotors has aroused interest as to the influence of a centrifugal field on the phenomenon, particularly with regard to any reduced effectiveness resulting, for example, from distortion or rupture of the jet sheet. Brief tests have been made with a model jet flap to determine any marked change between the lift characteristics measured in a wind tunnel and those measured on a whirling arm up to 15 "g." At constant thrust coefficient, a decrease of lift coefficient with increased spanwise acceleration was noted, the rate of decrease being approximately zero at 15 "g." A description is given of the balance used to measure the lift forces on the model while being whirled.

N-61543*

Aeronautical Research Council (Gt. Brit.)
NOTE ON SOLUTIONS OF THE NAVIER-STOKES EQUATIONS AT VERY LOW REYNOLDS NUMBERS. C. J. Apelt. March 18, 1958. 9p. ARC 19,998; FM 2659. (Ask for N-61543*)

The assumptions which are made in obtaining solutions for the Navier-Stokes equations for the steady motion in two dimensions of an incompressible viscous fluid at low Reynolds numbers are discussed. Two different approaches to the problem are distinguished and it is shown that, though these approaches take their point of departure from apparently similar physical considerations, they are in fact different mathematically and give rise to solutions which are in general different. Some paradoxical results arising therefrom are pointed out and are subsequently resolved.

N-61544*

Aeroplane and Armament Experimental Establishment (Gt. Brit.). A METHOD OF CALCULATING THE EFFECT OF ONE HELICOPTER ROTOR UPON ANOTHER. I. C. Cheeseman. April 15, 1958. 16p. diagrs. AAEE/Res/298. (Ask for N-61544*)

A model of the induced flow around a lifting rotor is derived by considering a lifting-line approximation to translational lift and a stream-tube model for propeller lift. This theory is applied to a tandem rotor configuration in rectilinear flight. It is shown that the values derived are in good agreement with the available experimental results, which relate the case of no gap or stagger. In this special case the stream-tube effect is negligible and only the lifting-line approximation is used.

N-61545*

Aeronautical Research Council (Gt. Brit.)
WIND TUNNEL EXPERIMENTS ON A MODEL OF A TANDEM ROTOR HELICOPTER. A. S. Halliday and D. K. Cox. January 10, 1958. 79p. diagrs., photos., tabs. ARC 19,829; H. 342. (Ask for N-61545*)

The main feature of the research was to be the investigation of mutual interference; the front rotor was to be fixed in position relative to the body while the rear one could be varied in height as well as distance from the front one. The angle of the axis of the rear rotor could also be varied in a fore and aft direction.

N-61546*

Royal Aircraft Establishment (Gt. Brit.)
THE CALCULATION OF LIFT SLOPES, ALLOWING FOR BOUNDARY LAYER, WITH APPLICATIONS TO THE R.A.E. 101 AND 104 AEROFOILS. D. A. Spence and J. A. Beasley. February 1958. 28p. diagrs., tab. RAE Report Aero 2598.
(Ask for N-61546*)

The need to know two-dimensional low-speed characteristics accurately in designing sweptback wings for transonic aircraft has led to a revival of interest in calculations of the loss of lift below the ideal flow value caused by the boundary layer. The existing methods for performing this calculation have now been reduced to a straightforward routine. This is sufficiently sensitive for coefficients to be evaluated at rather small incidences, for example, $\alpha = 2^{\circ}$, for which the boundary-layer part of the calculation is tractable; from these results the lift at higher incidences may be estimated. The method has been applied to RAE 101 and 104 sections of 6, 10, and 15 percent thickness at $R = 10^6$, 10^7, and 10^8 with a wide range of transition positions.

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N-61547*

Royal Aircraft Establishment (Gt. Brit.)
ON THE EXTRACTION OF STABILITY DERIVATIVES FROM FULL SCALE FLIGHT DATA. J. K. Zbrozek. April 1958. 29p. diagrs. RAE Tech.Note Aero 2559. (Ask for N-61547*)

The information obtained from longitudinal response measurement is insufficient to evaluate the three basic derivatives: m_w, m_q, and $m_{\dot{w}}$; only lift slope can be obtained. The values of m_w and m_q can be obtained from trim curves of η versus C_L for rectilinear and curvilinear flights. This limits the measurements of these derivatives to zero frequency, but it is believed this is only a minor disadvantage. Theoretically the basic seven lateral derivatives can be obtained from the measured transient responses to control inputs. With an additional effort the control derivatives can be evaluated also. Due to limited accuracy of flight measurements the extraction of l_r, and especially n_p, is extremely difficult. The problem of recording aircraft responses with sufficient accuracy is briefly discussed with the unpleasant conclusion that the basic instruments (gyro, accelerometer, yawmeter) at present available, are far below the standard required for dynamic measurements of stability of present and future aircraft.

N-61548*

Aeronautical Research Council (Gt. Brit.)
DOWNWASH TABLES FOR THE CALCULATION OF AERODYNAMIC FORCES ON OSCILLATING WINGS. Tables prepared at the National Physical Laboratory for the Aerodynamics Division by the Mathematics Division. 1958. 174p. tabs. ARC R & M 2956; NPL Aero 229. (Ask for N-61548*)

MISCELLANEOUS

Errata on NACA Rept. 1325, by Moore and Ostrach. 1957.

Revisions 2, 3, and 4 to Advisory Group for Aeronautical Research and Development Flight Test Manual.

CN-56538X

Advisory Group for Aeronautical Research and Development. INORGANIC TRANSPARENCIES FOR AIRCRAFT ENCLOSURES. C. H. Hahner and M. J. Kerper, National Bureau of Standards. (Presented at 6th meeting of AGARD Structures and Materials Panel, November 4-8, 1957, Paris.) November 1957. iv, 23p. diagrs., tabs. AGARD Report 161. (Ask for CN-56538X)

This paper is a review of the available information on glass and a report on work now being done under the sponsorship of WADC to obtain additional information on a few selected glasses that are believed to be most suitable for use in aircraft. The glasses for study are ones that can be made in the form of polished plate glass of the required sizes.

N-60354X

Advisory Group for Aeronautical Research and Development. THE AIRCRAFT STRUCTURAL FACTOR OF SAFETY. George N. Mangurian, Northrop Aircraft, Inc. (Presented at 6th meeting of AGARD Structures and Materials Panel, November 4-8, 1957, Paris.) November 1957. vi, 24p. diagrs., tabs. AGARD Report 154. (Ask for N-60354X)

Presents the case for a review of the Aircraft Structural Factor of Safety in the light of appreciable advancements in structural and aerodynamic knowledge. In certain design aspects, a reduction in the presently required ultimate factor of safety is realistic and should be considered; in other aspects, a reduction should not be considered at present.

CN-61705

Advisory Group for Aeronautical Research and Development. GENERAL REFLECTIONS ON THE SAFETY OF MATERIALS AND STRUCTURES. (Reflexions generales sur la securite des materiaux et des structures.) E. Marcel Prot. (Presented at 6th meeting of AGARD Structures and Materials Panel, Paris, November 4-8, 1957.) November 1957. iv, 11p. (French text.) AGARD Report 151. (Ask for CN-61705)

The notion of safety gets clearer when the notions of frequency and probability are taken into account and when the nature of the accidents, the risks of which one intends to reduce, and the importance of their consequences are considered. A safety coefficient can adequately be selected only through the striking of a balance which takes into account the various

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economic factors varying with this coefficient. The selection of a material and the design of a structure can only be effected after tests so numerous as to allow the assessment of the risks of damage of the structure considered. A test assumes value only if it can be summarized by the mean value x_n and the mean quadratic divergence y_n of the results obtained from a given number of tests. These figures allow calculation of mean value x and of mean quadratic divergence y of the overall material concerned.

UNPUBLISHED PAPERS

N-61572*

Metallurgical Research Laboratories, Syracuse University Research Institute. TENSION, COMPRESSION AND FATIGUE TESTS OF SEVERAL ALLOYS TO DETERMINE THEIR SUITABILITY AS BEARING MATERIALS. R. J. Sell and G. Sachs. Interim Technical Report prepared for NACA under NACA Contract NAw-6481. February 1957. 29p. diagrs., tabs. Metallurgical Research Labs., Syracuse U. Research Inst. MET415-572T. (Ask for N-61572*)

A major portion of the work has been devoted to the development of testing procedures for tension, compression, and fatigue tests at both room and elevated temperatures. Reliable test data for these extremely hard materials are very scarce. It is known that the results obtained on testing such alloys by conventional methods may be greatly affected by eccentricity, but apparently little attention has been paid to the critical evaluation and to the development of sufficiently accurate and consistent test procedures. The test data reported relate only to conventional melt 52100 steel.

N-61573*

Metallurgical Research Laboratories, Syracuse University Research Institute. TENSION, COMPRESSION AND FATIGUE TESTS ON SEVERAL TOOL STEELS TO DETERMINE THEIR SUITABILITY AS ROLLER CONTACT BEARING MATERIALS. A. T. Viggiano, R. J. Sell, and G. Sachs. Prepared for NACA on NACA Contract NAw-6481. August 1957. 103p. diagrs., photo., tabs. Metallurgical Research Labs., Syracuse U. Research Inst. Interim Tech. Rept. 2; MET415-5710T2. (Ask for N-61573*)

This report includes laboratory tests performed on 52100 electric furnace melt, 52100 vacuum melt, and Halmo vacuum melt steels at five different hardness levels; namely, 50, 54, 58, 62, and 65 Rc. The tension and compression elastic limits on these tests were obtained by the use of SR-4 gages and cycle loading. Also strain gages, an extensometer, and a dial indicator were used to obtain tensile and compressive strength data. For the performance of the tension and compression tests, special concentric fixtures were designed and built to keep the eccentricity factor as small as possible at room and elevated temperatures. Endurance limits at room temperature were obtained by the use of R. R. Moore type fatigue machines, adapted also for elevated temperature testing. In addition, Jominy hardenability tests were completed on two of the three materials.

N-61602*

Southwest Research Institute. MATERIALS TESTING PROGRAM FOR PILOT MODEL OF HIGH THERMAL FLUX UNIT. F. C. Todd. Summary report prepared for NACA on NACA Contract NAw-6513. February 14, 1958. 39p. diagrs., photos. Southwest Research Inst. (Ask for N-61602*)

The objective of this research program was to construct a pilot model of equipment for the high-temperature testing of materials in which a thermal flux of the order of 4000 to 5000 BTU per ft^2-sec was to be obtained. An electric arc was to be the source of the thermal flux. This report includes: the stability, maintenance, and expected life of the power supply; possible error from oxidation of the front surface of the copper disk during measurement of the radiant flux density; calculation of the efficiency of the mirror system; techniques for discharging air through the arc and from the furnace and its effect on the arc; explanation of flame suppression by the air blast in the "blown" arc; and irradiation of several materials.

N-61603*

University of North Carolina. CALCULATION OF THE ENERGIES OF TRIATOMIC HYDROGEN USING A MODIFIED ROOTHAAN PROCEDURE. Willard Edward Meador, Jr. (Thesis submitted to the Faculty of North Caroline U. in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Physics. Prepared for NACA on NACA Contract NAw-6469.) 1957. 84p. diagrs., tabs. North Carolina U. (Ask for N-61603*)

In the present paper potential energies for some linear, symmetric configurations of H_3 have been calculated using a modified Roothaan procedure with configuration interaction (CI) and including a variable shifting parameter. Calculations for two excited states are given and comparison of ground state energies with other work is made.

DECLASSIFIED NACA RESEARCH REPORTS

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#NACA RM 9D13, by NACA Subcommittee on Aircraft Fuels.

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DECLASSIFIED NACA RESEARCH REPORTS

#NACA RM A50C20, by Spahr and Robinson.

NACA RM A50I27

FLIGHT-DETERMINED BUFFET BOUNDARIES OF TEN AIRPLANES AND COMPARISONS WITH FIVE BUFFETING CRITERIA. Burnett L. Gadeberg and Howard L. Ziff. January 5, 1951. 44p. diagrs., photo., tab. (NACA RM A50I27)

The flight-determined buffet boundaries of eight straight-wing and two swept-wing airplanes are presented. Comparisons are made with five proposed buffeting criteria. The general conformity of the trend of the buffet boundaries with that of the criteria for seven of the eight straight-wing airplanes indicates that the wing was probably the primary cause of the buffeting. A reasonable estimate of the buffet boundary of a straight-wing airplane may be obtained from the buffet criteria discussed.

NACA RM A52C04

EXPERIMENTAL INVESTIGATION OF THE STATIC AERODYNAMIC AND DYNAMIC DAMPING-IN-ROLL CHARACTERISTICS OF AN 8-CM AIRCRAFT ROCKET WITH SOLID AND SLOTTED FINS. Robert S. Chubb. June 1952. ii, 43p. diagrs., photo. (NACA RM A52C04)

The static aerodynamic and dynamic damping-in-roll characteristics of an 8-cm aircraft rocket having cruciform fins of trapezoidal plan form were determined experimentally at various Mach numbers ranging from 0.6 to 1.9. The effects of two large elongated slots cut through the panels of each stabilizing fin were investigated by testing both solid- and slotted-fin configurations.

NACA RM A53F12

CORRELATION BY THE HYPERSONIC SIMILARITY RULE OF PRESSURE DISTRIBUTIONS AND WAVE DRAGS FOR MINIMUM-DRAG NOSE SHAPES AT ZERO ANGLE OF ATTACK. Leland H. Jorgensen. August 1953. 23p. diagrs. (NACA RM A53F12)

Second-order-theory pressure distributions and wave drags for Kármán and Newtonian minimum-drag nose shapes (theoretically optimized for given length and diameter) are correlated for values of the hypersonic similarity parameter from about 0.4 to 1.0. From the correlated data simple expressions for pressure distribution and wave drag are developed. The theoretical wave-drag expressions for the Kármán and Newtonian shapes are checked with available experimental data, and drag comparisons are made with theoretical results for cones and tangent ogives.

NACA RM A53F22

LIFT, DRAG, AND HINGE MOMENTS AT SUPERSONIC SPEEDS OF AN ALL-MOVABLE TRIANGULAR WING AND BODY COMBINATION. William C. Drake. September 1953. 38p. diagrs., photos., tabs. (NACA RM A53F22)

Lift, drag, and hinge-moment variations with angles of attack and deflection are presented at a Mach number of 1.46; also presented are hinge-moment data at M = 1.99. Comparison of the results with the predictions of theory showed satisfactory agreement at small angles of attack and small deflections. It was found that variations of Reynolds number and wing-body gap, and fixing transition on the body nose had little or no effect within the scope of the tests.

NACA RM A54E12

A FLIGHT INVESTIGATION AT TRANSONIC SPEEDS OF THE AERODYNAMIC CHARACTERISTICS OF A MODEL HAVING A THIN UNSWEPT WING OF ASPECT RATIO 3.1. Maurice D. White. August 1954. 41p. diagrs., photo., tabs. (NACA RM A54E12)

The longitudinal aerodynamic characteristics of a model having a low-aspect-ratio, thin unswept wing and a 45° swept horizontal tail mounted in the chord plane of the wing were investigated at transonic speeds by the free-falling recoverable-model technique. Static and dynamic stability data, and some load-distribution results are presented.

NACA RM A55F02a

ADDITIONAL MEASUREMENTS OF THE LOW-SPEED STATIC STABILITY OF A CONFIGURATION EMPLOYING THREE TRIANGULAR WING PANELS AND A BODY OF EQUAL LENGTH. Noel K. Delany. July 1955. 31p. diagrs. (NACA RM A55F02a)

The model investigated had three triangular airfoils of low aspect ratio, two forming wings and one a vertical fin, radially disposed about a central body which had the same length as the airfoils. Two vertical-fin sizes were investigated as well as the effect of varying the dihedral from 0° to -30° for a large range of angles of attack and sideslip. The damping in roll for 0° angles of attack and sideslip was also measured.

NACA RM A55F06

ADDITIONAL COMPARISONS BETWEEN COMPUTED AND MEASURED TRANSONIC DRAG-RISE COEFFICIENTS AT ZERO LIFT FOR WING-BODY-TAIL CONFIGURATIONS. George H. Holdaway. August 1955. 43p. diagrs., photo., tabs. (NACA RM A55F06)

Zero-lift wave-drag coefficients computed by the method of NACA RM A53H17 for three triangular wings of aspect ratio 2, 3, and 4, and for an airfoil section modification on a 45° sweptback wing are shown to be in reasonable agreement with measured values.

UNAVAILABLE; contains proprietary or obsolete information.

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NACA RM A55F21

A FLIGHT INVESTIGATION AT TRANSONIC SPEEDS OF A MODEL HAVING A TRIANGULAR WING OF ASPECT RATIO 2. Maurice D. White. September 1955. 39p. diagrs., photo., tabs. (NACA RM A55F21)

The longitudinal aerodynamic characteristics of a model having a triangular wing of aspect ratio 2 and a 45° sweptback horizontal tail located in the extended wing chord plane were investigated at transonic speeds by the free-falling recoverable-model technique. Static and dynamic longitudinal stability data, and force and moment data for the major components of the model are presented for Mach numbers from 0.8 to 1.1 and angles of attack up to about 25° to 30°, depending on the Mach number.

NACA RM A56F01

APPLICATION OF AREA SUCTION TO LEADING-EDGE AND TRAILING-EDGE FLAPS ON A 44° SWEPT-WING MODEL. Curt A. Holzhauser, Robert K. Martin, and V. Robert Page. September 1956. 66p. diagrs., photos., tabs. (NACA RM A56F01)

Lift, drag, and moment characteristics for a large-scale model with trailing-edge and leading-edge flaps were determined both with and without suction applied. Various chordwise extents of uniform and variable porosity were used in the tests and suction requirements are presented. Applying area suction to the trailing-edge flap increased the lift throughout the angle-of-attack range, and applying area suction to the leading-edge flap increased the maximum lift coefficient.

NACA RM E51F13

COMPARISON OF MEASURED EFFICIENCIES OF NINE TURBINE DESIGNS WITH EFFICIENCIES PREDICTED BY TWO EMPIRICAL METHODS. Robert E. English and Richard H. Cavicchi. August 1951. 23p. diagrs., tab. (NACA RM E51F13)

Empirical methods of Ainley and of Kochendorfer and Nettles were used to predict performances of nine turbine designs. Measured and predicted performances were compared. Appropriate values of blading-loss parameter were determined for the method of Kochendorfer and Nettles. The measured design-point efficiencies were lower than predicted by as much as 0.09 (Ainley) and 0.07 (Kochendorfer and Nettles). For the method of Kochendorfer and Nettles, appropriate values of blading-loss parameter ranged from 0.63 to 0.87 and the off-design performance was accurately predicted.

NACA RM E51F26

INVESTIGATION AT MACH NUMBER 1.91 OF SIDE AND BASE PRESSURE DISTRIBUTIONS OVER CONICAL BOATTAILS WITHOUT AND WITH JET FLOW ISSUING FROM BASE. Edgar M. Cortright, Jr., and Albert H. Schroeder. September 1951. 59p. diagrs., photos. (NACA RM E51F26)

Experimental side and base pressure distributions over a series of conical boattails without and with jet flow from the base are presented at a Mach number of 1.91. For the case of no jet flow, the methods of characteristics and linearized theory are shown to overpredict the side pressure drag. A semiempirical theory is presented to predict the effect of boattail angle on base pressure. With the boattail extending to a sharp edge at the nozzle exit, the overpressure jet is shown to decrease the side pressure drag. Presence of an annular base may eliminate the effect of the jet on the side pressure drag, but the jet effect on the base pressure drag may greatly increase or decrease the total boattail drag.

NACA RM E52B18

INVESTIGATION OF A 10-STAGE SUBSONIC AXIAL-FLOW RESEARCH COMPRESSOR. I - AERODYNAMIC DESIGN. Irving A. Johnsen. April 1952. 41p. diagrs., tabs. (NACA RM E52B18)

The aerodynamic design of a 10-stage axial-flow research compressor was based on the use of a symmetrical velocity diagram with constant total enthalpy at all radii. With the use of selected aerodynamic limitations, the design procedure established a design pressure ratio of 6.45 and an equivalent weight flow of 57.5 pounds per second at the design equivalent tip speed of 869 feet per second.

NACA RM E52C04

INVESTIGATION OF A 10-STAGE SUBSONIC AXIAL-FLOW RESEARCH COMPRESSOR. II - PRELIMINARY ANALYSIS OF OVER-ALL PERFORMANCE. Ray E. Budinger and Arthur R. Thomson. June 1952. 23p. diagrs., photos. (NACA RM E52C04)

An investigation of the overall performance of a 20-inch-tip-diameter 10-stage compressor was conducted as the initial step in an investigation of the problems encountered in an axial-flow compressor having a high pressure ratio per stage. The investigation was made over a range of weight flows at equivalent speeds from 30 to 110 percent of design speed. The compressor had a smooth surge line and a broad range of high part-speed efficiency. Maximum measured total-pressure ratio obtained at design speed was 7.52 at an equivalent weight flow of 53.7 pounds per second with an adiabatic efficiency of 0.81. Peak adiabatic efficiency of 0.84 was obtained at approximately 85 percent of design speed.

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#NACA RM E52D04, by Spooner.

NACA RM E52F02

TRANSONIC FREE-FLIGHT INVESTIGATION OF THE TOTAL DRAG AND OF THE COMPONENT DRAGS (COWL PRESSURE, ADDITIVE, BASE, FRICTION, AND INTERNAL) ENCOUNTERED BY A 16-INCH-DIAMETER RAM-JET ENGINE FOR MACH NUMBERS FROM 0.80 TO 1.43. Wesley E. Messing and Leonard Rabb. August 1952. 34p. diagrs., photos. (NACA RM E52F02)

The transonic drag of a 16-inch-diameter ram-jet engine operating under simulated combustion conditions was determined for a Mach number range from 0.80 to 1.43. The components of the overall drag, namely, the additive, cowl pressure, friction, base, and internal drag, were determined for mass-flow ratios from 0.66 to 0.84. The total drag determined from the summation of the component drags agreed with the total drag as obtained from an independent measurement of the acceleration to within 94 percent.

NACA RM E52F25

SPREADING OF EXHAUST JET FROM 16-INCH RAM JET AT MACH NUMBER 2.0. Fred Wilcox and Donald Pennington. August 1952. 14p. diagrs., photo., tab. (NACA RM E52F25)

An investigation of the jet-spreading characteristics of a 16-inch ram-jet engine was conducted in the 8- by 6-foot supersonic tunnel at a Mach number of 2.0; both a converging nozzle having a contraction ratio of 0.71 and a cylindrical extension to the combustion chamber were used. The jet boundaries determined by means of pitot pressure surveys were compared with boundaries calculated from one-dimensional continuity and momentum relations. For the cylindrical nozzle, the jet reaches its maximum diameter, 4 percent greater than calculated, about 0.6 nozzle-exit diameter downstream of the nozzle exit. The maximum diameter for the converging nozzle was 7 percent greater than calculated from one-dimensional relations and occurred from 1 to 1.5 nozzle-exit diameters downstream of the exit. Non-dimensional maximum jet diameters agreed closely with results of an investigation by Rousso and Baughman; these data were obtained with low-temperature jets exhausting into a stream at a Mach number of 1.91 from nozzles having exit diameters of 0.75 inch.

NACA RM E53C11

INVESTIGATION OF A 10-STAGE SUBSONIC AXIAL-FLOW RESEARCH COMPRESSOR. IV - INDIVIDUAL STAGE PERFORMANCE CHARACTERISTICS. Ray E. Budinger and George K. Serovy. April 1953. 37p. diagrs., photo. (NACA RM E53C11)

The individual stage performance was determined for a 10-stage 20-inch tip diameter axial-flow compressor from circumferentially fixed radial rake measurements of total temperature and total pressure obtained at the discharge of each stage. The interstage data indicated that the knee in the compressor surge line and the shape of the intermediate speed curves appear to be directly associated with positive stall of some inlet stage at low speeds and its effect through stage interactions on the performance of succeeding and preceding stages. The magnitude of the knee in the surge line is probably affected by the type of stall initiated in the inlet stages. The progressive tip-to-hub stall found in the early stages of this compressor at low speeds lessens the effects of stage stall on the overall compressor performance and probably tends to reduce the effects of stage interactions.

NACA RM E53C19

INVESTIGATION OF A 10-STAGE SUBSONIC AXIAL-FLOW RESEARCH COMPRESSOR. III - INVESTIGATION OF ROTATING STALL, BLADE VIBRATION, AND SURGE AT LOW AND INTERMEDIATE COMPRESSOR SPEEDS. Merle C. Huppert, Eleanor L. Costilow, and Ray E. Budinger. May 1953. 47p. diagrs., photos., tabs. (NACA RM E53C19)

Rotating stall and surge were investigated at low and intermediate speeds on a 10-stage subsonic axial-flow research compressor. The flow fluctuations of rotating stall due to rotor tip stall of the inlet stages were obtained at compressor speeds up to and including 70 percent of design speed. The amplitude of the flow fluctuations due to rotating stall was greatest in the first four stages and somewhat reduced in the latter stages. Surge was found to result in cyclic stall and stall recovery of the compressor.

NACA RM E53F16

A COMPARISON OF SEVERAL SYSTEMS OF BOUNDARY-LAYER REMOVAL AHEAD OF A TYPICAL CONICAL EXTERNAL-COMPRESSION SIDE INLET AT MACH NUMBERS OF 1.88 AND 2.93. Thomas G. Piercy and Harry W. Johnson. September 1953. 58p. diagrs., photos. (NACA RM E53F16)

The performance of external-compression side inlet models using several systems of boundary-layer removal was determined at Mach numbers of 1.88 and 2.93. The investigation included conventional scoop-type removal and alternative systems of removal consisting of deflection wedges and cowl-lip scoops. It was observed that the maximum inlet total-pressure recoveries for all systems of boundary-layer removal were comparable when sufficient boundary layer was removed.

NACA RM E53F18

UTILIZATION OF EXTERNAL-COMPRESSION DIFFUSION PRINCIPLE IN DESIGN OF SHOCK-IN-ROTOR SUPERSONIC COMPRESSOR BLADING. John W. R. Creagh and John F. Klapproth. September 1953. 37p. diagrs., photos., tab. (NACA RM E53F18)

The application of the external-compression principle to a cascade of blades in an attempt to achieve a closer approach to isentropic contraction ratios in

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supersonic compressor blading is presented. The limiting contraction ratio is shown to depend upon the entrance Mach number and the blade leading-edge wedge angle. Tests of a rotor designed to incorporate the external-compression principle gave no improvement over previous shock-in-rotor compressors. The observed contraction ratios were generally equal to or less than those observed in previous designs because of an inadequate allowance for the blade leading-edge thickness.

NACA RM E53H10

INVESTIGATION OF A 10-STAGE SUBSONIC AXIAL-FLOW RESEARCH COMPRESSOR. V - EFFECT OF REDUCING INLET-GUIDE-VANE TURNING ON OVER-ALL AND INLET-STAGE PERFORMANCE. Ray E. Budinger and George K. Serovy. March 1954. 37p. diagrs., photo. (NACA RM E53H10)

The inlet-guide-vane setting of a 10-stage compressor was reduced by 5° in order to approximate more closely the design absolute entrance flow angles to the first rotor. The performance of the inlet stage was obtained simultaneously with the overall compressor performance for both the original and the reset vanes in order to determine the effects of the radial redistribution of flow conditions entering the first rotor. At the reduced guide-vane setting only the speeds above the knee in the compressor surge line were noticeably affected. The surge pressure ratio and the choke weight flow increased from 7.52 to 7.66 and from 56.7 to 58.2 pounds per second, respectively, at design speed with approximately a one-point increase in peak efficiency. The knee in the compressor surge line occurred at 73 percent of design speed for the reduced guide-vane setting, compared with 70 percent for the original setting. The changes in overall compressor performance at high speeds were attributed primarily to the inlet stage, which exhibited a higher total-pressure ratio when operating at the same average angle of attack for the reduced guide-vane setting.

NACA RM E54B25

INVESTIGATION OF IMPULSE-TYPE SUPERSONIC COMPRESSOR WITH HUB-TIP RATIO OF 0.6 AND TURNING TO AXIAL DIRECTION. I - PERFORMANCE OF ROTOR ALONE. Ward W. Wilcox. May 1954. 41p. diagrs., photos., tab. (NACA RM E54B25)

The supersonic-compressor rotor described herein was designed as an impulse type with some deceleration along the tip and with turning to the axial direction. Design speed was 1400 feet per second, and the rotor was stressed to operate in air. Guide vanes were provided to set up a 16° counter prerotation at the tip with free-vortex-type distribution radially. Tests of the rotor and guide vanes determined that, at design speed, the maximum pressure ratio of 4.7 and peak efficiency of 0.85 occurred at the maximum weight flow of 24.84 pounds per second per square foot of frontal area. At this operating point, the average outlet Mach number was 1.75 and the average flow angle was 43.5°. At 90 percent speed, flow conditions were judged to be more satisfactory for stator work, inasmuch as the average Mach number dropped to 1.4 at a flow angle of 47°. At this point, the pressure ratio was 3.7, efficiency 0.86, and the weight flow 23.6 pounds per square foot unit frontal area. The radial distributions of pressure ratio, Mach number, and flow angle were considered satisfactory at this speed.

NACA RM E54F02

EXPERIMENTAL DATA FOR FOUR FULL-SCALE CONICAL COOLING-AIR EJECTORS. C. C. Ciepluch and D. B. Fenn. November 1954. 41p. diagrs., photo., tab. (NACA RM E54F02)

The ejector configurations investigated simulated a variable-primary-nozzle-area and variable-diameter-ratio ejector which operated at diameter ratios of 1.11 and 1.31 for nonafterburning and afterburning flight conditions, respectively. Performance data were obtained at spacing ratios of 0.4 and 0.8. The spacing ratio was found to influence both ejector pumping and thrust performance.

NACA RM E54F03

INVESTIGATION OF EFFECT OF INCREASED DIFFUSION OF ROTOR-BLADE SUCTION-SURFACE VELOCITY ON PERFORMANCE OF TRANSONIC TURBINE. Robert Y. Wong, Daniel E. Monroe, and William T. Wintucky. August 1954. 19p. diagrs., photo., tab. (NACA RM E54F03)

Design-point efficiency of a turbine with 0.30 diffusion parameter was four points less than that of a turbine with 0.15 diffusion. Surveys indicated comparable efficiencies in the hub and mean sections and a drop-off from the mean radius to the tip for both turbines that was much greater for the higher-diffusion turbine. The turbine three-dimensional characteristics may have an important effect on rotor losses by causing a transport of low-momentum fluids from the hub and mean section to the tip, which add to the measured losses and may even create further losses in this region.

NACA RM E54F21

AN EVALUATION OF TURBOJET ENGINE THRUST CONTROL BY EXHAUST-NOZZLE-AREA MODULATION AND COMPRESSOR-INLET THROTTLING. James L. Harp, Jr., Wallace W. Velie, and William E. Mallett. August 1954. 17p. diagrs., photos. (NACA RM E54F21)

At rated speed, a thrust reduction of 38 percent of rated thrust was obtained with an exhaust-nozzle area 45 percent greater than rated area. A thrust reduction of 61 percent of rated thrust was obtained by combined throttling of the engine inlet to produce a 31-percent pressure drop and use of the increased exhaust-nozzle area of 45 percent. Thrust reduction available from both exhaust-nozzle-area modulation and compressor-inlet throttling was predictable for this engine within an accuracy of 4 percent.

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NACA RM E54F23

INVESTIGATION OF TRANSONIC TURBINE DESIGNED FOR ZERO DIFFUSION OF SUCTION-SURFACE VELOCITY. Warren J. Whitney, Daniel E. Monroe, and Robert Y. Wong. August 1954. 20p. diagrs., photo., tab. (NACA RM E54F23)

From a comparison of the experimental performance of a zero-diffusion turbine with that of a 0.15- and a 0.30-diffusion turbine, the design-point efficiency of the subject turbine (between 0.86 and 0.87) represented an improvement in overall performance over that of the other turbines. From the results of the three turbines, it was indicated that the diffusion parameter is an important turbine design consideration that affects the overall turbine performance. As shown from previous compressor research, compressor blade losses could also be correlated by a similar diffusion factor.

NACA RM E54F28

INVESTIGATION OF A 10-STAGE SUBSONIC AXIAL-FLOW RESEARCH COMPRESSOR. VI - PERFORMANCE EVALUATION AND FLOW DISTRIBUTIONS IN THE FIRST, FIFTH, AND TENTH STAGES. Ray E. Budinger. August 1954. 42p. diagrs., photo., tabs. (NACA RM E54F28)

The results indicate that two-dimensional low-speed cascade data are applicable to subsonic compressor design. The stage efficiencies indicate lower peak values in the first and tenth stages than in the fifth stage, rather than the constant value assumed in the design. Simple radial equilibrium satisfactorily predicted the axial-velocity distributions in the first and fifth stages, but was inadequate in the tenth stage. Design matching of all three stages was not obtained at design speed because of high inlet-guide-vane turning. Higher than assumed design efficiencies and no boundary-layer allowance resulted in design matching of the fifth and tenth stages at design speed.

NACA RM E54G16

THERMAL STABILITY OF PENTABORANE IN THE RANGE 329° TO 419° F. Glen E. McDonald. December 1956. 4p. diagrs. (NACA RM E54G16)

The thermal stability of pentaborane, as measured by the formation of nonvolatile residue, has been determined as a function of time over the temperature range 329° to 419° F. A plot of the reciprocal Rankine temperature against the logarithm of the time in minutes required for the formation of 20-percent nonvolatile residue was linear. The time required for the formation of 20 percent of residue at either higher or lower temperatures may be estimated from extrapolation of this line.

NACA RM E55F28

INVESTIGATION OF IMPULSE-TYPE SUPERSONIC COMPRESSOR WITH HUB-TIP RATIO OF 0.6 AND TURNING TO AXIAL DIRECTION. II - STAGE PERFORMANCE WITH THREE DIFFERENT SETS OF STATORS. Ward W. Wilcox. August 1955. 49p. diagrs., photos., tab. (NACA RM E55F28)

An impulse-type supersonic compressor designed for turning to the axial direction was tested in air with three different sets of stator blades at eight angle settings. The good performance of the rotor alone was compromised by the stators. Low values of overall pressure ratio and adiabatic efficiency were observed, and range of weight flow was severely restricted. At stator-inlet Mach numbers below 1.4, most of the losses occurred as a result of secondary flows, friction, and mixing of the nonuniform Mach number and energy levels that came from the rotor.

NACA RM E55F29a

SPONTANEOUS IGNITION OF PENTABORANE SPRAYS IN A HOT-AIR STREAM. Erwin A. Lezberg and Albert M. Lord. November 1956. 26p. diagrs. (NACA RM E55F29a)

The boron hydrides, because of their high reactivity, have been suggested for use as ignition or relight fuels in jet engines. Spontaneous-ignition temperatures and ignition delays were therefore determined for pentaborane in a hot-air stream. Ignition temperatures from 600° to 675° F were found for ignition delays of about 3 to 20 milliseconds over a range of pressure from 5 to 29 in. Hg abs. Temperature effects on ignition delay can be represented by the Arrhennius equation, and pressure effects by an equation of the type $p^n = ke^{-E/RT}$. The mean value of n was 1.6 for combustor pressures of 10 to 29 in. Hg abs. A flame stabilizer reduced ignition temperatures for pentaborane.

NACA RM E55F30

A VARIABLE-GEOMETRY AXISYMMETRIC SUPERSONIC INLET WITH TELESCOPING CENTERBODY. James F. Connors and Rudolph C. Meyer. September 1955. 27p. diagrs., photos., tabs. (NACA RM E55F30)

A centerbody consisting of a number of individual, translating, concentric elements was used to produce a discontinuous surface, the envelope of which approximated any desired contour. In an actual inlet application, maximum total-pressure recoveries of 0.89 and 0.60 were obtained at Mach numbers of 1.90 and 3.05, respectively. At both Mach numbers, supercritical mass-flow ratios of approximately unity were obtained with subcritical stability ranges of 38 and 21 percent of maximum possible mass flow.

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NACA RM E55H02

FACTORS THAT AFFECT OPERATIONAL RELIABILITY OF TURBOJET ENGINES. Lewis Laboratory Staff. January 1956. 376p. diagrs., photos., tabs. (NACA RM E55H02)

The problem of improving operational reliability of turbojet engines is studied in a series of papers. Failure statistics for this engine are presented, the theory and experimental evidence on how engine failures occur are described, and the methods available for avoiding failure in operation are discussed. The individual papers of the series are Objectives, Failure Statistics, Foreign-Object Damage, Compressor Blades, Combustor Assembly, Nozzle Diaphragms, Turbine Buckets, Turbine Disks, Rolling Contact Bearings, Engine Fuel Controls, and Summary Discussion.

NACA RM E56F11a

EFFECTS OF EXTERNAL STREAM FLOW AND AFTERBODY VARIATIONS ON THE PERFORMANCE OF A PLUG NOZZLE AT HIGH SUBSONIC SPEEDS. R. J. Salmi and E. M. Cortright, Jr. October 1956. 19p. diagrs. (NACA RM E56F11a)

The off-design operation of an isentropic plug nozzle designed for a jet pressure ratio of 15 was investigated experimentally at subsonic Mach numbers up to 0.9 and jet pressure ratios up to 5. When installed in a cylindrical nacelle with a sharp turn at the nozzle lip, the interaction of the jet and the external stream produced low pressures on the base formed by the high lip angle. These low pressures increased the nacelle drag and caused an overexpansion of the jet, which resulted in lower pressures on the plug and, hence, reduced thrust. With a boattail ahead of the plug nozzle, the base pressures were increased and the jet overexpansion significantly reduced.

NACA RM E56F21

ANALYSIS OF TURBOMACHINE VISCOUS LOSSES AFFECTED BY CHANGES IN BLADE GEOMETRY. James W. Miser, Warner L. Stewart, and Warren J. Whitney. October 1956. 50p. diagrs., tab. (NACA RM E56F21)

The effect of changes in blade geometry on the viscous losses in turbomachines is analyzed. The viscous losses can be expressed as a function of three variables: the blade height-to-spacing ratio, the solidity, and a blade-height Reynolds number. A method of optimizing the number of blades and the solidity is given. The effect of trailing-edge blockage on blade loss and its effect on the choice of blade number for a particular design are also discussed.

NACA RM E56F29

ANALYSIS OF TURBOJET-ENGINE CONTROLS FOR AFTERBURNER STARTING. W. E. Phillips, Jr. October 1956. 61p. diagrs., tabs. (NACA RM E56F29)

A simulation procedure is developed for studying the effects of an afterburner start on a controlled turbojet engine. The afterburner start is represented by introducing a step decrease in the effective exhaust-nozzle area, after which the control returns the controlled engine variables to their initial values. The degree and speed with which the control acts are a measure of the effectiveness of the particular control system. Data are presented from five systems investigated using an electronic analog computer and the developed simulation procedure. These systems are compared with respect to steady-state errors, speed of response, and transient deviations of the system variables.

NACA RM E57A28

ANALYSIS OF EXPERIMENTAL LOW-SPEED LOSS AND STALL CHARACTERISTICS OF TWO-DIMENSIONAL COMPRESSOR BLADE CASCADES. Seymour Lieblein. March 1957. 64p. diagrs., tabs. (NACA RM E57A28)

Significant experimental correlation between pressure loss and blade loading is obtained for several conventional 10-percent-thick low-speed compressor cascade blades when loss is expressed in terms of ratio of wake momentum thickness to chord length and blade loading is expressed as the diffusion ratio given either by the measured ratio of maximum blade upper-surface velocity to outlet velocity or an equivalent ratio based on the velocity triangle and the blade solidity. Limiting diffusion ratios are established for stall at minimum loss and higher angles of attack, and procedures for estimating low-speed total-pressure loss and unstalled range of operation are presented.

NACA RM H54G29a

DETERMINATION OF LONGITUDINAL HANDLING QUALITIES OF THE D-558-II RESEARCH AIRPLANE AT TRANSONIC AND SUPERSONIC SPEEDS TO A MACH NUMBER OF ABOUT 2.0. Herman O. Ankenbruck. November 1954. 25p. diagrs., photos., tab. (NACA RM H54G29a)

Flight tests were performed with the Douglas D-558-II research airplane to investigate the longitudinal handling qualities and trim characteristics at transonic and supersonic speeds. This paper describes the changes with Mach number of the lift, maneuvering, and trim characteristics with elevator and stabilizer to a Mach number of about 2.0.

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NACA RM H54H16

LONGITUDINAL STABILITY CHARACTERISTICS IN ACCELERATED MANEUVERS AT SUBSONIC AND TRANSONIC SPEEDS OF THE DOUGLAS D-558-II RESEARCH AIRPLANE EQUIPPED WITH A LEADING-EDGE WING CHORD-EXTENSION. Jack Fischel and Cyril D. Brunn. October 1954. 62p. diagrs., photos., tab. (NACA RM H54H16)

On the basis of improved longitudinal stability characteristics exhibited in wind-tunnel model tests, the Douglas D-558-II research airplane was modified to include wing leading-edge chord-extensions, and was flight tested at Mach numbers up to about 1.0. The results of subsonic and transonic flight measurements of the longitudinal stability characteristics of the airplane are presented. The levels of normal-force coefficient at which the stick-fixed stability decays and pitch-up starts have been determined through the speed range tested, as have the variation of the stability parameters $d\delta_e/dC_{N_A}$, dF_e/dn, and $dC_{N_A}/d\alpha$ with Mach number. Comparisons of these data with comparable data for the unmodified airplane are also presented.

NACA RM H54I27

LATERAL MOTIONS ENCOUNTERED WITH THE DOUGLAS D-558-II ALL-ROCKET RESEARCH AIRPLANE DURING EXPLORATORY FLIGHTS TO A MACH NUMBER OF 2.0. Herman O. Ankenbruck and Chester H. Wolowicz. December 1954. 32p. diagrs., photos., tab. (NACA RM H54I27)

Flight tests were performed with the Douglas D-558-II research airplane to investigate the lateral motions obtained during exploratory flights at supersonic speeds. This paper describes the effects of Mach number and angle of attack on the lateral handling qualities during oscillations at supersonic speeds. Some calculations of period and damping are included. Also shown are the results of some measurements of the variation of rudder hinge moments with sideslip and the effects of power on the variation.

NACA RM H54L27

WING-LOAD MEASUREMENTS AT SUPERSONIC SPEEDS OF THE DOUGLAS D-558-II RESEARCH AIRPLANE. Glenn H. Robinson, George E. Cothren, Jr., and Chris Pembo. March 1955. 20p. diagrs., photos., tab. (NACA RM H54L27)

Flight measurements of the aerodynamic wing loads on the D-558-II airplane have been made in the Mach number range from 1.0 to 2.0. Results of measurements of the wing-panel normal-force, bending-moment, and pitching-moment coefficients, normal-force-curve slope, lateral center of pressure, and chordwise center of pressure are presented.

NACA RM H55E31a

EFFECT OF SEVERAL WING MODIFICATIONS ON THE LOW-SPEED STALLING CHARACTERISTICS OF THE DOUGLAS D-558-II RESEARCH AIRPLANE. Jack Fischel and Donald Reisert. July 1955. 62p. diagrs., photos., tabs. (NACA RM H55E31a)

The low-speed stalling and lift characteristics of the Douglas D-558-II research airplane were measured in a series of 1g stalls performed with several wing modifications designed to alleviate swept-wing instability and pitch-up. The various configurations investigated include the basic wing configuration and two wing-fence configurations in combination with retracted, free-floating, or extended slats, and a wing leading-edge chord-extension configuration. All configurations were investigated with flaps and landing gear retracted and extended.

NACA RM H55J18

MACH NUMBER MEASUREMENTS AND CALIBRATIONS DURING FLIGHT AT HIGH SPEEDS AND AT HIGH ALTITUDES INCLUDING DATA FOR THE D-558-II RESEARCH AIRPLANE. Cyril D. Brunn and Wendell H. Stillwell. March 1956. 31p. diagrs., tabs. (NACA RM H55J18)

This paper contains data concerning research equipment and techniques pertaining to measurements of airspeed and altitude, with particular reference to high Mach number and altitude. Computations are presented for errors in determining Mach number for altitudes of 40,000 feet to 140,000 feet. Illustrative examples are included for maximum Mach number and altitude flights of the Douglas D-558-II research airplane.

NACA RM H56C30

EFFECT OF SEVERAL WING MODIFICATIONS ON THE SUBSONIC AND TRANSONIC LONGITUDINAL HANDLING QUALITIES OF THE DOUGLAS D-558-II RESEARCH AIRPLANE. Jack Fischel and Donald Reisert. June 1956. 57p. diagrs., photos., tabs. (NACA RM H56C30)

The subsonic and transonic longitudinal handling qualities of the Douglas D-558-II research airplane were measured with several wing modifications designed to alleviate swept-wing instability and pitch-up. Airplane configurations investigated include the basic wing configuration and two wing-fence configurations in combination with retracted, free-floating, or extended slats, and a wing leading-edge chord-extension configuration. Results indicated that the comparative effects of these wing modifications on airplane pitch-up and trim-stability and on the stability parameters $\frac{d\delta_e}{dC_N}$, $\frac{dF_e}{da_n}$, and C_{N_α} were essentially negligible. The various modifications had some measurable effect on airplane buffeting characteristics.

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NACA RM H58B11

PRELIMINARY FLIGHT SURVEY OF FUSELAGE AND BOUNDARY-LAYER SOUND-PRESSURE LEVELS. Norman J. McLeod and Gareth H. Jordan. May 1958. 25p. diagrs., photos. (NACA RM H58B11)

Presented are the results of a preliminary flight investigation of noise inside fuselages and in the fuselage boundary layer. The overall noise and frequency spectrum are presented for the B-47A at subsonic speeds. Measurements were made internally at three longitudinal locations and in the fuselage boundary layer at one location. The overall noise level is presented for one internal location of the D-558-II at subsonic and low supersonic speeds. The relative importance of engine noise and aerodynamic noise due to the boundary layer at various airspeeds and engine operating conditions is discussed for the locations at which measurements were made.

NACA RM L7G28

LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF AN AIRPLANE MODEL HAVING A 42.8° SWEPTBACK CIRCULAR-ARC WING WITH ASPECT RATIO 4.00, TAPER RATIO 0.50, AND SWEPTBACK TAIL SURFACES. Joseph Weil, Paul Comisarow, and Kenneth W. Goodson. October 17, 1947. 84p. diagrs., photos., tab. (NACA RM L7G28)

Tests were made in the Langley 300-mph 7- by 10-foot tunnel of an airplane model to determine its low-speed longitudinal stability and control characteristics. This investigation includes data on the effect of vertical-wing location, fuselage size, horizontal-tail location, stall-control vanes on the wing, and nose-flap deflection.

NACA RM L7G31

LATERAL STABILITY AND CONTROL CHARACTERISTICS OF AN AIRPLANE MODEL HAVING A 42.8° SWEPTBACK CIRCULAR-ARC WING WITH ASPECT RATIO 4.00, TAPER RATIO 0.50, AND SWEPTBACK TAIL SURFACES. Kenneth W. Goodson and Paul Comisarow. October 17, 1947. 72p. diagrs., photos., tab. (NACA RM L7G31)

Low-speed lateral stability and control data are given for a model of a proposed supersonic airplane having a swept circular-arc wing. A series of changes including lowering the wing, incorporating a smaller-fineness-ratio fuselage, and increasing the vertical-tail size were made to improve the aerodynamic characteristics of the original-model configuration.

NACA RM L7J15

SUPERSONIC-TUNNEL TESTS OF TWO SUPERSONIC AIRPLANE MODEL CONFIGURATIONS. Macon C. Ellis, Jr., Lowell E. Hasel, and Carl E. Grigsby. December 31, 1947. 49p. diagrs., photos., tab. (NACA RM L7J15)

Supersonic-tunnel tests of two supersonic airplane model configurations were made at Mach numbers of 1.55, 1.90, and 2.32 to determine values of the lift, drag, pitching moment, yawing moment, and side force. The principal difference between the two models was the vertical location of the wing relative to the horizontal tail. The test results indicated no difference in the lift characteristics and little difference in the drag characteristics of the two models. However, a significant variation with Mach number of the differences between the pitching-moment values is shown by the test results.

NACA RM L8D02

PRELIMINARY INVESTIGATION AT A MACH NUMBER OF 1.9 AND A REYNOLDS NUMBER OF 2,200,000 OF THREE AILERONS APPLICABLE TO THE BELL XS-2 AIRPLANE DESIGN. James C. Sivells and D. William Conner. May 25, 1948. 11p. diagrs., tab. (NACA RM L8D02)

A 42.7° sweptback tapered wing with three types of ailerons was tested at a Mach number of 1.9 and a Reynolds number of 2,200,000 in the Langley 9- by 12-inch supersonic blowdown tunnel. The wing geometry was essentially that of the XS-2 airplane.

NACA RM L8I14

WIND-TUNNEL INVESTIGATION OF THE STABILITY OF THE JETTISONABLE NOSE SECTION OF THE XS-2 AIRPLANE. Stanley H. Scher and Roscoe H. Goodwin. October 14, 1948. 19p. diagrs., photos., tabs. (NACA RM L8I14)

An investigation of the stability of the jettisonable nose section of the XS-2 airplane has been conducted in the Langley 20-foot free-spinning tunnel. It was found that the model rotated end over end about its normal axis or rolled about its longitudinal axis. Installation of suitable fins caused the model to descend in a stable nose-down attitude.

NACA RM L9G13

ANALYSIS OF THE DYNAMIC-LATERAL-STABILITY CHARACTERISTICS OF THE BELL X-2 AIRPLANE AS AFFECTED BY VARIATIONS IN MASS, AERODYNAMIC, AND DIMENSIONAL PARAMETERS. W. H. Michael, Jr., and M. J. Queijo. August 10, 1949. 33p. diagrs., tabs. (NACA RM L9G13)

Contains results of calculations to show the effects of various mass and aerodynamic parameters on the dynamic lateral stability of the Bell X-2 airplane in

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the landing configuration and in the high-speed configuration at Mach numbers below 0.87. Calculations included determination of the period and rate of damping of the lateral oscillation, and the results are compared with the USAF criterion for satisfactory period-damping relationship.

NACA RM L9G15a

AN INVESTIGATION IN THE LANGLEY 20-FOOT FREE-SPINNING TUNNEL OF THE SPIN AND RECOVERY CHARACTERISTICS OF A 1/30-SCALE MODEL OF THE BELL X-2 AIRPLANE. Lawrence J. Gale. July 20, 1949. 15p. diagrs., photo., tabs. (NACA RM L9G15a)

An investigation of the spin and recovery characteristics of a 1/30-scale model of the Bell X-2 airplane has been conducted in the Langley 20-foot free-spinning tunnel. The effects of control settings upon the erect- and inverted-spin and recovery characteristics of the model were determined for the model at the design gross-weight loading condition. The effects of varying the loading, the stabilizer incidence, and of extending the leading-edge and trailing-edge wing flaps were also determined.

NACA RM L9L08

AN INVESTIGATION OF A SUPERSONIC AIRCRAFT CONFIGURATION HAVING A TAPERED WING WITH CIRCULAR-ARC SECTIONS AND 40° SWEEPBACK. STATIC LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS AT A MACH NUMBER OF 1.40. M. Leroy Spearman. April 3, 1950. 27p. diagrs., photos., tab. (NACA RM L9L08)

Tests were made in the Langley 4- by 4-foot supersonic tunnel to determine the longitudinal stability and control characteristics at a Mach number of 1.40 of an airplane model having a 40° sweptback circular-arc wing with aspect ratio 4 and taper ratio 0.5. The tests covered an angle-of-attack range from -4° to 10° for the model with the stabilizer removed and with the stabilizer on with incidence angles from 3.7° to -10.2°.

NACA RM L50C17

AN INVESTIGATION OF A SUPERSONIC AIRCRAFT CONFIGURATION HAVING A TAPERED WING WITH CIRCULAR-ARC SECTIONS AND 40° SWEEPBACK. STATIC LATERAL STABILITY CHARACTERISTICS AT MACH NUMBERS OF 1.40 AND 1.59. M. Leroy Spearman. June 14, 1950. 28p. diagrs., photos., tab. (NACA RM L50C17)

Tests were made in the Langley 4- by 4-foot supersonic tunnel to determine the lateral stability characteristics of a supersonic airplane configuration at Mach numbers of 1.40 and 1.59. A comparison is made with results of tests in the Langley 9-inch supersonic tunnel of a similar model.

NACA RM L50C24

AN INVESTIGATION OF A SUPERSONIC AIRCRAFT CONFIGURATION HAVING A TAPERED WING WITH CIRCULAR-ARC SECTIONS AND 40° SWEEPBACK. A PRESSURE-DISTRIBUTION STUDY OF THE AERODYNAMIC CHARACTERISTICS OF THE WING AT MACH NUMBER 1.59. Morton Cooper and M. Leroy Spearman. May 23, 1950. 52p. diagrs., photos., tabs. (NACA RM L50C24)

A pressure-distribution investigation on a tapered 40° swept wing of aspect ratio 4 and of circular-arc sections has been conducted in the Langley 4- by 4-foot supersonic tunnel at a Mach number of 1.59 and a Reynolds number of 0.575×10^6. A comparison of the results of the experimental measurements is made with linear supersonic theory to indicate the accuracy with which the flow can be estimated.

NACA RM L50E08

SUPPLEMENTARY ANALYSIS OF THE DYNAMIC LATERAL STABILITY CHARACTERISTICS OF THE BELL X-2 AIRPLANE AS AFFECTED BY VARIATIONS IN MASS AND AERODYNAMIC PARAMETERS. William H. Michael, Jr., and M. J. Queijo. June 26, 1950. 15p. diagrs. (NACA RM L50E08)

Contains results of extended calculations of the dynamic lateral stability of the Bell X-2 airplane utilizing values of the derivative of yawing moment due to rolling C_{n_p} based on results of recent research.

NACA RM L50E12

AN INVESTIGATION OF A SUPERSONIC AIRCRAFT CONFIGURATION HAVING A TAPERED WING WITH CIRCULAR-ARC SECTIONS AND 40° SWEEPBACK. STATIC LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS AT A MACH NUMBER OF 1.59. M. Leroy Spearman and John H. Hilton, Jr. June 29, 1950. 22p. diagrs., photo., tab. (NACA RM L50E12)

An investigation has been conducted to determine the static longitudinal stability and control characteristics at Mach number 1.59 of an airplane model having a 40° sweptback, circular-arc wing with aspect ratio 4 and taper ratio 0.5. The tests covered an angle-of-attack range from -4° to 10° with the stabilizer removed and with the stabilizer on with incidence angles from 4° to -10°. A comparison is made with results obtained for the same model at a Mach number of 1.40.

NACA RM L50H16

FLIGHT MEASUREMENTS WITH THE DOUGLAS D-558-II (BUAERO NO. 37974) RESEARCH AIRPLANE. MEASUREMENTS OF WING LOADS AT MACH NUMBERS UP TO 0.87. John P. Mayer, George M. Valentine, and Beverly J. Swanson. December 26, 1950. 35p. diagrs., photos., tab. (NACA RM L50H16)

Results are presented from flight measurements of the aerodynamic wing normal force, bending moment, and pitching moment on the Douglas D-558-II airplane at Mach numbers up to 0.87 and at angles of attack up to 38° for low Mach numbers.

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NACA RM L50I11

AN INVESTIGATION OF A SUPERSONIC AIRCRAFT CONFIGURATION HAVING A TAPERED WING WITH CIRCULAR-ARC SECTIONS AND 40° SWEEPBACK. STATIC LATERAL CONTROL CHARACTERISTICS AT MACH NUMBERS OF 1.40 AND 1.59. Ross B. Robinson. November 10, 1950. 40p. diagrs., photos., tabs. (NACA RM L50I11)

An investigation was conducted in the Langley 4- by 4-foot supersonic tunnel to determine the lateral control characteristics of a supersonic aircraft configuration at Mach numbers of 1.40 and 1.59. Aileron tests were made through an angle-of-attack range of -4° to 10° at zero angle of yaw with an aileron-deflection range of about ±15°. Rudder tests were made through a yaw range of ±10° at zero angle of attack with a rudder-deflection range of -3° to 20° for $M = 1.40$ and -3° to 25.5° for $M = 1.59$. A discussion of the accuracy of the strain-gage balance system used is included.

NACA RM L50J13

FLIGHT MEASUREMENTS WITH THE DOUGLAS D-558-II (BUAERO NO. 37974) RESEARCH AIRPLANE. MEASUREMENTS OF THE DISTRIBUTION OF THE AERODYNAMIC LOAD AMONG THE WING, FUSELAGE, AND HORIZONTAL TAIL AT MACH NUMBERS UP TO 0.87. John P. Mayer and George M. Valentine. January 19, 1951. 33p. diagrs., photos., tab. (NACA RM L50J13)

Flight measurements of aerodynamic wing and tail loads have been made on the Douglas D-558-II airplane from which the distribution of the aerodynamic load among the wing, fuselage, and horizontal tail has been determined at Mach numbers up to 0.87.

NACA RM L50J31

AN INVESTIGATION AT MACH NUMBERS OF 1.40 AND 1.59 OF THE EFFECTS OF AILERON PROFILE ON THE AERODYNAMIC CHARACTERISTICS OF A COMPLETE MODEL OF A SUPERSONIC AIRCRAFT CONFIGURATION. M. Leroy Spearman and Robert A. Webster. January 15, 1951. 40p. diagrs., photos., tabs. (NACA RM L50J31)

Tests were made in the Langley 4- by 4-foot supersonic tunnel at Mach numbers of 1.40 and 1.59 to determine the effects of aileron profile on the aerodynamic characteristics of a complete model having a tapered wing with circular-arc sections and 40° sweepback. The profiles included the basic circular-arc section and three flat-sided ailerons having ratios of trailing-edge thickness to hinge-line thickness of 0, 0.5, and 1.0. The tests covered an angle-of-attack range of -4° to 10° with an aileron-deflection range of about ±15°.

NACA RM L50K14

AN INVESTIGATION OF A SUPERSONIC AIRCRAFT CONFIGURATION HAVING A TAPERED WING WITH CIRCULAR-ARC SECTIONS AND 40° SWEEPBACK. FORCE CHARACTERISTICS OF THE COMPLETE CONFIGURATION AND ITS VARIOUS COMPONENTS AT MACH NUMBERS OF 1.40 AND 1.59. Norman F. Smith and Jack E. Marte. January 22, 1951. 55p. diagrs., photos., tab. (NACA RM L50K14)

A force investigation of a supersonic aircraft configuration and various combinations of its components has been conducted in the Langley 4- by 4-foot supersonic tunnel at Mach numbers of 1.40 and 1.59 and a Reynolds number of 0.6×10^6. The wing of the model had a sweepback of 40°, aspect ratio of 4, and 10-percent-thick circular-arc sections. Longitudinal- and lateral-force characteristics and stability derivatives are presented, along with interference effects. Comparisons with theory and with results of pressure investigations are made.

#NACA RM L50K24, by NACA Pilotless Aircraft Research Division.

NACA RM L51C06

AN INVESTIGATION OF A SUPERSONIC AIRCRAFT CONFIGURATION HAVING A TAPERED WING WITH CIRCULAR-ARC SECTION AND 40° SWEEPBACK. A PRESSURE-DISTRIBUTION STUDY OF THE AERODYNAMIC CHARACTERISTICS OF THE WING AT MACH NUMBER 1.40. Norman F. Smith, Julian H. Kainer, and Robert A. Webster. April 20, 1951. 48p. diagrs., photos., tabs. (NACA RM L51C06)

A pressure-distribution investigation of a wing having 10-percent-thick circular-arc sections perpendicular to the quarter-chord line, 40° sweepback of the quarter-chord line, a taper ratio of 0.5, and an aspect ratio of 4 was conducted in the Langley 4- by 4-foot supersonic tunnel at a Mach number of 1.40 and a Reynolds number, based on the mean aerodynamic chord, of 0.598×10^6. Comparisons of the results of the experimental measurements at Mach number 1.40 are made with linearized supersonic theory and with previously published data for Mach number 1.59.

NACA RM L51E14

AN INVESTIGATION OF SINGLE-DEGREE-OF-FREEDOM SNAKING OSCILLATIONS ON A MODEL OF A HIGH-SPEED RESEARCH AIRPLANE BY THE NACA WING-FLOW METHOD. Harold I. Johnson and Stanley Faber. August 1951. 22p. diagrs., photos., tab. (NACA RM L51E14)

Records are presented showing the snaking characteristics of 12 different configurations of a 1/40-scale wingless model of a research airplane and of another higher fineness-ratio model. The models were mounted on a wing-flow test panel with freedom to rotate in yaw only. The test Mach number range was 0.70 to 1.15. Results indicated snaking can be caused by flow separation. In the subject investigation the snaking was largely eliminated by making the rates of closure of the aerodynamic bodies and surfaces small.

NACA RM L51F05

BASIC PRESSURE MEASUREMENTS ON A FUSELAGE AND A 45° SWEPTBACK WING-FUSELAGE COMBINATION AT TRANSONIC SPEEDS IN THE

UNAVAILABLE; contains proprietary or obsolete information.

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SLOTTED TEST SECTION OF THE LANGLEY 8-FOOT HIGH-SPEED TUNNEL. Donald L. Loving and Claude V. Williams. September 1951. 59p. diagrs., photos. (NACA RM L51F05)

A discussion is presented on the basic pressure measurements made on a fuselage and a wing-fuselage combination employing a wing having 45° of sweepback of the 0.25-chord line, aspect ratio 4, taper ratio 0.6, and NACA 65A006 airfoil sections parallel to the airstream. The pressure data were obtained at Mach numbers from 0.60 to 1.13 and angles of attack from 0° to 20° in the slotted test section of the Langley 8-foot high-speed tunnel.

NACA RM L51L17

AN INVESTIGATION OF A SUPERSONIC AIRCRAFT CONFIGURATION HAVING A TAPERED WING WITH CIRCULAR-ARC SECTIONS AND 40° SWEEPBACK. ESTIMATED DOWNWASH ANGLES DERIVED FROM PRESSURE MEASUREMENTS ON THE TAIL AT MACH NUMBERS OF 1.40 AND 1.59. Frederick C. Grant and John P. Gapcynski. March 1952. 27p. diagrs., photos., tabs. (NACA RM L51L17)

A comparison is made between estimated downwash values obtained from an analysis of pressures on the horizontal tail of a supersonic aircraft configuration with a 40° sweptback wing and those obtained from an application of linearized theory. This is done for Mach numbers 1.40 and 1.59 with the wing on and the wing off. Available force-tests results are compared with pressure and theoretical results.

NACA RM L52A08

HANDLING QUALITIES OF HIGH-SPEED AIRPLANES. W. C. Williams and A. S. Crossfield. January 1952. 17p. diagrs. (NACA RM L52A08)

Because there have been such drastic changes in the speed range and the configuration of airplanes in the past decade it becomes necessary to reexamine the requirements for satisfactory handling qualities as proposed by Gilruth in 1940. This paper does not attempt to describe completely the handling qualities of all the research airplanes but does attempt to describe the objectionable characteristics and those which indicate review of the requirements. The research airplanes discussed are the X-1, D-558-1, D-558-2, X-4, F-86A, and the XF-92A.

NACA RM L52A21

THE AERODYNAMIC CHARACTERISTICS OF A SUPERSONIC AIRCRAFT CONFIGURATION WITH A 40° SWEPTBACK WING THROUGH A MACH NUMBER RANGE FROM 0 TO 2.4 AS OBTAINED FROM VARIOUS SOURCES. M. Leroy Spearman and Ross B. Robinson. April 1952. 50p. diagrs., photo., tab. (NACA RM L52A21)

A summary and analysis have been made of the results of various investigations to determine the aerodynamic characteristics of a supersonic aircraft configuration. This configuration had a wing with 40° sweepback at the quarter-chord line, aspect ratio 4, taper ratio 0.5, and 10-percent-thick circular-arc sections normal to the quarter-chord line. Experimental data were available for a Mach number range from 0.16 to 2.32. Results obtained from wing-flow, rocket-model, transonic-bump, and tunnel tests are presented and, where possible, are supplemented by empirical and theoretical calculations.

NACA RM L52F13

EFFECTS OF SYSTEMATICALLY VARYING THE SPANWISE AND VERTICAL LOCATION OF AN EXTERNAL STORE ON THE AERODYNAMIC CHARACTERISTICS OF AN UNSWEPT TAPERED WING OF ASPECT RATIO 4 AT MACH NUMBERS OF 1.41, 1.62, AND 1.96. Carl R. Jacobsen. August 1952. 34p. diagrs. (NACA RM L52F13)

An investigation has been made in the Langley 9- by 12-inch supersonic blowdown tunnel to determine the effects of an external store on the lift, drag, and pitching-moment characteristics of an unswept wing at Mach numbers of 1.41, 1.62, and 1.96. The spanwise and vertical location of a store having the Douglas Aircraft Company store shape was systematically varied over the outer 60 percent of the wing semispan. For a wing area of 500 square feet, the store would have sufficient volume to contain about 400 gallons of fuel.

NACA RM L52I18

LOW-SPEED STATIC LONGITUDINAL AND LATERAL STABILITY CHARACTERISTICS OF A MODEL WITH LEADING-EDGE CHORD-EXTENSIONS INCORPORATED ON A 40° SWEPTBACK CIRCULAR-ARC WING OF ASPECT RATIO 4 AND TAPER RATIO 0.50. Kenneth W. Goodson and Albert G. Few, Jr. November 1952. 46p. diagrs., photos., tab. (NACA RM L52I18)

An investigation was conducted to determine the aerodynamic effects at low speed of wing leading-edge chord-extensions incorporated on a complete airplane model having a 40° sweptback circular-arc wing of aspect ratio 4 and taper ratio 0.5. Comparison of several nose and plain-flap configurations in conjunction with a chord-extension are also made.

NACA RM L52I26a

MEASUREMENTS OF AERODYNAMIC HEATING OBTAINED DURING DEMONSTRATION FLIGHT TESTS OF THE DOUGLAS D-558-II AIRPLANE. Ira P. Jones, Jr. November 1952. 19p. diagrs., photo., tab. (NACA RM L52I26a)

Measurements of transient skin and canopy-glass temperature and stagnation temperature were made on the Douglas D-558-II research airplane up to a Mach number of 1.89 and to an altitude of about 77,000 feet. The maximum temperatures that were obtained for the positions measured were not great enough to cause loss in structural strength.

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NACA RM L52L02a

SOME EFFECTS OF A SONIC JET EXHAUST ON THE LOADING OVER A YAWED FIN AT A MACH NUMBER OF 3.03. John E. Hatch, Jr., and William M. Savelle. January 1953. 12p. diagrs., photo. (NACA RM L52L02a)

The results of an experimental investigation are presented which show the effects of a sonic jet exhaust on the loading over a yawed fin located at the jet exit in a free stream of Mach number 3.03.

NACA RM L53A06

SOME MEASUREMENTS OF FLYING QUALITIES OF A DOUGLAS D-558-II RESEARCH AIRPLANE DURING FLIGHTS TO SUPERSONIC SPEEDS. Herman O. Ankenbruck and Theodore E. Dahlen. March 1953. 25p. diagrs., photos., tab. (NACA RM L53A06)

Results of measurements of lateral and longitudinal flying qualities of the Douglas D-558-II research airplane in flights to a Mach number of 1.87 and an altitude of 67,000 feet are presented.

NACA RM L53A16

FLIGHT DETERMINATION OF THE LONGITUDINAL STABILITY IN ACCELERATED MANEUVERS AT TRANSONIC SPEEDS FOR THE DOUGLAS D-558-II RESEARCH AIRPLANE INCLUDING THE EFFECTS OF AN OUTBOARD WING FENCE. Jack Fischel and Jack Nugent. March 1953. 28p. diagrs., photo., tab. (NACA RM L53A16)

The results of transonic flight measurements of the longitudinal stability characteristics of the Douglas D-558-II research airplane in the original configuration and with outboard fences mounted on the wings are presented. The levels of normal-force coefficient at which the stability decreases and pitch-up starts have been determined for both airplane configurations at Mach numbers up to about 0.94.

NACA RM L53B24

MAXIMUM ALTITUDE AND MAXIMUM MACH NUMBER OBTAINED WITH THE MODIFIED DOUGLAS D-558-II RESEARCH AIRPLANE DURING DEMONSTRATION FLIGHTS. Theodore E. Dahlen. April 1953. 14p. diagrs., tabs. (NACA RM L53B24)

The maximum values of Mach number and altitude obtained with the Douglas D-558-II all-rocket research airplane and determined by the radar-phototheodolite method are presented in this paper.

NACA RM L53C06

FREE-SPINNING-TUNNEL INVESTIGATION TO DETERMINE THE EFFECT OF SPINS AND RECOVERIES OF WING LEADING-EDGE CHORD-EXTENSIONS AND DROOPED LEADING-EDGE FLAPS ON SCALE MODELS OF TWO SWEPTBACK-WING FIGHTER AIRPLANES. Jack H. Wilson and Walter J. Klinar. May 1953. 28p. photo., diagrs., tabs. (NACA RM L53C06)

An investigation was conducted in the Langley 20-foot free-spinning tunnel to determine the effect of wing chord-extensions and drooped leading-edge flaps on the spin and recovery characteristics of models of two swept-wing fighter airplanes. A comparison of the spin and recovery characteristics of each model with and without chord-extensions installed in the chord plane of the wing is presented. Results are also presented for one model with drooped chord-extensions in conjunction with drooped leading-edge flaps.

NACA RM L53D06

SOME MEASUREMENTS OF THE BUFFET REGION OF A SWEPT-WING RESEARCH AIRPLANE DURING FLIGHTS TO SUPERSONIC MACH NUMBERS. Thomas F. Baker. May 1953. 14p. diagrs., photos., tab. (NACA RM L53D06)

Limited measurements have been made of the region in which buffeting has been experienced by the swept-wing Douglas D-558-II research airplane during flights to supersonic Mach numbers. Buffet intensities and frequencies are given.

NACA RM L53E21

ENGINEERING METHOD OF RAM-JET THRUST DETERMINATION BASED ON EXPERIMENTALLY OBTAINED COMBUSTOR PARAMETERS. H. Rudolph Dettwyler and Maxime A. Faget. August 1953. 44p. diagrs., tab. (NACA RM L53E21)

A parameter is presented which simplifies the accounting for pressure losses in ram-jet combustors. The parameter, called the combustor-force coefficient, relates the ratio of the jet force and the total pressure at the combustion-chamber entrance. Experimental data for seven different combustors are presented for evaluation and comparisons. A calculation method is presented which reduces the ram-jet thrust equation to linear relationships and leads to a short method for determination of the proper ram-jet free-stream tube area.

NACA RM L53F02

A TRANSONIC WIND-TUNNEL INVESTIGATION OF THE EFFECT OF MODIFICATIONS TO AN INDENTED BODY IN COMBINATION WITH A 45° SWEPTBACK WING. Donald L. Loving. September 1953. 29p. diagrs., photos., tabs. (NACA RM L53F02)

A force-test investigation was conducted at transonic speeds on wing-body combinations having indented bodies which were modified from the symmetrical

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shape designed on the basis of the transonic drag-rise rule. The wing of the combination had 45° sweepback, an aspect ratio of 4, a taper ratio of 0.6, and NACA 65A006 airfoil sections parallel to the plane of symmetry. The modified indentations were designed specifically to improve the transonic drag characteristics of the wing-body combinations at lifting conditions as well as for the nonlifting case.

NACA RM L53F05

AN INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS AT TRANSONIC MACH NUMBERS OF A SWEPT-WING SUPERSONIC BOMBER CONFIGURATION. Ralph P. Bielat and J. Lawrence Cooper. February 1956. 92p. diagrs., photos., tabs. (NACA RM L53F05)

An investigation of a swept-wing supersonic bomber configuration has been made at transonic speeds in the Langley 8-foot transonic tunnel. The wing had an aspect ratio of 3.5, a taper ratio of 0.2, 47° sweepback of the 0.25-chord line, and airfoil sections which were 5.5 percent thick parallel to the plane of symmetry. The results reported consist of the longitudinal force characteristics of the complete model and of various combinations of its components. The Mach number range extended from 0.70 to approximately 1.11, and the Reynolds number based on the wing mean aerodynamic chord varied from 2.60×10^6 to 2.95×10^6.

NACA RM L53F23

EFFECTS OF LEADING-EDGE SLATS ON THE AERODYNAMIC CHARACTERISTICS OF A 45° SWEPTBACK WING-FUSELAGE CONFIGURATION AT MACH NUMBERS OF 0.4 TO 1.03. Jack F. Runckel and Seymour Steinberg. August 1953. 50p. diagrs., photos. (NACA RM L53F23)

Aerodynamic characteristics of a 45° sweptback wing-fuselage combination with outboard leading-edge slats of 45 percent semispan and 0°, 10°, and 20° slat deflection, and 35 percent-semispan slats having 0° and 10° deflection are presented for Mach numbers from 0.4 to 1.03. Improved performance at high lift coefficients was demonstrated with the slat configurations tested.

NACA RM L53G03a

MEASUREMENTS OBTAINED DURING THE GLIDE-FLIGHT PROGRAM OF THE BELL X-2 RESEARCH AIRPLANE. Richard E. Day. July 30, 1953. 27p. diagrs., photos., tabs. (NACA RM L53G03a)

Results obtained during the glide-flight program of the Bell X-2 research airplane are presented. Limited measurements of flying qualities, landing data, and pilot's comments obtained from the three glide flights are presented.

NACA RM L53I17

SOME MEASUREMENTS OF BUFFETING ENCOUNTERED BY A DOUGLAS D-558-II RESEARCH AIRPLANE IN THE MACH NUMBER RANGE FROM 0.5 TO 0.95. Thomas F. Baker. November 1953. 22p. diagrs., photos., tabs. (NACA RM L53I17)

Measurements of the intensity of buffeting were made with a swept-wing Douglas D-558-II research airplane at subsonic speeds. The variation of buffet intensity with lift, angle of attack, and Mach number is presented. The results are compared with similar measurements made with another Douglas D-558-II airplane at high subsonic and supersonic speeds.

NACA RM L53I22

STATIC LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A 1/16-SCALE MODEL OF THE DOUGLAS D-558-II RESEARCH AIRPLANE AT MACH NUMBERS OF 1.61 AND 2.01. M. Leroy Spearman. November 1953. 34p. diagrs., tabs. (NACA RM L53I22)

The static longitudinal stability and control characteristics of a 1/16-scale model of the D-558-II research airplane are presented for Mach numbers of 1.61 and 2.01. Various combinations of component parts were investigated through an angle-of-attack range from -4° to about 16°. Summary figures are presented to show the variation of certain aerodynamic parameters through a Mach number range from 0.6 to 2.0.

NACA RM L53I22b

DRAG DUE TO LIFT AT MACH NUMBERS UP TO 2.0. Edward C. Polhamus. November 1953. 18p. diagrs. (NACA RM L53I22b)

This report presents a summary of some of the more recent data on drag due to lift at Mach numbers up to 2.0. It includes the effect of Reynolds number, thickness ratio, leading-edge radius, aspect ratio, surface shape, and application of the "area rule."

NACA RM L53I29a

STATIC LATERAL STABILITY CHARACTERISTICS OF A 1/16-SCALE MODEL OF THE DOUGLAS D-558-II RESEARCH AIRPLANE AT MACH NUMBERS OF 1.61 AND 2.01. Frederick C. Grant and Ross B. Robinson. November 1953. 39p. diagrs., photo., tabs. (NACA RM L53I29a)

Static lateral stability characteristics of the complete 1/16-scale model of the Douglas D-558-II research airplane are presented along with the characteristics without wings and without vertical tail and for the body alone. The test Mach numbers were 1.61 and 2.01. The test angles of attack were 0° and 4° at each Mach number. Tables of the static-stability derivatives for the complete and partial models are tabulated and comparisons with flight and theoretical results are made.

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NACA RM L53J20

DETERMINATION OF LONGITUDINAL STABILITY IN SUPERSONIC ACCELERATED MANEUVERS FOR THE DOUGLAS D-558-II RESEARCH AIRPLANE. Herman O. Ankenbruck. February 1954. 29p. diagrs., photos., tab. (NACA RM L53J20)

Flight tests were performed with the Douglas D-558-II research airplane to investigate the longitudinal stability of the airplane in accelerated flight at supersonic speeds to a Mach number of 1.67. This paper shows the conditions where instability occurs at supersonic speeds.

NACA RM L53L10

MEASURED DATA PERTAINING TO BUFFETING AT SUPERSONIC SPEEDS OF THE DOUGLAS D-558-II RESEARCH AIRPLANE. Thomas F. Baker. February 1954. 16p. diagrs., photos., tab. (NACA RM L53L10)

Data pertaining to buffeting have been measured at supersonic speed and high lift with the Douglas D-558-II airplane. Buffeting was encountered at normal-force coefficients greater than about 0.7 in the Mach number range from 0.96 to 1.27 but at a Mach number of 1.57, a peak normal-force coefficient of 0.80 was attained with no indication of buffeting. Buffet intensities at normal-force coefficients up to 1.5 are given for low supersonic Mach numbers. Sample records of flight in rough air at supersonic speed are included.

NACA RM L53L16

EFFECT OF WING SLATS AND INBOARD WING FENCES ON THE LONGITUDINAL STABILITY CHARACTERISTICS OF THE DOUGLAS D-558-II RESEARCH AIRPLANE IN ACCELERATED MANEUVERS AT SUBSONIC AND TRANSONIC SPEEDS. Jack Fischel. February 1954. 125p. diagrs., photos., tabs. (NACA RM L53L16)

The results of subsonic and transonic flight measurements of the longitudinal stability characteristics of the Douglas D-558-II research airplane for several wing-slat and inboard wing-fence configurations are presented at Mach numbers up to 1.0. The improvement provided by fully extended slats, compared to the stability characteristics of the slats-retracted configuration, is shown; and the effects of inboard wing fences on the stability characteristics with slats fully extended are also discussed. Limited data obtained with slats half extended indicated the similarity of this configuration to the slats-retracted configuration. The effects of a bungee (which improved the stick-free stability characteristics) in alleviating the stability changes apparent to the pilot are also discussed.

NACA RM L54F01

THE HYDRODYNAMIC PLANING LIFT OF FOUR SURFACES AS MEASURED IN A 200-FPS FREE JET. John R. McGehee, Bernard Weinflash, and Charles A. Pelz. July 1954. 24p. diagrs., photos. (NACA RM L54F01)

Four types of planing surfaces were tested on a rectangular free-water jet 3 inches wide by 3/4 inch deep at speeds varying from 80 to 200 fps. No large effect of speed was obtained on any of the models tested but the lift coefficients for the flat plate and the longitudinally curved surface appeared to increase slightly with speed in the higher portion of the speed range. The lift data for the flat plate and the hydroski obtained on the free-water jet were less than those obtained for similar surfaces in comparatively unrestricted towing tanks. For the trims and length-beam ratios investigated, the ratio of tank lift data to jet lift data for the flat plate appeared to be a function of the ratio of the height of the trailing edge of the model above the lower jet boundary to the wetted length.

NACA RM L54F02

EXPLORATORY INVESTIGATION OF EXTERNAL STORES ON THE AERODYNAMIC CHARACTERISTICS OF A 1/16-SCALE MODEL OF THE DOUGLAS D-558-II RESEARCH AIRPLANE AT A MACH NUMBER OF 2.01. Norman F. Smith. August 1954. 25p. diagrs., photos. (NACA RM L54F02)

As part of a coordinated investigation of stores on the Douglas D-558-II research airplane in the wind tunnel and in flight, an investigation has been conducted in the Langley 4- by 4-foot supersonic pressure tunnel at a Mach number of 2.01 on a 1/16-scale model of this airplane equipped with various store configurations. The investigation was exploratory in nature and shows overall effects of stores upon the airplane characteristics but does not provide breakdown data necessary to isolate these effects. The drag produced by addition of stores was high for all configurations and is shown to be consistent with values measured in previous investigations for stores in similar positions. Changes in other forces and moments were moderate with the exception of directional stability, which was decreased by one-third by the addition of stores.

NACA RM L54F03

LIFT AND DRAG CHARACTERISTICS OF THE DOUGLAS D-558-II RESEARCH AIRPLANE OBTAINED IN EXPLORATORY FLIGHTS TO A MACH NUMBER OF 2.0. Jack Nugent. August 1954. 20p. diagrs., photo., tab. (NACA RM L54F03)

A flight investigation was made of the Douglas D-558-II swept-wing airplane in the slats-retracted configuration. Lift and drag were determined for Mach numbers up to 2.0. The lift-coefficient range extended from below 0.1 to about 0.7.

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NACA RM L54F09

WIND-TUNNEL INVESTIGATION AT A MACH NUMBER OF 2.01 OF THE AERODYNAMIC CHARACTERISTICS IN COMBINED PITCH AND SIDESLIP OF SOME CANARD-TYPE MISSILES HAVING CRUCIFORM WINGS AND CANARD SURFACES WITH 70° DELTA PLAN FORMS. M. Leroy Spearman and Cornelius Driver. August 1954. 121p. diagrs., tabs. (NACA RM L54F09)

An investigation has been conducted in the Langley 4- by 4-foot supersonic pressure tunnel to determine the static longitudinal stability and control characteristics of several missiles at a Mach number of 2.01. The missiles had cruciform wings and canard surfaces of delta plan form with the leading edges swept 70°. Two models were tested with body fineness ratios of 19.1 and 15.7. The results of the tests are presented for an incidence angle range from -2° to about 26° at various roll angles from 0° to 90°. A resolution of these results provides the aerodynamic characteristics for the missiles at angles of attack up to about 26° at zero sideslip or at combinations of angle of attack and angle of sideslip up to a maximum of about 16° for each.

NACA RM L54F14

INVESTIGATION OF THE EFFECT OF INDENTATION ON AN M-PLAN-FORM-WING—BODY COMBINATION AT TRANSONIC SPEEDS. Donald L. Loving. August 1954. 24p. diagrs., photos., tab. (NACA RM L54F14)

An investigation at transonic speeds was conducted to determine the effect of body indentation on the aerodynamic characteristics of an M-wing—body combination. In addition, a sweptback wing was tested. The wings had 45° of sweep of the quarter-chord line, aspect ratio 6, taper ratio 0.6, and NACA 65A009 airfoil sections parallel to the free stream. Data were obtained at angles of attack from 0° to 12° for a Mach number range from 0.80 to 1.13.

NACA RM L54F15

AN INVESTIGATION OF A SUPERSONIC AIRCRAFT CONFIGURATION HAVING A TAPERED WING WITH CIRCULAR-ARC SECTIONS AND 40° SWEEPBACK. STABILITY AND CONTROL CHARACTERISTICS AT A MACH NUMBER OF 1.61 OF THE COMPLETE CONFIGURATION EQUIPPED WITH SPOILERS. Clyde V. Hamilton and Cornelius Driver. September 1954. 28p. diagrs. (NACA RM L54F15)

Six-component force tests were made in the Langley 4- by 4-foot supersonic pressure tunnel to determine the static stability and control characteristics at a Mach number of 1.61 of a supersonic aircraft configuration equipped with spoilers. Tests were made at angles of attack from -8° to 16° and angles of sideslip from -8° to 8°. Some effects of various types of spoilers, spoiler span, projection, and chordwise position were also investigated.

NACA RM L54F21

A METHOD FOR INCREASING THE EFFECTIVENESS OF STABILIZING SURFACES AT HIGH SUPERSONIC MACH NUMBERS. Charles H. McLellan. August 1954. 14p. diagrs. (NACA RM L54F21)

Large increases in lift-curve slope at low angles of attack at high supersonic Mach numbers can be obtained by the use of wedge-shape airfoil sections. The use of such sections on the tail surfaces operating at low angles of attack on airplanes or missiles traveling at these speeds can greatly decrease the stabilizing-surface area required. Moderate increases in section effectiveness (lift-curve slope) over that for more conventional tail sections can be obtained with little or no increase in total drag because of the decreased surface area required. Larger increases can be obtained; however, they will be accompanied by increases in stabilizing-surface drag.

NACA RM L54F25

EFFECTS OF CANOPY, REVISED VERTICAL TAIL, AND A YAW-DAMPER VANE ON THE AERODYNAMIC CHARACTERISTICS OF A 1/16-SCALE MODEL OF THE DOUGLAS D-558-II RESEARCH AIRPLANE AT A MACH NUMBER OF 2.01. Ross B. Robinson. August 1954. 29p. diagrs., tabs. (NACA RM L54F25)

The aerodynamic characteristics in pitch and sideslip with and without a yaw-damper vane of a revised 1/16-scale model of the Douglas D-558-II research airplane are presented for a Mach number of 2.01. The model was tested through an angle-of-attack range of -2° to about 13° at an angle of sideslip of 0° and an angle-of-sideslip range of -2° to about 10° at an angle of attack of 0°. The results are compared with those previously obtained for the original model configuration.

NACA RM L54G26a

AN INVESTIGATION OF A SUPERSONIC AIRCRAFT CONFIGURATION HAVING A TAPERED WING WITH CIRCULAR-ARC SECTIONS AND 40° SWEEPBACK. STATIC LONGITUDINAL AND LATERAL STABILITY AND CONTROL CHARACTERISTICS AT A MACH NUMBER OF 1.89. M. Leroy Spearman and Edward B. Palazzo. October 1954. 24p. diagrs., photo., tab. (NACA RM L54G26a)

The static longitudinal and lateral stability and control characteristics of a supersonic aircraft configuration are presented for a Mach number of 1.89. The configuration had a wing with 40° sweepback at the quarter-chord line, aspect ratio 4, taper ratio 0.5, and 10-percent-thick circular-arc sections normal to the quarter-chord line. The angle-of-attack range varied from -4° to 28° and the angle of sideslip range varied from -4° to 44°. The results are compared with results previously obtained for Mach numbers of 1.40 to 1.59.

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NACA RM L54H19

AN INVESTIGATION OF A SUPERSONIC AIRCRAFT CONFIGURATION HAVING A TAPERED WING WITH CIRCULAR-ARC SECTIONS AND 40° SWEEPBACK. AERODYNAMIC CHARACTERISTICS OF THE CONFIGURATION EQUIPPED WITH A CANARD CONTROL SURFACE AT A MACH NUMBER OF 1.89. M. Leroy Spearman and Edward B. Palazzo. October 1954. 22p. diagrs., photo., tab. (NACA RM L54H19)

The aerodynamic characteristics at a Mach number of 1.89 are presented for a supersonic aircraft configuration equipped with a canard control surface in addition to a conventional horizontal stabilizer. The configuration had a wing with 40° sweepback at the quarter-chord line, aspect ratio 4, taper ratio 0.5, and 10-percent-thick circular-arc sections normal to the quarter-chord line. The canard had a trapezoidal plan form with an exposed area about one-twelfth of the wing area and was located 2.27 mean aerodynamic chord lengths ahead of the reference center of gravity. The angle-of-attack range varied from -4° to 28° and the angle-of-sideslip range varied from -4° to 44° at $\alpha = 0°$ only.

NACA RM L54L10

EFFECTS OF INCREASING REYNOLDS NUMBER FROM 2×10^6 TO 6×10^6 ON THE AERODYNAMIC CHARACTERISTICS AT TRANSONIC SPEEDS OF A 45° SWEPT WING WITH 6° LEADING-EDGE DROOP. James W. Schmeer and J. Lawrence Cooper. February 1955. 22p. diagrs., photo. (NACA RM L54L10)

An investigation has been made in the Langley 16-foot and 8-foot transonic tunnels to determine the effects of Reynolds number on the aerodynamic characteristics of a 45° swept wing with 6° leading-edge droop. Lift, drag, and pitching-moment results are presented at Reynolds numbers of about 2×10^6 and 6×10^6 through a Mach number range from 0.80 to 1.03. The effects of roughness strips were also investigated. The results showed only small effects of increasing Reynolds number or of adding roughness strips.

NACA RM L55A31

LATERAL STABILITY CHARACTERISTICS AT LOW LIFT BETWEEN MACH NUMBERS OF 0.85 AND 1.15 OF A ROCKET-PROPELLED MODEL OF A SUPERSONIC AIRPLANE CONFIGURATION HAVING A TAPERED WING WITH CIRCULAR-ARC SECTIONS AND 40° SWEEPBACK. Charles T. D'Aiutolo and Allen B. Henning. April 1955. 50p. diagrs., photos., tabs. (NACA RM L55A31)

A rocket-propelled model of a supersonic airplane configuration employing a 40° sweptback wing having circular-arc sections was tested in the Mach number range of 0.85 and 1.15 to obtain lateral stability data at low lift from the lateral response due to an impulsive rudder deflection. The model was statically stable throughout the Mach number range but was dynamically unstable over a small range of Mach numbers. A low-lift buffet was experienced below a Mach number of 0.95. An analysis of the Dutch roll transient oscillations was performed by the time-vector method to obtain the lateral stability derivatives C_{Y_β}, C_{n_β}, C_{l_β}, C_{l_r}, and $C_{n_r} - C_{n_{\dot\beta}}$. Comparisons were made with other data in order to evaluate the test technique.

NACA RM SL55D18, by Shanks.

NACA RM L55E18

ANALYSIS OF EFFECTS OF AIRPLANE CHARACTERISTICS AND AUTOPILOT PARAMETERS ON A ROLL-COMMAND SYSTEM WITH AILERON RATE AND DEFLECTION LIMITING. Albert A. Schy and Ordway B. Gates, Jr. September 1955. 68p. diagrs., tab. (NACA RM L55E18)

The dynamic characteristics of an airplane with a proportional-gain roll-control autopilot are discussed. The significant aspects of the dynamic characteristics of the airplane are analyzed. A comparison of three different high-speed fighter airplanes is presented. The dynamic effects of time lags and various gains in the system are described. REAC results are presented to show the results of limiting the aileron deflection and rate of deflection on the dynamic characteristics of the system.

NACA RM L55F01b

A FLIGHT INVESTIGATION OF THE HANDLING CHARACTERISTICS OF A FIGHTER AIRPLANE CONTROLLED THROUGH AUTOMATIC-PILOT CONTROL SYSTEMS. S. A. Sjoberg. September 1955. 12p. diagrs., tabs. (NACA RM L55F01b)

The paper presents some results of a flight investigation made to obtain experimental information on the handling qualities of a fighter airplane controlled through automatic-pilot control systems. Two types of automatic pilots were used; one of these was of the attitude type and the other was of the rate type.

NACA RM L55F02a

A TRANSONIC WIND-TUNNEL INVESTIGATION OF THE STATIC LONGITUDINAL CHARACTERISTICS OF A 3-PERCENT-THICK, ASPECT-RATIO-3, DELTA WING CAMBERED AND TWISTED FOR HIGH LIFT-DRAG RATIOS. Dale L. Burrows and Warren A. Tucker. August 1955. 38p. diagrs., photos., tab. (NACA RM L55F02a)

A transonic wind-tunnel investigation at Mach numbers from 0.77 to 1.39 was made at angles of attack to 20° and at Reynolds numbers of about 5×10^6 of a 3-percent-thick, aspect-ratio-3, delta wing cambered and twisted for near optimum lift-drag ratios at the design condition of Mach number equal to 1.2 and lift coefficient equal to 0.2. The results when compared with the same wing without camber and

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twist indicate appreciable improvements in drag at lifting conditions and increase in lift-curve slope in the subsonic range and in the region of the design Mach number.

NACA RM L55F07

HIGH-SPEED CASCADE TESTS OF A BLADE SECTION DESIGNED FOR TYPICAL HUB CONDITIONS OF HIGH-FLOW TRANSONIC ROTORS. Melvyn Savage, A. Richard Felix, and James C. Emery. September 1955. 48p. diagrs., photos., tab. (NACA RM L55F07)

High-speed cascade tests were made of a blade section designed specifically for conditions typical of the hub section of high-flow transonic rotors. The blade section has a camber of 1.8, a maximum thickness of 8 percent, an arbitrarily selected A_6I_{4b} mean line (which has more of its loading in the rearward portion of the blade), and a thickness distribution which has its maximum thickness at the 65-percent-chord point and is somewhat similar to the NACA 65-series thickness distribution reversed. The tests were made at four combinations of inlet angle and angle of attack at a solidity of 1.5. The inlet angles ranged from 26.9° to 34.1°. Measurements of surface pressure distribution, profile momentum loss, and turning angle, as well as schlieren photographs, were made for inlet Mach numbers ranging from 0.30 to the blade choke condition.

NACA RM L55F09a

A FREE-FLIGHT INVESTIGATION OF THE EFFECTS OF SIMULATED SONIC TURBOJET EXHAUST ON THE DRAG OF A BOATTAIL BODY WITH VARIOUS JET SIZES FROM MACH NUMBER 0.87 TO 1.50. Ralph A. Falanga. August 1955. 23p. diagrs., photos., tab. (NACA RM L55F09a)

Three 7.5° boattail bodies of revolution with varying base-annulus areas and jet sizes provided with simulated-turbojet-exhaust rocket motors were flight tested to determine the jet interference effects on body drag over a Mach number range from approximately 0.87 to 1.5. It was found that, in the transonic and low supersonic speed range, the jet caused positive pressure increments on the base and boattail which appreciably reduced the configuration drag from the power-off condition; whereas at the higher supersonic speeds, the jet caused positive pressure increments only on the base resulting in a smaller drag reduction.

NACA RM L55F22a

INVESTIGATION AT TRANSONIC SPEEDS OF AERODYNAMIC CHARACTERISTICS OF AN UNSWEPT SEMIELLIPTICAL AIR INLET IN THE ROOT OF A 45° SWEPTBACK WING. Gene J. Bingham. September 1955. 37p. diagrs., photos., tabs. (NACA RM L55F22a)

An investigation has been made in the Langley transonic blowdown tunnel at Mach numbers from 0.65 to 1.40 to study the internal and external aerodynamic characteristics of an unswept semielliptical air intake with 30° lip stagger installed in the root of a 45° sweptback wing. Tests were made through an angle-of-attack range from 0° to 9.6° at mass-flow ratios from about 0.55 to 0.90. The results of this investigation have been compared with those of a similar inlet swept back along the wing leading edge. Increases in compressor-face total-pressure recovery with decreasing mass-flow ratio were effected at all test conditions because of a "natural" bypassing of the fuselage boundary layer around the inlet. This unusual phenomenon resulted in normal-shock recovery at a mass-flow ratio of 0.65 for a Mach number of 1.40.

NACA RM L55F23

AERODYNAMIC CHARACTERISTICS AT MACH NUMBERS FROM 0.7 TO 1.75 OF A FOUR-ENGINE SWEPT-WING AIRPLANE CONFIGURATION AS OBTAINED FROM A ROCKET-PROPELLED MODEL TEST. Rowe Chapman, Jr. September 1955. 39p. diagrs., photos., tabs. (NACA RM L55F23)

Drag and stability data obtained from free-flight test of a rocket-propelled model of a swept-wing airplane configuration are presented for Mach numbers from 0.70 to 1.75. The configuration had four nacelles closely coupled underneath the wing for which pressure recovery, mass flow, and internal drag data are presented. Test data cover lift coefficients from 0 to 0.40 at subsonic speeds and -0.05 to 0.12 at supersonic speeds. Results from the present test are compared with unpublished data from tunnel tests of similar configurations.

NACA RM L55F27

LONGITUDINAL CHARACTERISTICS AT TRANSONIC AND SUPERSONIC SPEEDS OF A ROCKET-PROPELLED AIRPLANE MODEL HAVING A 60° DELTA WING AND A LOW SWEPT HORIZONTAL TAIL. Robert F. Peck and Lucille C. Coltrane. September 1955. 33p. diagrs., photo., tabs. (NACA RM L55F27)

A rocket-propelled model has been flown to determine the longitudinal stability and drag characteristics of an airplane configuration having a 60° delta wing (with an NACA 65A003 airfoil section) and a swept horizontal tail mounted near the wing plane extended. Comparisons are made between this model and a

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model with the same wing-fuselage combination but with a horizontal tail considerably above the wing plane extended. Comparisons are also made with two models with the same fuselage-tail arrangement as the present test model but one with a 52.5° delta wing and the other with a diamond wing.

NACA RM L55H16

WIND-TUNNEL MEASUREMENTS OF THE DYNAMIC CROSS DERIVATIVE $C_{l_r} - C_{l_{\dot{\beta}}}$ (ROLLING MOMENT DUE TO YAWING VELOCITY AND TO ACCELERATION IN SIDESLIP) OF THE DOUGLAS D-558-II AIRPLANE AND ITS COMPONENTS AT SUPERSONIC SPEEDS INCLUDING DESCRIPTION OF THE TECHNIQUE. William B. Boatright. November 1955. 57p. diagrs., photos. (NACA RM L55H16)

A technique is described and results are presented of wind-tunnel forced-oscillation tests of a model of the Douglas D-558-II research airplane instrumented to obtain the dynamic cross derivative, rolling moment due to yawing velocity and to acceleration in sideslip $C_{l_r} - C_{l_{\dot{\beta}}}$, and the static rolling moment due to sideslip C_{l_β}. The tests were conducted at Mach numbers 1.62, 1.94, and 2.41 for an angle-of-attack range from 0° to 8°. Results of the component tests of the body wing and the body tail, which were made at Mach numbers 1.62 and 2.41, are also presented.

NACA RM L55I07

TRANSONIC WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF EXTERNAL STORES AND STORE POSITION ON THE AERODYNAMIC CHARACTERISTICS OF A 1/16-SCALE MODEL OF THE DOUGLAS D-558-II RESEARCH AIRPLANE. Thomas C. Kelly. November 1955. 31p. diagrs., photos., tab. (NACA RM L55I07)

Tests have been conducted in the Langley 8-foot transonic tunnel at Mach numbers from 0.60 to 1.15 and angles of attack from approximately -2° to 12° to study the effects of adding pylon-suspended external stores to a 1/16-scale model of the Douglas D-558-II research airplane. Results indicate that the drag penalty incurred by adding external stores at the 0.61-semispan location may be reduced slightly at transonic speeds by positioning the stores at the 0.44-semispan location in order to obtain an improvement in the longitudinal area development.

NACA RM L56E25

WIND-TUNNEL INVESTIGATION AT HIGH SUBSONIC SPEEDS OF JET, SPOILER, AND AILERON CONTROLS ON A 1/16-SCALE MODEL OF THE DOUGLAS D-558-II RESEARCH AIRPLANE. Raymond D. Vogler. July 1956. 52p. diagrs., photo., tabs. (NACA RM L56E25)

An investigation of jet, spoiler, and aileron controls on a 1/16-scale model of the D-558-II research airplane has been made in the Langley high-speed 7- by 10-foot tunnel at Mach numbers from 0.60 to 0.96. All controls gave considerable effectiveness through the angle-of-attack range though much less above 12° than at small angles of attack. The jet control with the jet holes located at the wing trailing edge and supplied with ram air from wing-tip inlets gave constant effectiveness through the Mach range while the ailerons and spoilers decreased between Mach numbers 0.90 and 0.96. Data were obtained for variations in jet-control span and jet diameter, and for drag comparisons of the three controls.

NACA RM L56F07

WIND-TUNNEL INVESTIGATION OF THE DAMPING IN ROLL OF THE DOUGLAS D-558-II RESEARCH AIRPLANE AND ITS COMPONENTS AT SUPERSONIC SPEEDS. Russell W. McDearmon. September 1956. 36p. diagrs., photos. (NACA RM L56F07)

Investigations of the damping in roll at zero angle of attack of the Douglas D-558-II research airplane have been made in the Langley 9-inch supersonic tunnel. The damping in roll of the complete configuration and the contributions of the components to the damping in roll were measured at Mach numbers of 1.62, 1.94, 2.22, 2.41, and 2.62. Also, some effects of Reynolds number, boundary layer, wing-incidence angle, and the canopy on the damping in roll were determined. Comparisons were made with some theoretical predictions.

NACA RM L56F07a

RESULTS FROM AN INVESTIGATION IN ROUGH AIR AT MACH NUMBERS FROM 0.84 TO 1.67 OF A TAILLESS ROCKET MODEL HAVING 60° TRIANGULAR WINGS. A. James Vitale. July 1956. 16p. diagrs., photo., tab. (NACA RM L56F07a)

A flight investigation has been made in rough air from Mach numbers 0.84 to 1.67 of a tailless rocket model having cruciform 60° triangular wings. Test results are presented in the form of time histories of acceleration, power spectra of acceleration, and the variation of root-mean-square acceleration increment with Mach number.

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NACA RM L56F11

HINGE MOMENT AND EFFECTIVENESS OF AN UNSWEPT CONSTANT-CHORD CONTROL AND AN OVERHANG-BALANCED, SWEPT HINGE-LINE CONTROL ON AN 80° SWEPT POINTED WING AT MACH NUMBERS FROM 0.75 TO 1.96. Lawrence D. Guy. August 1956. 39p. diagrs., photo. (NACA RM L56F11)

A wind-tunnel investigation has been made of an unswept constant-chord control and an overhang-balanced, swept hinge-line control on an 80° swept pointed wing. Control hinge moment and effectiveness characteristics were obtained for control deflections up to 25° over an angle-of-attack range of ±16° at Mach numbers from 0.75 to 1.96. Reynolds numbers varied between 3.2×10^6 and 4.4×10^6.

NACA RM L56F13a

WIND-TUNNEL INVESTIGATION OF DAMPING IN ROLL AT SUPERSONIC SPEEDS OF TRIANGULAR WINGS AT ANGLES OF ATTACK. Russell W. McDearmon and Robert A. Jones. September 1956. 32p. diagrs., photos., tab. (NACA RM L56F13a)

The damping in roll of three triangular wings has been obtained in the Langley 9-inch supersonic tunnel at Mach numbers of 1.62, 1.94, 2.22, 2.41, and 2.62 over a range of angle of attack of approximately 0° to 13°. Comparisons are made with predictions of the damping in roll from linear theory. Angle of attack had no significant effect on the damping in roll for the range of angles of attack investigated.

NACA RM L56F15

INVESTIGATION OF SPOILER-SLOT-DEFLECTOR AILERONS AND OTHER SPOILER AILERONS ON A 45° SWEPTBACK-WING—FUSELAGE COMBINATION AT MACH NUMBERS FROM 0.60 TO 1.03. F. E. West, Jr., Charles F. Whitcomb, and James W. Schmeer. September 1956. 59p. diagrs., tab. (NACA RM L56F15)

Tests were made in the Langley 16-foot transonic tunnel to evaluate several types of spoiler ailerons. Six-component force and moment data were obtained on a 45° sweptback-wing—body combination at Mach numbers from 0.60 to 1.03 (Reynolds number from 5.05×10^6 to 6.0×10^6) and angles of attack from 0° to about 20°. Variations in configuration included: removal of small inboard segments from a flap-type spoiler, spoiler-slot-deflector ailerons with different length deflectors, changes in projection of a deflector aileron, and addition of wing leading-edge chord-extensions.

NACA RM L56F18

LOW-SPEED INVESTIGATION OF THE LATERAL-CONTROL CHARACTERISTICS OF A FLAP-TYPE SPOILER AND A SPOILER-SLOT-DEFLECTOR ON A 30° SWEPTBACK WING-FUSELAGE MODEL HAVING AN ASPECT RATIO OF 3, A TAPER RATIO OF 0.5, AND NACA 65A004 AIRFOIL SECTION. Alexander D. Hammond. August 1956. 25p. diagrs., tab. (NACA RM L56F18)

A wind-tunnel investigation was made at low speed to determine the effect of deflector projection on the control effectiveness of spoiler-slot-deflectors on a 30° sweptback wing-fuselage model equipped with a 15-percent-chord spoiler, slot, and deflector that extended from the 20- to the 99-percent semispan station of the right wing. The tests were made at angles of attack from -4° to 24° at a Mach number of 0.26, which corresponds to a Reynolds number of 2.6×10^6, and for control projections from 0 to 12 percent of the wing chord. The deflector of the spoiler-slot-deflector configurations was tested at projections from zero to a projection equal to the spoiler projection at each control projection.

NACA RM L56F21

TRANSONIC WIND-TUNNEL INVESTIGATION OF STATIC LONGITUDINAL FORCE AND MOMENT CHARACTERISTICS OF TWO WING-BODY COMBINATIONS WITH CLIPPED-TIP AND FULL DELTA WINGS OF ASPECT RATIO 1.73. Dale L. Burrows. September 1956. 26p. diagrs. (NACA RM L56F21)

Wind-tunnel tests at Mach numbers from 0.76 to 1.39 have been made on two low-aspect-ratio wing-body combinations to obtain lift, drag, and pitching-moment data at angles of attack up to 20° and at Reynolds numbers up to about 7×10^6. A 4-percent-thick clipped delta wing (taper ratio 0.4) and a 3-percent-thick full delta wing were tested. In general, the full delta wing had better drag and pitching-moment characteristics but lower lift-curve slopes as compared with clipped wing.

NACA RM L56F21a

STATISTICAL MEASUREMENTS OF LANDING CONTACT CONDITIONS OF FIVE MILITARY AIRPLANES DURING ROUTINE DAYTIME OPERATIONS. Norman S. Silsby. August 1956. 17p. diagrs., tabs. (NACA RM L56F21a)

Statistical measurements of contact conditions have been obtained by means of a special photographic technique of about 100 to 300 landings for each of five military airplanes made during routine daytime operations in clear air. The types were the Lockheed F-94C jet interceptor, the Republic F-84F jet fighter bomber, the Lockheed T-33 jet trainer, the Martin B-57 jet bomber, and the Douglas B-26 twin-propeller bomber. Vertical velocities, bank angles, rolling velocities, and airspeeds at the instant before contact, and touchdown locations from the start of the 8,000-foot runway have been evaluated. A limited statistical analysis of the results has been made.

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NACA RM L56J03

STATIC LONGITUDINAL CHARACTERISTICS AT HIGH SUBSONIC SPEEDS OF A COMPLETE AIRPLANE MODEL WITH A HIGHLY TAPERED WING HAVING THE 0.80 CHORD LINE UNSWEPT AND WITH SEVERAL TAIL CONFIGURATIONS. Kenneth W. Goodson. January 1957. 57p. diagrs., photo., tabs. (NACA RM L56J03)

The present paper presents static longitudinal stability characteristics at high subsonic speeds of a wing-fuselage model having an aspect-ratio-4.0 wing with zero taper and an unswept 0.80 chord line. The pointed wing was modified by clipping small portions off the wing tips to form wings with aspect ratios of 3.50, 3.25, and 3.00. The aspect-ratio-3.50 wing was extensively tested as a complete model with various horizontal and vertical-tail combinations. The tail configurations consisted of a chord-plane horizontal tail, a high or T-tail configuration, and a combined T-tail and chord-plane tail (biplane tail) configuration.

NACA RM L56K02

INVESTIGATION OF THE INFLUENCE OF THE BOUNDARIES OF A HIGH-SPEED FREE WATER JET ON THE PLANING LIFT OF A FLAT PLATE. John R. McGehee. March 1957. 21p. diagrs., photos. (NACA RM L56K02)

In order to determine the influence of the boundaries of a high-speed free water jet on planing lift, a flat plate was tested in jets having a constant width and variable depths, a constant depth and variable widths, and was also tested in Langley tank no. 2, which has relatively great depth and great width. No appreciable influence of speed on the planing lift coefficient for speeds from 50 to 200 feet per second was observed. Apparently, a jet having a width of three model beams and a depth of two model beams is sufficient to give the equivalent of tank planing data obtained from the same size model for the range of parameters covered in this investigation.

NACA RM L57F25

EFFECT OF NOSE SHAPE ON SUBSONIC AERODYNAMIC CHARACTERISTICS OF A BODY OF REVOLUTION HAVING A FINENESS RATIO OF 10.94. Edward C. Polhamus. August 1957. 29p. diagrs. (NACA RM L57F25)

The effect of nose shape on the aerodynamic characteristics of a body of revolution having a fineness ratio of 10.94 is presented for Mach numbers up to 0.90 and angles of attack up to 22°. Six different nose shapes which were investigated included flat-faced noses having various corner radii, a hemispherical nose, and two ogival noses.

NACA RM L57I06

EFFECT OF BOUNDARY SOLIDITY ON PLANING LIFT OBTAINED IN A HIGH-SPEED WATER JET WITH A SINGLE LONGITUDINAL SLOT IN EACH RIGID BOUNDARY. Bernard Weinflash. October 1957. 27p. diagrs., photos. (NACA RM L57I06)

Hydrodynamic planing-lift forces were obtained with a 0.72-inch-beam flat plate at speeds of 200 and 100 feet per second in a rectangular jet 3.00 inches wide and 1.50 inches deep for trims and length-beam ratios corresponding to drafts up to 100 percent of the jet depth. The jet had rigid side and bottom boundaries with longitudinal-slot configurations varying from 0 to 100 percent in solidity. At a solidity of about 72 percent all the jet data were within 5 percent of the infinite-boundary values. No significant difference was noted between data obtained at 200 and at 100 feet per second.

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NACA Rept. 1332

SEAT DESIGN FOR CRASH WORTHINESS. I. Irving Pinkel and Edmund G. Rosenberg. 1957. ii, 16p. diagrs., photos., tab. (NACA Rept. 1332. Supersedes TN 3777)

On the basis of deceleration data obtained in full-scale crashes, a description of crash deceleration pulses is presented which is suitable for seat design. Charts are presented for obtaining the maximum deceleration loads experienced by the seat and passenger in response to their crash deceleration pulses. Finally, a method is presented for determining the seat strength, spring stiffness, and deformation beyond the elastic limit required to serve in a crash deceleration pulse of given description. Measurement of passenger decelerations in full-scale laboratory and crash studies shows that the general principles presented in the report apply.

NACA TM 1414

AERODYNAMIC RESEARCH ON FUSELAGES WITH RECTANGULAR CROSS SECTION. (Aerodynamische Untersuchungen an Rümpfen mit rechteckähnlichem Querschnitt.) K. Maruhn. July 1958. 37p. diagrs. (NACA TM 1414. Translation from Jahrbuch 1942 der deutschen Luftfahrtforschung, p. 263-279.)

The two-dimensional flow characteristics around square and rectangular cross sections with rounded edges as calculated by conformal mapping techniques are presented and compared with corresponding results from elliptical and rectangular cross sections. A few examples of the fuselage induced rolling moment due to sideslip are presented.

NACA TN 4085

METHOD OF SPLIT RIGIDITIES AND ITS APPLICATION TO VARIOUS BUCKLING PROBLEMS. P. P. Bijlaard, Cornell University. July 1958. 97p. diagrs., tabs. (NACA TN 4085)

A comprehensive treatise on the method of split rigidities is presented. The method is applied to a number of buckling problems. The accuracy of the method is shown by comparing the results of the method with the results of exact solutions.

NACA TN 4100

VIBRATION SURVEY OF FOUR REPRESENTATIVE TYPES OF AIR-COOLED TURBINE BLADES. Howard F. Calvert and Gordon T. Smith. July 1958. 22p. diagrs., photos., tabs. (NACA TN 4100)

The vibrational characteristics, frequencies, and stresses were determined both with and without coolant flow for four types of air-cooled turbine blades utilized in turbine-cooling research. Two types had a standard 4-inch span and two types had a long 6-1/4 inch span. The blade vibrational frequencies increased from 2 to 3 percent with coolant flow. The standard-span blades exhibited only resonant-type vibrations, whereas the long-span blades vibrated at all engine speeds. Static fatigue tests were also conducted with the same blades used for the engine investigation.

NACA TN 4135

INFLUENCE OF SOLID-BODY ROTATION ON SCREEN-PRODUCED TURBULENCE. Stephen C. Traugott, Johns Hopkins University. August 1958. 100p. diagrs., photos. (NACA TN 4135)

The influence of solid-body rotation on a screen-produced turbulence in a flow between concentric, rotating cylinders has been investigated. Radial distributions of the three components of turbulence intensity and the three turbulent shear stresses were measured at a fixed distance downstream of the screen both with and without rotation. An energy balance is made for the three intensities from measured decay and dissipation terms. In addition, the change of the axial and peripheral mean velocity profiles with distance along the axis of rotation is presented.

NACA TN 4255

WIND-TUNNEL INVESTIGATION AT LOW SPEEDS OF FLIGHT CHARACTERISTICS OF A SWEPTBACK-WING JET-TRANSPORT AIRPLANE MODEL EQUIPPED WITH AN EXTERNAL-FLOW JET-AUGMENTED SLOTTED FLAP. Joseph L. Johnson, Jr. July 1958. 32p. diagrs., photos., tab., film suppl. available on request. (NACA TN 4255)

The investigation was made over a lift-coefficient range up to about 12.5 for a range of angles of attack from -12° to about 13°. For lift coefficients higher than about 6, a downwardly directed nose jet was used to supplement the trimming power of the horizontal tail. Flight characteristics of the model without the nose jet were generally satisfactory up to a lift coefficient of about 4. Flight characteristics of the model with the nose jet were generally satisfactory

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over the test lift-coefficient range, but the control effectiveness provided by conventional control surfaces was barely sufficient for maintaining flight at a lift coefficient of 12.5.

NACA TN 4277

A BODY MODIFICATION TO REDUCE DRAG DUE TO WEDGE ANGLE OF WING WITH UNSWEPT TRAILING EDGE. William C. Pitts and Jack N. Nielsen. July 1958. 13p. (NACA TN 4277)

This paper considers a term in Ward's slender-body-theory drag formula that is neglected in engineering applications of the transonic area rule. This term depends only upon the cross-sectional shape and surface slopes at the model base, and is therefore independent of the cross-sectional area distribution. For the particular case considered it is found that (neglecting any change in base drag) a drag reduction is obtainable which is an additional 12 percent of that obtained with the area-rule modification. The probable effect of viscosity on this theoretical result is discussed.

NACA TN 4279

EFFECTS OF FIXING TRANSITION ON THE TRANSONIC AERODYNAMIC CHARACTERISTICS OF A WING-BODY CONFIGURATION AT REYNOLDS NUMBERS FROM 2.4 TO 12 MILLION. Lynn W. Hunton. July 1958. 56p. diagrs. (NACA TN 4279)

A wing-body combination having a plane tapered wing of aspect ratio 3 and 3-percent-thick biconvex sections was tested. Lift, drag, and pitching-moment results are shown for Mach numbers from 0.7 to 1.3 and Reynolds numbers from 2.4 to 12 million. The large effects of Reynolds number found for the model were practically eliminated when transition was fixed with a single element wire on both the body and the wings.

NACA TN 4280

PRESSURE DISTRIBUTIONS AT TRANSONIC SPEEDS FOR SLENDER BODIES HAVING VARIOUS AXIAL LOCATIONS OF MAXIMUM DIAMETER. John B. McDevitt and Robert A. Taylor. July 1958. 112p. diagrs., photo. (NACA TN 4280)

The measured static-pressure distributions at the model surface and in the surrounding flow field are presented for a related series of five bodies of revolution having various axial locations of maximum cross-sectional area. The bodies were tested at zero angle of attack through a Mach number range from 0.80 to 1.20.

NACA TN 4282

BOUNDARY-LAYER STABILITY DIAGRAMS FOR ELECTRICALLY CONDUCTING FLUIDS IN THE PRESENCE OF A MAGNETIC FIELD. Vernon J. Rossow. August 1958. 32p. diagrs., tabs. (NACA TN 4282)

Neutral stability curves pertaining to a two-dimensional infinitesimal sinusoidal disturbance are presented for the laminar flow of an incompressible, electrically conducting fluid over a semi-infinite flat plate in the presence of either a coplanar or transverse magnetic field. The magnetic field is found to be stabilizing in all of the cases studied except one.

NACA TN 4294

EFFECTS OF NOSE SHAPE AND SPRAY CONTROL STRIPS ON EMERGENCE AND PLANING SPRAY OF HYDRO-SKI MODELS. John R. McGehee. July 1958. 28p. diagrs., photos. (NACA TN 4294)

The emergence-spray characteristics of the models with various bow shapes were investigated for depths of submersion of the bow from 0.50 inch to -0.50 inch. The planing-spray characteristics of the models with the various deflectors were determined for a draft corresponding to a length-beam ratio of 4. This investigation was performed for trims of 12° and 20° at a speed of 30 feet per second. The emergence-spray and planing-spray patterns are shown in photographs.

NACA TN 4297

FLIGHT INVESTIGATION OF THE ACCEPTABILITY OF A SMALL SIDE-LOCATED CONTROLLER USED WITH AN IRREVERSIBLE HYDRAULIC CONTROL SYSTEM. Helmut A. Kuehnel and Robert W. Sommer. July 1958. 19p. diagrs., photos., tabs. (NACA TN 4297)

Results indicate that the side location of the controller is consistent with pilot comfort and the airplane is flyable with this type of controller. Hand motion pivoting at the wrist is somewhat uncomfortable when large stick deflections and forces are required for longitudinal control. Results are based on the opinions of six pilots and are supported by time-history records of typical flight runs.

NACA TN 4300

HEAT-TRANSFER AND PRESSURE MEASUREMENTS ON FLAT-FACED CYLINDERS AT A MACH NUMBER OF 2. William E. Stoney, Jr., and J. Thomas Markley. July 1958. 38p. diagrs., photos., tab. (NACA TN 4300)

Flat-faced cylinders of 12-inch diameter and 4-inch diameter were tested at a Mach number of 2 and sea-level conditions in a preflight jet. The pressure

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data from the 4-inch-diameter model agreed well with the results of several other investigations. The stagnation-point pressure gradient was indicated to be about 30 percent of the gradient on a hemisphere of equivalent size. The heat-transfer data agreed reasonably well with the theoretical results when the flow was laminar. The stagnation-point heating rates of a flat face were approximately 55 percent of the stagnation heating rates on a hemisphere of equal diameter.

NACA TN 4305

WIND-TUNNEL INVESTIGATION OF EFFECTS OF SPOILER LOCATION, SPOILER SIZE, AND FUSELAGE NOSE SHAPE ON DIRECTIONAL CHARACTERISTICS OF A MODEL OF A TANDEM-ROTOR HELICOPTER FUSELAGE. James L. Williams. July 1958. 44p. diagrs., photos., tab. (NACA TN 4305)

The results of a low-speed investigation in the Langley stability tunnel on a model of a tandem-rotor helicopter fuselage showed that spoiler size, spoiler location, and fuselage nose shape were important factors in the directional stability characteristics of the fuselage-tail configuration. Tuft-grid pictures showed that the tail operated in an adverse flow field that resulted in a low tail effectiveness.

NACA TN 4312

INTERNAL CHARACTERISTICS AND PERFORMANCE OF AN AERODYNAMICALLY CONTROLLED, VARIABLE-DISCHARGE CONVERGENT NOZZLE. Jack G. McArdle. July 1958. 33p. diagrs., photo., tabs. (NACA TN 4312)

The effective flow area of a convergent exhaust nozzle was reduced as much as 67 percent by injecting a secondary jet into the nozzle near the exit. Analytical expressions relating the performance with significant operating and design variables were developed, and experimental coefficients were evaluated. Some configurations were operated as jet deflectors.

NACA TN 4313

EFFECT OF FAVORABLE PRESSURE GRADIENTS ON TRANSITION FOR SEVERAL BODIES OF REVOLUTION AT MACH 3.12. John R. Jack. July 1958. 28p. diagrs., photo. (NACA TN 4313)

Transition locations on two constant-pressure-gradient models and two power-profile models ($r \propto x^n$) were compared with those from a conventional cone. A constant pressure gradient $[d(p/p_0)/dx]$ of -0.10 per inch increased the distance to transition by a factor of 1.58 times that for a cone, whereas the combined effect of blunting and a favorable pressure gradient increased the distance to transition by a factor of 2.7 times that obtained for a cone. In each case the transition Reynolds number based on local conditions was independent of unit Reynolds number.

NACA TN 4314

ICING FREQUENCIES EXPERIENCED DURING CLIMB AND DESCENT BY FIGHTER-INTERCEPTOR AIRCRAFT. Porter J. Perkins. July 1958. 30p. diagrs., tabs. (NACA TN 4314)

Relative frequencies of occurrence and severity of icing cloud layers encountered up to an altitude of 30,000 feet are presented. Jet fighters on routine operations of the Air Defense Command (USAF) near Duluth, Minnesota, and Seattle, Washington, were equipped with icing meters for 1 year. Icing occurred on approximately 5 percent of the flights, with ice-accretion thickness averaging less than 1/32 inch on a small sensing probe. Probabilities of icing severity (including average liquid-water content and maximum ice accretion) were calculated using earlier data measured in icing clouds.

NACA TN 4315

AN ESTIMATE OF THE FLUCTUATING SURFACE PRESSURES ENCOUNTERED IN THE REENTRY OF A BALLISTIC MISSILE. Edmund E. Callaghan. July 1958. 18p. diagrs. (NACA TN 4315)

An analysis of the sound pressure levels encountered during the reentry of a blunt-nosed vehicle shows the probability of the existence of levels of 150 decibels or more. The exposure time to high levels is short, that is, of the order of 25 seconds. The results are presented in terms of dimensionless parameters, which cover a wide range of conditions in regard to body size and weight and reentrance angle and velocity.

NACA TN 4318

ANALYTICAL RELATION FOR WAKE MOMENTUM THICKNESS AND DIFFUSION RATIO FOR LOW-SPEED COMPRESSOR CASCADE BLADES. Seymour Lieblein. August 1958. 31p. diagrs. (NACA TN 4318)

Presents derivation of simple equation for blade-wake momentum thickness as function of suction-surface diffusion ratio that describes previously reported experimental correlation. Equation is based on boundary-layer theory in conjunction with simplifying approximations and empirical constants. Calculations are made from derived equation to indicate the comparative effects on the limiting diffusion ratio of blade-chord Reynolds number, surface roughness, and location of transition. Results are utilized for discussions of experimental correlations and general blade design considerations.

NACA TN 4329

INFLUENCE OF HEAT TREATMENT ON MICROSTRUCTURE AND HIGH-TEMPERATURE PROPERTIES OF A NICKEL-BASE PRECIPITATION-HARDENING ALLOY. R. F. Decker, John P. Rowe, W. C. Bigelow, and J. W. Freeman, University of Michigan. July 1958. 53p. diagrs., photos., tabs. (NACA TN 4329)

Studies were made of the influence of various heat treatments on the rupture properties and microstructure of a 55Ni-20Cr-15Co-4Mo-3Ti-3Al alloy to

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provide more fundamental information on the relationships between structure and high-temperature properties in alloys of this type. The effects of variations in solution treatment, cooling rate after solution treatment, and aging treatment on the stress-rupture properties of the alloy at 1,600° F and 25,000 psi were measured and related to variations in the size and distribution of precipitates within the alloy and to residual rolling effects.

NACA TN 4341

LOW-SPEED EXPERIMENTAL DETERMINATION OF THE EFFECTS OF LEADING-EDGE RADIUS AND PROFILE THICKNESS ON STATIC AND OSCILLATORY LATERAL STABILITY DERIVATIVES FOR A DELTA WING WITH 60° OF LEADING-EDGE SWEEP. Herman S. Fletcher. July 1958. 45p. diagrs., photos., tabs. (NACA TN 4341)

Six delta-wing models with 60° of leading-edge sweep were oscillated about their vertical axes to determine the effects of systematic variation of leading-edge radius and profile thickness on the in-phase and out-of-phase combination lateral stability derivatives resulting from the motion. The results showed that, in general, increasing the leading-edge radius caused noticeable decreases in all the derivatives and increasing the airfoil thickness reduced the effective-dihedral parameter.

NACA TN 4351

SUMMARY OF METHODS OF MEASURING ANGLE OF ATTACK ON AIRCRAFT. William Gracey. August 1958. 29p. diagrs. (NACA TN 4351)

Wind-tunnel calibrations of three types of angle-of-attack sensing devices - the pivoted vane, the differential pressure tube, and the null-seeking pressure tube - are presented. Flight data on the position errors of three sensor locations - ahead of the fuselage nose, ahead of the wing tip, and on the forebody of the fuselage - are also presented. Various methods for calibrating angle-of-attack installations in flight are briefly described.

NACA TN 4355

LOW TIP MACH NUMBER STALL CHARACTERISTICS AND HIGH TIP MACH NUMBER COMPRESSIBILITY EFFECTS ON A HELICOPTER ROTOR HAVING AN NACA 0009 TIP AIRFOIL SECTION. Robert D. Powell, Jr., and Paul J. Carpenter. July 1958. 28p. diagrs. (NACA TN 4355)

An investigation has been conducted on the Langley helicopter test tower to determine experimentally the low tip Mach number maximum mean lift coefficient and high tip Mach number compressibility effects on a helicopter rotor having an NACA 0009 airfoil tip section, an NACA 0017 airfoil root section, and 5.4° of negative twist. Data, presented for blade-tip Mach numbers ranging from 0.28 to 0.72 (corresponding blade-tip Reynolds number range of 1.65×10^6 to 4.29×10^6), have been compared with two-dimensional data as well as with other rotor experimental data.

NACA TN 4359

A REVIEW OF THE THERMODYNAMIC, TRANSPORT, AND CHEMICAL REACTION RATE PROPERTIES OF HIGH-TEMPERATURE AIR. C. Frederick Hansen and Steve P. Heims. July 1958. 33p. diagrs. (NACA TN 4359)

Thermodynamic and transport properties of high-temperature air, and the reaction rates for the important chemical processes which occur in air, are reviewed. Semiempirical, analytic expressions are presented for thermodynamic and transport properties of air. Examples are given illustrating the use of these properties to evaluate (1) equilibrium conditions following shock waves, (2) stagnation region heat flux to a blunt, high-speed body, and (3) some chemical relaxation lengths in stagnation region flow.

NACA TN 4361

IDEALIZED WINGS AND WING-BODIES AT A MACH NUMBER OF 3. Elliott D. Katzen. July 1958. 11p. diagrs. (NACA TN 4361)

Calculations indicate the possibility of obtaining high lift-drag ratios at a Mach number of 3, and some experiments which were designed to exploit the theory are described. The relatively high lift-drag ratios calculated were partly realized. A trimmed lift-drag ratio of 9 was obtained, instead of the estimated value of 11, at the maximum test Reynolds number of 3.5 million (based on wing mean aerodynamic chord).

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N-40490X*

Aeronautical Research Council (Gt. Brit.)
THE ICING OF COMPRESSOR BLADES AND THEIR PROTECTION BY SURFACE HEATING. G. L. Shires and G. E. Munns. 1958. 41p. diagrs., photos., tabs. ARC R & M 3041; ARC 18,246 Supersedes NGTE Report R. 178.
(Ask for N-40490X*)

Experiments with surface-heated inlet guide vanes and stator blades were performed in the icing tunnel at the RAE. An electrically heated blade, having almost uniform surface temperature, was developed and then used to determine the effects of air velocity and icing conditions on the minimum heat flow required to prevent the formation of ice. The theoretical method, by J. K. Hardy, of calculating this heat requirement shows reasonable agreement with the

*AVAILABLE ON LOAN ONLY.

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experimental results. Steel, copper, and copper-plated gas-heated blades with various internal passage shapes were also tested and their heat requirement compared with those of the corresponding electrically heated blades under the same external conditions. Finally, a method of estimating the pressure drop through the gas-heated blades is suggested.

N-42198X*

Aeronautical Research Council (Gt. Brit.)
SOME FACTORS INFLUENCING THE SPEED OF RESPONSE OF HYDRAULIC POSITION SERVO-MECHANISMS. C. W. Lewis. 1958. 13p. diagrs. ARC R & M 3089; ARC 19,345. Supersedes RAE Tech. Note GW 378. (Ask for N-42198X*)

A study is made of the influence of working pressure, relay torque-arm radius, and other design factors on the maximum output speed and velocity constant of a single-stage hydraulic servo for guided missile use. Methods are given for determining the best relay torque-arm radius, which may be applied to valves having nonlinear flow and reaction characteristics.

N-42468X*

Aeronautical Research Council (Gt. Brit.)
THE INFLUENCE OF PLAIN BEARINGS ON SHAFT WHIRLING. E. Downham. 1958. 25p. diagrs., photo., tabs. ARC R & M 3046; ARC 18,523. Supersedes RAE Report Structures 192. (Ask for N-42468X*)

Experiments are described which show the effects of bearing length, bearing clearance, and lubricant viscosity on the critical whirling speeds of a single-shaft rotor system supported in plain bearings. The critical speed of a two-bearing-shaft rotor system is shown to depend upon rotor unbalance for bearings of normal clearance. When the clearance is small relative to the bearing length, unsymmetric stiffness characteristics are obtained and produce two critical speeds instead of one. The lubricant in a drip-feed bearing is shown to have a stiffening effect, with consequent increase of critical whirling speed. It is also shown that the critical whirl amplitudes with dry bearings can be appreciably larger than those obtained with lubricated bearings.

CN-62328*

Forest Products Research Laboratory, Department of Scientific and Industrial Research (Gt. Brit.)
RADIO FREQUENCY AND OTHER HEATING PROCESSES. THE PERFORMANCE OF SOME SYNTHETIC RESIN GLUES UNDER RADIO FREQUENCY HEATING. (A PRELIMINARY INVESTIGATION.) J. F. S. Carruthers and B. H. Paxton. (Progress report seventeen.) May 1958. 9p. tabs. Forest Products Research Lab., Dept. of Scientific and Industrial Research (Gt. Brit.). (Ask for CN-62328*)

The object of the investigation is to determine the relative efficiencies of glue line and transverse radio frequency heating at a number of frequencies and to assess the effect of the wooden components of a glued joint on the heating rate of the adhesive. As a preliminary to this investigation the behavior of a number of commercially available synthetic resin glues was examined under relatively fast radio frequency glue line heating, that is, a voltage gradient of 2000 volts/in. was applied to the joint giving glue setting times between 10 and 40 seconds.

CN-62495*

Royal Aircraft Establishment (Gt. Brit.)
A DATA TRANSMISSION SYSTEM FOR PUNCHED CARDS. E. S. Mallett and H. W. P. Knapp. December 1957. 42p. diagrs., photo., tab. RAE TD 25. (Ask for CN-62495*)

A means of sending the information on punched cards via a teleprinter line is described. The cards fed into the transmitter are reproduced at the receiving end, the rate of transmission being limited by the teleprinter network to five cards per minute. A checking facility prevents wrong cards being reproduced. The system has been used for 9 months sending raw data from Aberporth range to Farnborough and the results of calculations back again to Aberporth.

CN-62500*

Royal Aircraft Establishment (Gt. Brit.)
THERMODYNAMICS OF THE ZINC-SILVER OXIDE CELL. M. E. Bedwell. February 1958. 27p. diagrs., tabs. RAE Report Chem. 515. (Ask for CN-62500*)

The E.M.F's of the three cells: Ag, Ag_2O-KOH-AgO, Ag_2O; Zn, ZnO-KOH-Ag_2O, Ag; and Zn, ZnO-KOH-AgO, Ag_2O have been measured over the temperature range 0° to 25° C and used to calculate the corresponding heats of reaction and the heat of formation of argentic oxide.

N-62502*

Royal Aircraft Establishment (Gt. Brit.)
THE EVALUATION OF "MARANYL" NYLON ("CALATON") AS A RAIN EROSION RESISTANT MATERIAL. J. H. Sewell. February 1958. 7p. tab. RAE Tech. Note Chem. 1326. (Ask for N-62502*)

A methoxy methyl nylon "Maranyl" ("Calaton") type DV 55 has been evaluated as a rain erosion-resistant material. Although its high dielectric constant and hygroscopic properties preclude its use on radomes, this material can be used to protect metal components on aircraft. It can be easily repaired and is not likely to be seriously affected by climatic weathering.

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N-62503*

Aeronautical Research Council (Gt. Brit.)
MEASUREMENT OF THE SOUND FROM CIRCULAR CYLINDERS IN AN AIR STREAM. J. H. Gerrard, University of Manchester. June 30, 1955. 14p. diagrs. ARC 17,725; FM 2271. (Ask for N-62503*)

The frequency and intensity of the sound produced by flow past circular cylinders were investigated experimentally in the range of RN in which a periodic shedding of vortices occurs. The cylinders were placed in a wind tunnel or on a whirling device. The sound resulting from the production of a vortex street was found to possess a dipole field which consisted of a predominant fundamental frequency accompanied by harmonics. The investigation was confined to the examination of the intensity and frequency of the fundamental. When this frequency was expressed as a Strouhal number agreement was obtained between the acoustic frequency and that found, by other workers, in the wake itself. The sound intensity was found to vary with RN in a similar way to the pressure coefficient at the rear of the cylinder.

N-62508*

Royal Aircraft Establishment (Gt. Brit.)
EFFECTS OF SOME CHANGES IN BODY LENGTH AND NOSE SHAPE ON THE AERODYNAMIC CHARACTERISTICS OF WING-BODY COMBINATIONS AT SUPERSONIC SPEEDS. S. Tomlin and A. Stanbrook. February 1958. 13p. diagrs. RAE Tech.Note Aero 2542. (Ask for N-62508*)

Three bodies have been tested alone and in combination with each of two wings, at Mach numbers of 1.42 and 1.61, to find the effect of body length and nose shape on the aerodynamic characteristics of the wing-body combinations. The increments in the forces and moment resulting from the addition of the wing to the body varied little with the different body shapes tested.

N-62510*

Royal Aircraft Establishment (Gt. Brit.)
THE THEORY OF A THIN, SLENDER, CONICAL WING WITH THE WING BOUNDARY CONDITION APPLIED AT ITS SURFACE. J. H. B. Smith. March 1958. 31p. diagrs. RAE Report Aero 2602. (Ask for N-62510*)

Slender wing theory is used to calculate the lift and drag forces acting on a thin slender delta wing cambered to form part of the surface of a circular cone, in the type of flow in which separation is from the trailing edge only. The boundary condition satisfied by the flow on the wing surface is applied there, instead of on a nearby plane as is usual in linearized theory. This has relatively little effect on the overall forces on a wing at a given incidence. However, a large discrepancy arises between the overall forces at the incidence for which the singularity in the pressure at the leading edge vanishes, as calculated by the present and by the usual linearized theory. This is particularly important, since it is at this incidence that the type of flow treated is expected to be realized in a physical fluid. The lift-dependent drag factor found is below the usual linearized theory value for this type of wing at the incidence of no leading-edge singularity and, for large lift, is below unity, which is the minimum for a trailing vortex sheet which is effectively flat.

N-62512*

Aeronautical Research Council (Gt. Brit.)
A RAPIDLY CONVERGENT PROCESS FOR SOLVING THE EQUATIONS OF SUBSONIC FLOW. II. ANALYTIC SOLUTIONS IN TWO DIMENSIONS. A. B. Tayler, Mathematical Institute, Oxford. March 28, 1958. 23p. diagrs. ARC 20,028; FM 2573a. (Ask for N-62512*)

This is a continuation of ARC 19,470 which obtained a second approximation to the subsonic flow of an irrotational inviscid fluid. Results were obtained numerically for a circular cylinder with $M_\infty = 0.4$, and were shown to have an error of less than 1 percent. In this paper an analytic solution of the second approximation equations is obtained, valid for all two-dimensional shapes whose conformal transformation into a circle is known. Results are obtained for the circular cylinder at $M_\infty = 0.4$ and compared with those obtained numerically. Also results are obtained for Kaplan's airfoil and a circular cylinder with circulation.

MISCELLANEOUS

Errata on NACA TN 4098, by Priem. 1957.

Errata on NACA TN 4150, by Hansen. March 1958.

Errata on NACA TN 4262, By Deissler and Loeffler, Jr. 1958.

DECLASSIFIED NACA RESEARCH REPORTS

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NACA RM SA9D26, by Hamilton and Cleary.

NACA RM SA9H22, by Cleary and Mellenthin.

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NACA RM A50A03

WIND-TUNNEL TESTS OF A 0.16-SCALE MODEL OF THE X-3 AIRPLANE AT HIGH SUBSONIC SPEEDS. STABILITY AND CONTROL CHARACTERISTICS. William T. Hamilton and Joseph W. Cleary. April 21, 1950. 129p. diagrs., photos., tabs. (NACA RM A50A03)

Wind-tunnel tests of the 0.16-scale X-3 model were made at low and high subsonic Mach numbers to investigate the static longitudinal and lateral stability characteristics. The tests showed that undesirable changes in longitudinal stability at the stall were apparently caused by an altered downwash pattern at the tail. The jettisonable nose fins were highly destabilizing. Compressibility effects for the test Mach numbers were not detrimental to the longitudinal or lateral stability characteristics.

NACA RM A51F12

WIND-TUNNEL TESTS OF A 1/12-SCALE MODEL OF THE X-3 AIRPLANE AT SUBSONIC AND SUPERSONIC SPEEDS. Robert N. Olson and Robert S. Chubb. September 14, 1951. 111p. diagrs., photo., tabs. (NACA RM A51F12)

The static longitudinal, lateral, and directional stability and control characteristics of a 1/12-scale model of the Douglas X-3 airplane at subsonic and supersonic Mach numbers are presented. The model was equipped with an all-movable horizontal tail, an aileron on the left wing, and a rudder on the vertical-tail surface. The investigation covered a range of Mach numbers from 0.60 to 0.93 and 1.30 to 1.91 at Reynolds numbers of 0.98 to 2.61 million.

NACA RM A53G22

CORRELATION OF FLIGHT AND WIND-TUNNEL MEASUREMENTS OF ROLL-OFF IN LOW-SPEED STALLS ON A 35° SWEPT-WING AIRCRAFT. Seth B. Anderson. September 1953. 17p. diagrs., photos., tabs. (NACA RM A53G22)

Flight and full-scale wind-tunnel measurements were made of the low-speed stalling characteristics to correlate pilot opinion with quantitative measurements. Included in this study are the effects on the stalling characteristics of a number of wing modifications.

NACA RM A55G19

A STUDY OF CONICAL CAMBER FOR TRIANGULAR AND SWEPTBACK WINGS. John W. Boyd, Eugene Migotsky, and Benton E. Wetzel. November 1955. 79p. diagrs., tabs. (NACA RM A55G19)

A theoretical and experimental study has been made to determine the effectiveness of conical camber in reducing the drag due to lift of low-aspect-ratio triangular and sweptback wings. The wings investigated were derived by lifting-surface theory. Design charts for determination of the shape of the cambered surface are included. Experimental data obtained for an aspect-ratio-2 triangular wing and a 45° sweptback wing of aspect ratio 3 for Mach numbers from 0.22 to 1.90 are presented as a measure of the adequacy of the theory.

NACA RM A56H30

AN ANALOG COMPUTER STUDY OF SEVERAL STABILITY AUGMENTATION SCHEMES DESIGNED TO ALLEVIATE ROLL-INDUCED INSTABILITY. Brent Y. Creer. February 1957. 50p. diagrs., tab. (NACA RM A56H30)

In the analog computer study the stability augmentors considered were a roll-rate limiter, a sideslip limiter, an augmentor employing feedback proportional to the product of rolling velocity and pitching velocity, and combinations of the roll-rate limiter with each of the other two. The influence of changes in the system feedback characteristics on the airplane rolling motions was investigated for five different flight conditions. In each case, the motions of the augmented airplane are compared with those of the unaugmented airplane.

NACA RM E50J26

FORCE AND PRESSURE CHARACTERISTICS FOR A SERIES OF NOSE INLETS AT MACH NUMBERS FROM 1.59 TO 1.99. I - CONICAL SPIKE ALL-EXTERNAL COMPRESSION INLET WITH SUBSONIC COWL LIP. Fred T. Esenwein and Alfred S. Valerino. January 19, 1951. 73p. diagrs., photos., tabs. (NACA RM E50J26)

An experimental investigation to determine force and pressure characteristics of conical-spike all-external compression nose inlet with subsonic cowl lip was conducted over range of mass flows and angles of attack from 0° to 10° at Mach numbers 1.59 to 1.99. The Reynolds number, based on inlet diameter, was approximately 2.13×10^6. Internal-flow and pressure-recovery characteristics are included. Breakdown of measured drag coefficients at zero angle of attack into pressure, friction, and additive drag indicated that increase in drag with decreasing mass flow resulted from large increase in additive drag. Friction- and additive-drag coefficients closely agreed with calculated values; pressure drag was predicted for zero mass spillage only.

NACA RM E50J26a

FORCE AND PRESSURE CHARACTERISTICS FOR A SERIES OF NOSE INLETS AT MACH NUMBERS FROM 1.59 TO 1.99. II - ISENTROPIC-SPIKE ALL-EXTERNAL COMPRESSION INLET. L. J. Obery and G. W. Englert. February 9, 1951. 67p. diagrs., photos., tabs. (NACA RM E50J26a)

Internal- and external-flow characteristics of external-compression-type ram-jet-inlet configuration utilizing isentropic spike are presented for range of mass-flow ratios and angles of attack at Mach numbers 1.59, 1.79, and 1.99. Force and pressure measurements were made on configuration and comparison

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of experimental results with theory is made when possible. At zero angle of attack, additive and skin-friction drags were predicted reasonably well for all conditions and extrapolation of experimental data indicated that pressure drag would be accurately predicted at mass-flow ratio of unity. Lift and pitching moment agreed closely with theoretical values. Shock oscillation occurred at high Mach numbers and increased in severity with angle of attack and Mach number.

NACA RM E50J30

FORCE AND PRESSURE CHARACTERISTICS FOR A SERIES OF NOSE INLETS AT MACH NUMBERS FROM 1.59 TO 1.99. III - CONICAL-SPIKE ALL-EXTERNAL-COMPRESSION INLET WITH SUPERSONIC COWL LIP. Maynard I. Weinstein and Joseph Davids. February 14, 1951. 51p. diagrs., tabs. (NACA RM E50J30)

Force and pressure characteristics of an all-external-compression inlet having a supersonic cowl lip were experimentally investigated at Mach numbers 1.59, 1.79, and 1.99 for a range of mass flows and at angles of attack to 10°. The Reynolds number based on inlet diameter was 2.3×10^{6}. Analysis of drag components indicated that rapid increase of total drag with decreasing mass flow was due to increase of additive drag. At zero angle of attack, adequate theoretical predictions were made of additive drag, friction drag, and at shock swallowed conditions, of pressure drag. Total-pressure recovery was in general only slightly reduced by increases in angle of attack to 10°.

NACA RM E51B05

FORCE AND PRESSURE CHARACTERISTICS FOR A SERIES OF NOSE INLETS AT MACH NUMBERS FROM 1.59 TO 1.99. IV - CONICAL-SPIKE EXTERNAL-INTERNAL COMPRESSION INLET UTILIZING PERFORATED COWL. Robert T. Madden and Emil J. Kremzier. March 28, 1951. 46p. diagrs., photos., tabs. (NACA RM E51B05)

Investigation to determine force and pressure characteristics of conical-spike external-internal compression nose inlet utilizing perforated cowl was conducted over range of mass flows and angles of attack from 0° to 10° at Mach numbers of 1.59, 1.79, and 1.99. The Reynolds number based on inlet diameter was approximately 2.4×10^{6}. Use of a perforated cowl resulted in attainment of high pressure recoveries but was accompanied by relatively large increase in external drag as compared with nonperforated inlets. Range of shock oscillation encountered at lower mass-flow ratios increased with angle of attack. Subsonic-flow coefficient for perforations was 0.53.

NACA RM E52L23

FUNDAMENTAL FLAME VELOCITY, HEAT OF COMBUSTION, AND SPONTANEOUS IGNITION TEMPERATURE OF DIMETHYLAMINODIBORANE. Robert R. Hibbard and Gordon L. Dugger. December 1956. 6p. diagr., tab. (NACA RM E52L23)

The following properties have been determined for a sample of dimethylaminodiborane: (1) maximum fundamental flame velocity for fuel and air at 35° C, 115 ± 5 centimeters per second; (2) net (lower) heat of combustion of liquid fuel to gaseous nitrogen, carbon dioxide, and water, and to solid boric oxide, 19,225 ± 100 Btu per pound; and (3) spontaneous ignition temperature, 240° ± 10° F.

NACA RM E53E11

THE HEAT OF COMBUSTION OF TETRAETHYLDIBORANE. Stanley Tannenbaum. January 1957. 5p. tabs. (NACA RM E53E11)

The net heat of combustion of a sample of tetraethyldiborane was found to be 20,400 ± 130 Btu per pound for the reaction of liquid fuel to gaseous carbon dioxide, gaseous water, and solid boric oxide. The measurements were made in a Parr oxygen bomb calorimeter and the combustion is believed to have been 99 percent complete. A more reasonable value for the net heat of combustion would therefore be 20,600 ± 130 Btu per pound.

NACA RM E53G15

ALUMINUM BOROHYDRIDE AS AN IGNITION SOURCE FOR TURBOJET COMBUSTORS. David M. Straight, Edward A. Fletcher, and Hampton H. Foster. September 1953. 19p. diagrs., photos., tabs. (NACA RM E53G15)

An investigation was conducted to determine the feasibility of using aluminum borohydride as an ignition source in a single tubular turbojet-engine combustor. For combustor air-flow rates from 1.87 to 6.0 pounds per second per square foot, altitude pressures which limited ignition with aluminum borohydride (single injections of 1 to 2 cc) were about 2 inches of mercury lower than those obtained for a high-energy spark ignition system of 10 joules, 8 sparks per second. At a combustor-inlet pressure of 0.5 atmosphere, the air-velocity ignition limits with aluminum borohydride were about 25 percent greater than those with the 10-joule spark system and about double those with a 0.3-joule spark system. Static chamber tests indicated that mixtures with n-pentane containing as little as 20 mole percent aluminum borohydride were spontaneously flammable at pressure conditions more severe than those encountered in turbojet-engine operation. Aluminum borohydride appears to be an excellent ignition source for turbojet combustors. However, there remain problems of storing this chemical and the development of a suitable means of injecting the chemical into the combustor. Further work aimed at the solution of these problems for either aluminum borohydride or another igniter fluid is considered warranted.

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#NACA RM SE53G22, by Hatch and Lucas.

NACA RM E54G20

INVESTIGATION OF THREE HIGHLY LOADED SUBSONIC-INLET-STAGE AXIAL-FLOW COMPRESSORS EMPLOYING VARYING RADIAL GRADIENTS OF ENERGY ADDITION. Raymond M. Standahar. October 1954. 33p. diagrs., photos., tabs. (NACA RM E54G20)

Three experimental inlet-type axial-flow compressor stages were investigated to determine whether high pressure ratios can be obtained by means of high turning with highly cambered subsonic types of blading, and to determine the effectiveness of radial gradients of energy addition in reducing the deceleration across the rotor tip and thus relieving the effect of high tip loading. Efficiencies and pressure ratios ranged from 0.66 to 0.90, and 1.35 to 1.40, respectively. The rotor tip section for each design was in a state of stall at all times. Although the overall integrated results of two designs appeared good, the outlet-flow distribution would make staging of these designs very difficult.

NACA RM E55A27

DESIGN AND PERFORMANCE OF A 1400-FOOT-PER-SECOND-TIP-SPEED SUPERSONIC COMPRESSOR ROTOR. John F. Klapproth, John J. Jacklitch, Jr., and Edward R. Tysl. April 1955. 48p. diagrs., photo., tab. (NACA RM E55A27)

A supersonic compressor with a 1400 ft/sec tip speed was designed by a channel-flow method to have the same static-pressure recovery (that is, the ratio of static-pressure rise to inlet dynamic head of each blade row) in the rotor and the stator. The rotor performance results at design speed gave a total-pressure ratio of 2.17, an adiabatic efficiency of 89 percent, and a weight flow of 28 lb/sec. Maximum efficiency of 94 percent was obtained at a design speed of 82 percent and a total-pressure ratio of 1.65. For inlet relative Mach numbers up to 1.35, the blade-element losses are shown to be comparable with the losses in subsonic and transonic compressors operating at equivalent values of blade loading.

NACA RM E55C23

ANALYTICAL AND EXPERIMENTAL STUDY OF TRANSIENT-RESPONSE CHARACTERISTICS OF A TURBOPROP ENGINE. R. T. Craig, S. Nakanishi, and D. B. Wile. October 1955. 50p. diagrs., photo., tabs. (NACA RM E55C23)

Transient-response characteristics of a turboprop engine were studied over a range of Mach numbers from 0.15 to 0.5 at simulated altitudes of 15,000 and 35,000 feet. Generalized engine response was found to be dependent on power level and flight condition. Engine response to propeller-blade-angle disturbances was essentially first order and linear, while response to fuel-flow disturbances was of different form. Accurate prediction of engine transient performance from steady-state maps was found to be possible only when steady-state data are available for each flight condition considered.

NACA RM E55G14

ANALYTICAL COMPARISON OF CONVECTION-COOLED TURBINE BLADE COOLING-AIR REQUIREMENTS FOR SEVERAL RADIAL GAS-TEMPERATURE PROFILES. James E. Hubbartt and Henry O. Slone. September 1955. 46p. diagrs. (NACA RM E55G14)

Cooling-air requirements determined for several combustor-outlet radial gas-temperature profiles are compared, with the uniform profile as a basis. Profiles represented by complete and half-cycle cosine waves permit good combustor performance while generally decreasing the turbine casing cooling problem. For design conditions of immediate interest (turbine-inlet temperatures near 2600° R, blade root stresses of 25,000 psi, and flight Mach numbers near 2.0), the turbine rotor cooling-air requirements are slightly higher than those of the uniform profile. At the same conditions, the profile corresponding to the absolute minimum cooling-air flow presents severe stator inner-ring cooling problems with a saving in coolant flow of about 20 percent.

NACA RM E55G26

CALCULATED HEATS OF FORMATION AND COMBUSTION OF BORON COMPOUNDS (BORON, HYDROGEN, CARBON, SILICON). Aubrey P. Altshuller. October 1955. 28p. diagrs., tabs. (NACA RM E55G26)

The heats of formation and combustion for liquid and gaseous alkyl- and silyl-substituted boron hydrides have been calculated by a semitheoretical method. The effects of substitution of alkyl or silyl groups in decreasing the heats of combustion of boron hydrides are discussed in detail. The heats of combustion can be obtained with uncertainties of about 1 or 2 percent.

NACA RM E56G13

THERMODYNAMIC STUDY OF AIR-CYCLE AND MERCURY-VAPOR-CYCLE SYSTEMS FOR REFRIGERATING COOLING AIR FOR TURBINES OR OTHER COMPONENTS. Alfred J. Nachtigall, John C. Freche, and Jack B. Esgar. October 1956. 47p. diagrs. (NACA RM E56G13)

An analysis of air refrigeration systems indicated that air cycles are generally less satisfactory than simple heat exchangers unless high component efficiencies and high values of heat-exchanger effectiveness can be obtained. A system employing a mercury-vapor cycle appears to be feasible for refrigerating air that must enter the system at temperature levels of approximately 1500° R, and this cycle is more efficient than the air cycle. Weight of the systems was not considered. The analysis of the systems is presented in a generalized dimensionless form.

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NACA RM E56G20

EFFECT OF SEVERAL DESIGN VARIABLES ON INTERNAL PERFORMANCE OF CONVERGENT-PLUG EXHAUST NOZZLES. H. George Krull, William T. Beale, and Ralph F. Schmiedlin. October 1956. 33p. diagrs., photos., tab. (NACA RM E56G20)

Numerous experiments were conducted to determine factors which affect the internal performance of convergent-plug exhaust nozzles. The results of these experiments, which include effects of such things as plug shape, nozzle inlet Mach number, and outer-shell characteristics, provide a basis for optimum design from the standpoint of weight and size. The results also show performance penalties which can result when the nozzle is too small.

NACA RM E56G26

EFFECT OF FUSELAGE CIRCUMFERENTIAL INLET LOCATION ON DIFFUSER-DISCHARGE TOTAL-PRESSURE PROFILES AT SUPERSONIC SPEEDS. Emil J. Kremzier and Joseph F. Wasserbauer. October 1956. 14p. diagrs. (NACA RM E56G26)

An experimental investigation of the effect of angle of attack and inlet corrected air flow on diffuser-discharge total-pressure profiles of inlets located in various circumferential positions on a fuselage was conducted at supersonic speeds. Results indicated that the diffuser total-pressure profiles for a bottom inlet were least affected by angle of attack. The largest effect of angle of attack on distortion level was obtained with a side inlet. Variation in distortion for top inlets with angle of attack was confined to the supercritical range of inlet operation.

NACA RM E58B11 out to Sibley

EFFECT OF SLIDING VELOCITY ON FRICTION PROPERTIES AND ENDURANCE LIFE OF BONDED LEAD MONOXIDE COATINGS AT TEMPERATURES UP TO 1250° F. Harold E. Sliney. May 1958. 15p. diagrs. (NACA RM E58B11)

Thin lead monoxide coatings bonded to type 440-C stainless steel were evaluated at sliding velocities from 6 to 10,000 ft/min over a temperature range of 75° to 1250° F. Friction decreased when either ambient temperature or sliding velocity was increased. For sliding velocities of 350 and 2400 ft/min, endurance life increased with increasing temperature up to a maximum at approximately 1000° F.

NACA RM H54I17

LIFT AND DRAG CHARACTERISTICS OF THE DOUGLAS X-3 RESEARCH AIRPLANE OBTAINED DURING DEMONSTRATION FLIGHTS TO A MACH NUMBER OF 1.20. Donald R. Bellman and Edward D. Murphy. December 1954. 23p. diagrs., photos., tab. (NACA RM H54I17)

Lift and drag data for the Douglas X-3 airplane were obtained during some of the demonstration flights. The data extend over the Mach number range from 0.82 to 1.20 and for certain constant Mach numbers the lift coefficient range from 0 to 1.0 is covered. A comparison of the flight data with wind-tunnel and rocket-model tests shows that the model tests satisfactorily predict the performance of the airplane.

NACA RM H54K24

National Advisory Committee for Aeronautics. RESULTS OF MEASUREMENTS MADE DURING THE APPROACH AND LANDING OF SEVEN HIGH-SPEED RESEARCH AIRPLANES. Wendell H. Stillwell. February 1955. 25p. diagrs., tab. (NACA RM H54K24)

Measurements made during the approach and landing of the X-1, X-3, X-4, X-5, D-558-I, D-558-II, and XF-92A research airplanes are presented. Data are also presented for the effect of lift-drag ratio on the landing characteristics of the X-4 airplane.

NACA RM H55A10

PRELIMINARY FLIGHT-DETERMINED PRESSURE DISTRIBUTIONS OVER THE WING OF THE DOUGLAS X-3 RESEARCH AIRPLANE AT SUBSONIC AND TRANSONIC MACH NUMBERS. Gareth H. Jordan and C. Kenneth Hutchins, Jr. April 1955. 34p. diagrs., photos., tabs. (NACA RM H55A10)

Presented are preliminary flight-measured chordwise pressure distributions obtained at a midsemispan station on the wing of the Douglas X-3 research airplane through an angle-of-attack range at Mach numbers of approximately 0.61, 0.78, 0.94, and 1.10.

NACA RM H55A13

FLIGHT EXPERIENCE WITH TWO HIGH-SPEED AIRPLANES HAVING VIOLENT LATERAL-LONGITUDINAL COUPLING IN AILERON ROLLS. NACA High-Speed Flight Station. February 1955. 30p. diagrs., photos., tabs. (NACA RM H55A13)

During flight tests of two high-speed airplane configurations violent cross-coupled lateral and longitudinal motions were encountered following abrupt rudder-fixed aileron rolls at Mach numbers between 0.7 and 1.05.

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NACA RM H55E16

STABILITY AND CONTROL CHARACTERISTICS OBTAINED DURING DEMONSTRATION OF THE DOUGLAS X-3 RESEARCH AIRPLANE. Richard E. Day and Jack Fischel. July 1955. 51p. diagrs., photos., tab. (NACA RM H55E16)

Results obtained from flights of the manufacturer's demonstration program and from U. S. Air Force evaluation flights of the Douglas X-3 research airplane are presented. Data evaluation includes static longitudinal, directional, and lateral stability and control for Mach numbers up to 1.21 at pressure altitudes from 12,800 feet to 34,000 feet. Comparisons are made with wind-tunnel and rocket-model tests.

NACA RM H55E17b

FLIGHT EXPERIENCE OF INERTIA COUPLING IN ROLLING MANEUVERS. Joseph Weil, Ordway B. Gates, Jr., Richard D. Banner, and Albert E. Kuhl. July 1955. 12p. diagrs. (NACA RM H55E17b)

A brief discussion is presented of the flight tests of two airplanes which have exhibited strong coupling between their lateral and longitudinal motions. Results are presented which indicate the effect of directional stability and vertical tail size on the tail shear loads encountered in rolling maneuvers.

NACA RM H55G07

WING PRESSURE DISTRIBUTIONS OVER THE LIFT RANGE OF THE CONVAIR XF-92A DELTA-WING AIRPLANE AT SUBSONIC AND TRANSONIC SPEEDS. Earl R. Keener and Gareth H. Jordan. November 1955. 135p. diagrs., photos., tabs. (NACA RM H55G07)

Chordwise and spanwise pressure distributions are presented for the left wing of the Convair XF-92A delta-wing airplane at Mach numbers from 0.30 to 0.93. Reynolds number based on the mean aerodynamic chord of the wing varied between 22×10^6 and 49×10^6. The data cover the lift range from level flight to near-maximum lift. Effects of wing-section stall upon the elevon-section loads are included.

NACA RM H55G26

FLIGHT MEASUREMENTS OF DIRECTIONAL STABILITY TO A MACH NUMBER OF 1.48 FOR AN AIRPLANE TESTED WITH THREE DIFFERENT VERTICAL TAIL CONFIGURATIONS. Hubert M. Drake, Thomas W. Finch, and James R. Peele. October 1955. 22p. diagrs., photos., tab. (NACA RM H55G26)

Directional stability characteristics have been determined from the measured period and damping of a fighter-type airplane over the Mach number range from 0.72 to 1.48 at altitudes of 40,000 feet and 30,000 feet. Three different vertical tails of varying aspect ratio or area, or both, were employed.

NACA RM H56A23

FLIGHT MEASUREMENTS OF HORIZONTAL-TAIL LOADS ON THE DOUGLAS X-3 RESEARCH AIRPLANE. Harriet J. Stephenson. April 1956. 33p. diagrs., photo., tab. (NACA RM H56A23)

Horizontal-tail loads were obtained from strain-gage measurements during flight tests of the Douglas X-3 research airplane over a Mach number range of 0.65 to 1.16. The horizontal-tail-panel lift-curve slope was obtained from stabilizer pulses. Balancing-tail loads, downwash, and total airplane pitching moment were obtained from wind-up turns and pull-ups.

NACA RM H56G13

WING LOADS AND LOAD DISTRIBUTIONS THROUGHOUT THE LIFT RANGE OF THE DOUGLAS X-3 RESEARCH AIRPLANE AT TRANSONIC SPEEDS. Earl R. Keener and Gareth H. Jordan. November 1956. 191p. diagrs., photo., tabs. (NACA RM H56G13)

Wing loads and load distributions were obtained in flight by differential-pressure measurements between the upper and lower surfaces of the left wing of the Douglas X-3 research airplane. The effects of angle of attack and Mach number on the wing characteristics at transonic Mach numbers are shown. The wing has an aspect ratio of 3.09 and a modified 4.5-percent-thick hexagonal section. Data cover the range from near-zero lift to maximum lift, over a Mach number range of 0.71 to 1.15. Reynolds number based on the mean aerodynamic chord of the wing varied between 16×10^6 and 26×10^6.

NACA RM H56H08

ANALYSIS OF THE VERTICAL-TAIL LOADS MEASURED DURING A FLIGHT INVESTIGATION AT TRANSONIC SPEEDS OF THE DOUGLAS X-3 RESEARCH AIRPLANE. William L. Marcy, Harriet J. Stephenson, and Thomas V. Cooney. November 1956. 32p. diagrs., photo., tab. (NACA RM H56H08)

An analysis of the vertical-tail loads obtained from strain-gage measurements during a flight investigation of the Douglas X-3 research airplane in the transonic speed range is presented. Data from rudder pulses, gradually increasing sideslips, and rudder-fixed aileron rolls were used to obtain rudder effectiveness and the effective lift-curve slope of the vertical tail. The variation of airplane yawing-moment coefficient with sideslip as determined from the measured vertical-tail loads is also presented.

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NACA RM H57H09

FLIGHT DATA PERTINENT TO BUFFETING AND MAXIMUM NORMAL-FORCE COEFFICIENT OF THE DOUGLAS X-3 RESEARCH AIRPLANE. Thomas F. Baker, James A. Martin, and Betty J. Scott. November 1957. 41p. diagrs., photo., tabs. (NACA RM H57H09)

The X-3 airplane, which has a straight, 4.5-percent-thick wing, was flown to maximum wing lift at Mach numbers from 0.7 to 1.1 at an average altitude of 30,000 feet. Airplane and wing maximum normal-force coefficients and buffeting characteristics were determined. Wing maximum normal-force coefficients at low supersonic speeds were almost twice the values at subsonic speed ($M \approx 0.8$). At transonic speeds the buffet boundary abruptly increased, rather than decreased, with Mach number. The buffeting encountered did not constitute either an operational or a structural problem. The effective longitudinal maneuverability limit was defined by maximum wing lift. Limited data at subsonic speeds on the effects on lift and buffeting of deflecting the wing leading-edge flaps 7° are included.

NACA RM H57I05

FLIGHT INVESTIGATION OF THE TRANSONIC LONGITUDINAL AND LATERAL HANDLING QUALITIES OF THE DOUGLAS X-3 RESEARCH AIRPLANE. Jack Fischel, Euclid C. Holleman, and Robert A. Tremant. December 1957. 61p. diagrs., photos., tab. (NACA RM H57I05)

A flight investigation was performed to determine the longitudinal and lateral handling qualities of the Douglas X-3 research airplane in the clean configuration and with wing leading-edge flaps deflected. Static and dynamic stability and control characteristics were determined during trimmed and maneuvering flight at an average altitude of 30,000 feet over a Mach number range from 0.7 to 1.16. Statically and dynamically determined stability and control derivatives are presented, as well as pilot evaluation of the airplane.

NACA RM H57L06

HIGH-SPEED LANDING LOADS MEASURED ON THE DOUGLAS X-3 RESEARCH AIRPLANE. William L. Marcy. February 1958. 24p. diagrs., photo., tabs. (NACA RM H57L06)

Measured loads are shown for several landings of the Douglas X-3 at speeds from about 310 to 420 feet per second. Sinking speeds were between 2 and 5 feet per second. Some loads during taxiing and turning are also shown.

NACA RM L51G10

AN INVESTIGATION OF THE LONGITUDINAL CHARACTERISTICS OF THE X-3 CONFIGURATION WITH WING AND HORIZONTAL TAIL SURFACES OF ASPECT RATIO 3.0 BY MEANS OF ROCKET-PROPELLED MODELS. RESULTS AT HIGH LIFT COEFFICIENTS. Robert F. Peck and Jesse L. Mitchell. August 27, 1951. 34p. diagrs., photos. (NACA RM L51G10)

A rocket-propelled model of the X-3 configuration equipped with an all-movable tail of aspect ratio 3.0 has been flown, primarily to determine the longitudinal stability characteristics of this configuration at high lift coefficients.

NACA RM L51G12

DERIVATION OF THE EQUATIONS OF MOTION OF A SYMMETRICAL WING-TIP-COUPLED AIRPLANE CONFIGURATION WITH ROTATIONAL FREEDOM AT THE JUNCTURES. Albert A. Schy. October 1951. 45p. diagrs. (NACA RM L51G12)

The equations of motion are derived for a configuration consisting of a bomber and two identical fighters coupled wing tip to wing tip with complete rotational freedom at the coupling joints. It is shown how the equations may be simplified when one or two of the rotational degrees of freedom at the coupling joint are rigidly restrained. Although the equations are originally derived without considering aerodynamic interference between the airplanes, it is shown how these interference effects may be included when they are known.

NACA RM L51H08

A WIND-TUNNEL INVESTIGATION OF THE STATIC STABILITY CHARACTERISTICS OF A 1/8-SCALE EJECTABLE PILOT-SEAT COMBINATION AT A MACH NUMBER OF 0.8. Fioravante Visconti and Robert J. Nuber. December 1951. 29p. diagrs., photos. (NACA RM L51H08)

An investigation was made of a 1/8-scale model of an ejectable pilot-seat combination with and without stabilizing fins. The purpose of this investigation was to determine the static aerodynamic characteristics and the effectiveness of various stabilizing fins at a high subsonic Mach number.

NACA RM L51K12

FREE-SPINNING TUNNEL INVESTIGATION OF A 1/20-SCALE MODEL OF THE DOUGLAS X-3 AIRPLANE. Burton E. Hultz. December 26, 1951. 23p. diagrs., photos., tab. (NACA RM L51K12)

An investigation of the spin and recovery characteristics of a 1/20-scale model of the Douglas X-3 airplane has been conducted in the Langley 20-foot free-spinning tunnel. The results indicate that at spin test altitudes of 15,000 to 30,000 feet the airplane generally will not spin erect and should not exhibit any unusual trim conditions. At high altitudes, flat trimming tendencies appear possible on the airplane.

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NACA RM L52A10a

THE STATIC AND DYNAMIC LONGITUDINAL STABILITY CHARACTERISTICS OF SOME SUPERSONIC AIRCRAFT CONFIGURATIONS. Jesse L. Mitchell. January 1952. 19p. diagrs. (NACA RM L52A10a)

The static and dynamic longitudinal stability characteristics of several supersonic aircraft configurations are discussed at both subsonic and supersonic speeds. The presentation includes the effect of horizontal-tail height on static stability, the effect of stability changes with Mach number on maneuverability and trim, the damping-in-pitch derivative for some tailless aircraft, and the period and damping characteristics of the short-period longitudinal oscillation.

NACA RM L52G02

A TRANSONIC WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF NACELLE SHAPE AND POSITION ON THE AERODYNAMIC CHARACTERISTICS OF TWO 47° SWEPTBACK WING-BODY CONFIGURATIONS. Ralph P. Bielat and Daniel E. Harrison. September 1952. 87p. diagrs., photos., tab. (NACA RM L52G02)

An investigation has been made in the Langley 8-foot transonic tunnel to determine the effects of nacelle shape and position on the aerodynamic characteristics of two sweptback wing-body configurations. The two wings had 47° sweepback of the 0.25-chord line, aspect ratio of 3.5, taper ratio of 0.2, and zero twist and dihedral. Underslung, pylon-suspended, and wing-tip nacelles were investigated in conjunction with one of these wings which had 6-percent-thick sections along the span. Nacelles submerged in the wing root also were studied on this wing and on the second wing which had a root section that varied linearly in thickness ratio from 12 percent at the plane of symmetry to 6 percent at the 40-percent-semispan station. Lift, drag, and pitching-moment results are presented at Mach numbers varying from 0.50 to 1.12 and Reynolds numbers varying from 2.0×10^6 to 2.6×10^6 based on the wing mean aerodynamic chord.

NACA RM L52H01

AN INVESTIGATION OF A 0.16-SCALE MODEL OF THE DOUGLAS X-3 AIRPLANE TO DETERMINE MEANS OF IMPROVING THE LOW-SPEED LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS. John W. McKee and John M. Riebe. November 1952. 90p. diagrs., photos., tabs. (NACA RM L52H01)

Results and discussion are presented of an investigation made in the Langley 300 MPH 7- by 10-foot tunnel to determine means of improving the low-speed longitudinal stability and control characteristics of a 0.16-scale model of the Douglas X-3 airplane. Various high-lift devices in the form of plain and slotted leading-edge flaps and plain, split, and slotted trailing-edge flaps were also investigated on the model.

NACA RM L53F19a

A ROCKET-MODEL INVESTIGATION OF THE LONGITUDINAL STABILITY, LIFT, AND DRAG CHARACTERISTICS OF THE DOUGLAS X-3 CONFIGURATION WITH HORIZONTAL TAIL OF ASPECT RATIO 4.33. Robert F. Peck and James A. Hollinger. August 1953. 33p. diagrs., photos. (NACA RM L53F19a)

A rocket-propelled model of the Douglas X-3 airplane with an enlarged all-movable horizontal tail of aspect ratio 4.33 has been flown to determine its longitudinal stability, lift, and drag characteristics at transonic and supersonic speeds. Comparisons are made with corresponding data from rocket propelled models with tails of aspect ratio 3.0 and with data from the Ames 6- by 6-foot and Langley 7- by 10-foot wind tunnels. Data were also obtained on the drag of a model (with a body of revolution) having the same longitudinal distribution of cross-sectional area as the scale airplane model. The transonic drag rise from the two models shows agreement within approximately 10 percent.

NACA RM L53G07a

INVESTIGATION OF SPOILER AILERONS WITH AND WITHOUT A GAP BEHIND THE SPOILER ON A 45° SWEPTBACK WING-FUSELAGE COMBINATION AT MACH NUMBERS FROM 0.60 TO 1.03. F. E. West, Jr., William Solomon, and Edward M. Brummal. September 1953. 38p. diagrs. (NACA RM L53G07a)

An investigation was conducted with several 73 percent semispan inboard spoiler ailerons, projecting 4 percent of the local wing chord above the wing surface, located at the 70-percent chord line of a 45° sweptback wing-fuselage combination. The wing had an aspect ratio of 3.98, a taper ratio of 0.61, and NACA 65A006 airfoil sections parallel to the plane of symmetry. Six-component force data were obtained in the Langley 16-foot transonic tunnel at Mach numbers from 0.60 to 1.03, usually for angles of attack from -2° to 20° or higher. Upper-surface-spoiler configurations with a gap in the wing behind the spoiler retained at least a small amount of rolling-moment effectiveness even at high angles of attack for the entire transonic speed range, whereas an upper-surface-spoiler configuration without a gap lost complete effectiveness at high angles of attack for most Mach numbers. A lower-surface-spoiler configuration also lost effectiveness at high angles of attack. The effect of the width of the gap behind the upper-surface spoiler on rolling-moment effectiveness is discussed.

NACA RM L53G17

THEORETICAL CALCULATIONS OF THE STABILITY DERIVATIVES AT SUPERSONIC SPEEDS FOR A HIGH-SPEED AIRPLANE CONFIGURATION. Kenneth Margolis and Percy J. Bobbitt. October 1953. 59p. diagrs., tab. (NACA RM L53G17)

Theoretical calculations of the stability derivatives at supersonic speeds for a high-speed airplane configuration are presented. The methods discussed represent detailed consideration of the important effects and contributions of the various airplane

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components utilizing available theories and theoretically justifiable and reasonable approximations. Results of the analyses which are valid for motions involving small angles of attack and sideslip and low rates of rolling, pitching, and yawing, are presented in the form of graphs illustrating the variation of the stability derivatives with Mach number.

NACA RM L53G22a

LONGITUDINAL STABILITY CHARACTERISTICS AT TRANSONIC SPEEDS OF A ROCKET-PROPELLED MODEL OF AN AIRPLANE CONFIGURATION HAVING A 45° SWEPT WING OF ASPECT RATIO 6.0. John C. McFall, Jr. January 1954. 34p. diagrs., photos. (NACA RM L53G22a)

A flight investigation was conducted on a rocket-propelled airplane model having a 45° swept wing of aspect ratio 6.0, taper ratio 0.6, and NACA 65A009 airfoil section. The configuration had a swept empennage with a low tail position. Longitudinal stability and drag characteristics were determined over a Mach number range of 0.69 to 1.21.

NACA RM L53G31a

SUBSONIC AND SUPERSONIC HINGE-MOMENT AND EFFECTIVENESS CHARACTERISTICS OF AN UNBALANCED LATERAL CONTROL HAVING LOW THEORETICAL HINGE MOMENTS AT SUPERSONIC SPEEDS. Kennith L. Goin and William E. Palmer. October 1953. 55p. diagrs., photos. (NACA RM L53G31a)

Tests were made to determine the hinge-moment and effectiveness characteristics of an inversely tapered 60° half-delta control located at the tip of a clipped 60° delta wing. Tests were made at subsonic Mach numbers of 0.15 to 0.92 and at supersonic Mach numbers of 1.41, 1.62, and 1.96. Tests at subsonic Mach numbers were made at Reynolds numbers of 3.8×10^6 to 9×10^6 and tests at supersonic Mach numbers were made at Reynolds numbers of 2.2×10^6 to 3.3×10^6.

NACA RM L54G12a

EFFECTS OF OVERHANG BALANCE ON THE HINGE-MOMENT AND EFFECTIVENESS CHARACTERISTICS OF AN UNSWEPT TRAILING-EDGE CONTROL ON A 60° DELTA WING AT TRANSONIC AND SUPERSONIC SPEEDS. Lawrence D. Guy. September 1954. 48p. diagrs., photo. (NACA RM L54G12a)

A wind-tunnel investigation has been made of two unswept, partial-span, flap-type controls (differing only in hinge-line location) mounted on a 60° delta wing. One control was unbalanced and the other had a 100-percent overhang balance. Control hinge moments as well as aerodynamic characteristics of the complete wing-body combination were obtained for control deflections from 0° to 40° over an angle-of-attack range of ±12° at Mach numbers from 0.75 to 1.96. Reynolds numbers varied between 2.2×10^6 and 3.2×10^6. Expressions derived from linear theory for the hinge-moment coefficient due to angle of attack for unswept, partial-span controls (which extend neither to the wing tip nor to the wing center line) on triangular wings having subsonic leading edges are given in an appendix.

NACA RM L54G14

FLIGHT MEASUREMENTS OF AVERAGE SKIN-FRICTION COEFFICIENTS ON A PARABOLIC BODY OF REVOLUTION (NACA RM-10) AT MACH NUMBERS FROM 1.0 TO 3.7. J. Dan Loposer and Charles B. Rumsey. August 1954. 32p. diagrs., photos. (NACA RM L54G14)

Average skin-friction coefficients for a slender parabolic body of revolution (NACA RM-10) were obtained from boundary-layer measurements in flight at Mach numbers from 1.0 to 3.7 and Reynolds numbers from 40×10^6 to 170×10^6 and over a wide range of wall heating conditions. A comparison is made with wind-tunnel measurements of skin friction on the NACA RM-10 body, and with theoretical turbulent skin-friction coefficients for a flat plate with heat transfer. An empirical equation representing the data over the test range is also presented.

NACA RM L54G20

AERODYNAMIC CHARACTERISTICS AT A MACH NUMBER OF 2.01 OF TWO CRUCIFORM MISSILE CONFIGURATIONS HAVING 70° DELTA WINGS WITH LENGTH-DIAMETER RATIOS OF 14.8 AND 17.7 WITH SEVERAL CANARD CONTROLS. M. Leroy Spearman and Ross B. Robinson. August 1954. 32p. diagrs., tabs. (NACA RM L54G20)

An investigation has been made in the Langley 4- by 4-foot supersonic pressure tunnel to determine the aerodynamic characteristics at a Mach number of 2.01 of two cruciform 70° delta-wing missile configurations having length-diameter ratios of 14.8 and 17.7 with several different canard-control surfaces. The complete model and various combinations of component parts were tested through an angle-of-attack range from 0° to about 28° and an angle-of-sideslip range from 0° to about -10°.

NACA RM L54G23a

STABILITY AND DRAG CHARACTERISTICS AT MACH NUMBERS FROM 0.8 TO 1.5 OF A FREE-FLIGHT MODEL HAVING 3-PERCENT-THICK, 60° TRIANGULAR WING AND HORIZONTAL TAIL SURFACES. Rowe Chapman, Jr., and Harvey A. Wallskog. August 1954. 30p. diagrs., photos., tab. (NACA RM L54G23a)

A flight test of a rocket-propelled model having 60° triangular wing and horizontal tail surfaces 3-percent thick was made to investigate the stability and drag of the configuration. Drag and stability data are compared with similar triangular-wing configurations.

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NACA RM L54G27a

AERODYNAMIC CHARACTERISTICS AT TRANSONIC AND SUPERSONIC SPEEDS OF A ROCKET-PROPELLED AIRPLANE CONFIGURATION HAVING A DIAMOND-PLAN-FORM WING OF ASPECT RATIO 3.08 AND A LOW, SWEPT HORIZONTAL TAIL. Alan B. Kehlet. September 1954. 37p. diagrs., photos. (NACA RM L54G27a)

A flight investigation was conducted on a rocket-propelled airplane configuration having a diamond-plan-form wing of aspect ratio 3.08 and NACA 65A003 airfoil sections in the streamwise direction. The configuration had a swept empennage with a horizontal tail of 45° quarter-chord-line sweep mounted in a low position. Characteristics of trim, drag, damping, and longitudinal and directional stability are presented over a Mach number range of 0.95 to 1.79. Also presented are comparisons on the effects of wing plan form between the diamond wing and a delta wing of 52.5° leading-edge sweep and 3.08 aspect ratio.

NACA RM L54G28

INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS AT HIGH SUPERSONIC MACH NUMBERS OF A FAMILY OF DELTA WINGS HAVING DOUBLE-WEDGE SECTIONS WITH THE MAXIMUM THICKNESS AT 0.18 CHORD. Mitchel H. Bertram and William D. McCauley. October 1954. 54p. diagrs., photos., tabs. (NACA RM L54G28)

The aerodynamic characteristics of a family of blunt double-wedge-section delta wings have been investigated at the Langley 11-inch hypersonic tunnel. These wings had a maximum thickness of 8 percent located at the 18-percent-chord point. For the wings tested at a Mach number of 6.9, the semiapex angle was varied from 30° to 5° and the wings were tested over a range of angle of attack from 0° to 28° and Reynolds numbers from 0.8×10^6 to 3.6×10^6 based on root chord. Pertinent results from tests at Mach numbers as low as 1.6 have been utilized. The shock-expansion and Newtonian impact theories have been used to analyze the effects of changes made in the various parameters investigated.

NACA RM L54G28a

FREE-FLIGHT DETERMINATION OF FORCE AND STABILITY CHARACTERISTICS OF AN INCLINED BODY OF FINENESS RATIO 16.9 AT A MACH NUMBER OF 1.74. Warren Gillespie, Jr. November 1954. 17p. diagrs., photos., tab. (NACA RM L54G28a)

Force and stability characteristics were obtained in free flight from a body of fineness ratio 16.9 of a Mach number of 1.74 and a Reynolds number of 94×10^6. The test results compare favorably with a wind-tunnel test of a similar body tested at a Mach number of 1.79 and with calculations by the method of Allen (NACA RM A9I26) for estimating the effects of viscosity on an inclined body of revolution. When the boundary layer is turbulent and the crossflow drag coefficient corresponding to a yawed circular cylinder is used, the method developed in Naval Ordnance Test Station TM-998 overestimates the viscous body lift.

NACA RM L55E11c

LOADS ON THIN WINGS AT TRANSONIC SPEEDS. Don D. Davis, Jr., and Gerald Hieser. June 1955. 17p. diagrs. (NACA RM L55E11c)

Experimental loads data at transonic speeds are reviewed in an attempt to sort out the effects of several configuration variables on the overall wing loads, and to establish the relative importance of these variables.

NACA RM L55E25b

EFFECT OF AUTOMATIC STABILIZATION ON THE SIDESLIP AND ANGLE-OF-ATTACK DISTURBANCES IN ROLLING MANEUVERS. Ordway B. Gates, Jr., Joseph Weil, and C. H. Woodling. July 1955. 18p. diagrs. (NACA RM L55E25b)

Time histories are presented that illustrate the large motions which have been encountered in flight tests of some of the present-day fighter airplanes. Results of some analog studies are discussed which indicate that variations in certain of the airplane stability derivatives could have an appreciable effect on these undesirable motions.

NACA RM L55G05a

A FREE-FLIGHT INVESTIGATION OF THE DRAG COEFFICIENTS OF TWO SINGLE-ENGINE SUPERSONIC INTERCEPTOR CONFIGURATIONS FROM MACH NUMBER 0.8 TO 1.90 TO DETERMINE THE EFFECT OF INLET AND ENGINE LOCATION. APPENDIX: SEPARATION CHARACTERISTICS OF A MODEL FROM A LARGE UNDERSLUNG BOOSTER AT MACH NUMBER 1.95. Joseph H. Judd. September 1955. 49p. diagrs., photos., tabs. (NACA RM L55G05a)

Flight tests for a Mach number range from 0.8 to 1.95 and a Reynolds number range from 3.8×10^6 to 16×10^6 were made for two complete single-engine interceptor configurations and an idealized configuration, all with 52.5° sweptback wings, NACA 65A004 airfoil sections, taper ratios of 0.2, and aspect ratios of 3.0. One airplane configuration had a half-conical spike scoop inlet under the fuselage, with the design engine location in the aft portion of the fuselage; and the other airplane configuration had a full-conical spike inlet ahead of the engine pod, which was located under the fuselage. The supersonic drag coefficients of the two interceptor models were approximately 0.025 for Mach numbers from 1.3 to 1.9. Separation characteristics of a model from a large underslung booster at a Mach number of 1.95 are presented in an appendix. Loads measured on an idealized configuration during separation from the booster reached maximum normal-force coefficients of ±0.137.

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NACA RM L55G08

TRANSONIC WIND-TUNNEL INVESTIGATION OF EFFECTS OF WINDSHIELD SHAPE AND CANOPY LOCATION ON THE AERODYNAMIC CHARACTERISTICS OF CANOPY-BODY COMBINATIONS. Elden S. Cornette and Harold L. Robinson. September 1955. 55p. diagrs. (NACA RM L55G08)

Force and moment test results are presented for a fuselage forebody and for canopy-body configurations consisting of four different canopies mounted on a fuselage forebody. Two of the canopies had the same shape and size rearward of the windshield but one had a "flat" and the other a "vee" windshield. The remaining two canopies were located at different body stations and were geometrically similar. The tests covered a Mach number range from 0.80 to 1.13, an angle-of-attack range from 0° to 10°, and an angle-of-sideslip range from -8° to 8°.

NACA RM L55G14

FREE-FLIGHT INVESTIGATION TO OBTAIN DRAG-AT-LIFT AND STABILITY DATA FOR A 60° DELTA-WING–BODY CONFIGURATION OVER A MACH NUMBER RANGE OF 1.3 TO 1.6. Clement J. Welsh. October 1955. 23p. diagrs., photo., tab. (NACA RM L55G14)

A 60° delta-wing–body configuration has been flight tested over a Mach number range of 1.3 to 1.6; the wing had an NACA 0003-63 airfoil section. Zero-lift drag, drag at lift, and stability data have been presented for the configuration. Also included are results of a simplified method to calculate aeroelasticity effects on the configuration, associated with the loss in lift and static longitudinal stability, relative to rigid-wing conditions.

NACA RM L55G19

AN EXPERIMENTAL STUDY OF A METHOD FOR DESIGNING FUSELAGE SIDE AIR INLETS FOR HIGH PERFORMANCE AT TRANSONIC AND LOW SUPERSONIC SPEEDS. Robert R. Howell and Charles D. Trescot, Jr. January 1956. 24p. diagrs., photos., tabs. (NACA RM L55G19)

A brief experimental investigation has been made of a method for designing fuselage side air inlets with high internal total-pressure recovery and zero spillage drag at a specified Mach number and inlet mass-flow ratio. Experimental evidence is also presented which indicates that a scoop-type air inlet designed according to this concept had near-zero spillage drag at the design inlet mass-flow ratio of 0.8 and internal total-pressure recovery up to 0.96 at a Mach number of 1.4 and an angle of attack of zero.

NACA RM L56C15

SOME NOTES ON THE VIOLENT LATERAL-LONGITUDINAL COUPLING MOTIONS OF THE DOUGLAS X-3 AIRPLANE IN AILERON ROLLS. Ralph W. Stone, Jr. May 1956. 35p. diagrs., tab. (NACA RM L56C15)

This paper presents the results of a study of the violent lateral-longitudinal coupling motions of the Douglas X-3 airplane in aileron rolls. Calculations using five degrees of freedom are included. The results, in addition to showing the importance of principal-axis inclination, pitching moment due to sideslip, and out-of-trim moments on the magnitude of the motions attained, indicate the present need for at least five-degrees-of-freedom calculations to evaluate a given design in rapid rolls. Calculations were also made to determine the effects of yawing moment due to sideslip and roll direction.

NACA RM L56G09

FREE-FLIGHT INVESTIGATION OVER A MACH NUMBER RANGE FROM 0.74 TO 1.43 AT LIFT COEFFICIENTS FROM -0.15 TO 0.75 OF AN AIRPLANE-CONFIGURATION MODEL HAVING A 52.5° DELTA WING AND A LOW SWEPT HORIZONTAL TAIL. Alan B. Kehlet. September 1956. 41p. diagrs., photos. (NACA RM L56G09)

A free-flight investigation was conducted on an airplane-configuration model having a 52.5° delta wing with NACA 65A003 airfoil sections in the streamwise direction. The configuration had a swept empennage with a horizontal tail of 45° quarter-chord-line sweep mounted in a low position. Characteristics of trim, drag, longitudinal static stability, and side force are presented. Comparisons of lift, drag, and longitudinal static stability from the same and from similar configurations are presented. Theoretical studies of lift, drag, longitudinal static stability, trim, and side-force derivative are included for comparison.

NACA RM L56G20

EXPERIMENTAL HINGE MOMENTS ON FREELY OSCILLATING FLAP-TYPE CONTROL SURFACES. C. William Martz. October 1956. 29p. diagrs., photos., tab. (NACA RM L56G20)

Oscillatory hinge-moment characteristics have been obtained from free-flight tests of two rocket-powered models each equipped with a 60° sweptback clipped delta wing featuring an unbalanced, constant-chord, full-span, trailing-edge control. One control had a sharp trailing edge, and the other had a trailing-edge thickness equal to 1/2 the thickness at the hinge line. Data were obtained at zero angle of attack and variable deflection amplitudes from $\pm 1^{\circ}$ to $\pm 14^{\circ}$. Control reduced frequencies ranged from 0.09 to 0.035. The Mach number range of the investigation was from 0.4 to 1.9.

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NACA RM L56G31

WIND-TUNNEL MEASUREMENTS OF WING BUFFETING ON 1/16-SCALE MODEL OF DOUGLAS D-558-II RESEARCH AIRPLANE. William B. Kemp, Jr., and Thomas J. King, Jr. September 1956. 34p. diagrs.; photos., tabs. (NACA RM L56G31)

Exploratory measurements have been made of the fluctuations of wing bending moment during normal performance and stability wind-tunnel tests of a model of the Douglas D-558-II research airplane at Mach numbers from 0.60 to 0.96. The effects of leading-edge chord-extensions and several pylon-mounted underwing external stores were investigated. The standard deviation of the wing bending moment was found to be a qualitative indication of buffeting intensity.

This is authority for those possessing copies of the following research report to declassify it from Secret. Effective date of declassification June 24, 1958.

NACA RM E52C11

DISTRIBUTION OF FISSIONABLE MATERIAL IN THERMAL REACTORS OF SPHERICAL GEOMETRY FOR UNIFORM POWER GENERATION. Robert R. McCready, Robert B. Spooner, and Michael F. Valerino. June 1952. 36p. diagrs., tab. (NACA RM E52C11)

The two-group equations for reflected thermal reactors of spherical geometry are solved for constant power generation over the reactor-core volume. Illustrative calculations are made for specified core and reflector compositions and a range of reflector thicknesses to obtain the distributions of fissionable material over the reactor volume required to give uniform power generation. The calculations show that for reactors with moderate or thick reflectors substantial increase in reactor power output can be achieved.

National Advisory Committee for Aeronautics

Research Abstracts and Reclassification Notice

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NACA Rept. 1322

METHOD FOR CALCULATING THE AERODYNAMIC LOADING ON AN OSCILLATING FINITE WING IN SUBSONIC AND SONIC FLOW. Harry L. Runyan and Donald S. Woolston. 1957. ii, 30p. diagrs., tabs. (NACA Rept. 1322. Supersedes TN 3694)

A method is presented for calculating the loading on a finite wing oscillating in subsonic or sonic flow. The method is applicable to any plan form and may be used for determining the loading on deformed wings. The procedure is approximate and requires a numerical integration over the wing surface.

NACA Rept. 1331

INFLUENCE OF ALLOYING UPON GRAIN-BOUNDARY CREEP. F. N. Rhines, W. E. Bond, and M. A. Kissel, Carnegie Institute of Technology. 1957. ii, 6p. diagrs., tab. (NACA Rept. 1331. Supersedes TN 3678)

Grain-boundary displacement, occurring in bicrystals during creep at elevated temperature (350° C), was measured as a function of the copper content (0.1 to 3 percent) in a series of aluminum-rich aluminum-copper solid-solution alloys. Because alloying effects alone were to be investigated, the conditions of observation were limited to a single temperature and range of stress.

NACA Rept. 1337

DETERMINATION OF LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS FROM FREE-FLIGHT MODEL TESTS WITH RESULTS AT TRANSONIC SPEEDS FOR THREE AIRPLANE CONFIGURATIONS. Clarence L. Gillis and Jesse L. Mitchell. 1957. ii, 28p. diagrs., photos., tabs. (NACA Rept. 1337)

Techniques have been developed for determining aerodynamic performance and the longitudinal stability and control parameters from an analysis of transient oscillations obtained in free-flight tests of rocket-propelled models. Details of the techniques have been indicated and the feasibility of the methods for determining both linear and nonlinear aerodynamic characteristics has been demonstrated by data measured in the transonic speed range on several airplane configurations.

NACA Rept. 1340

INVESTIGATION OF DOWNWASH, SIDEWASH, AND MACH NUMBER DISTRIBUTION BEHIND A RECTANGULAR WING AT A MACH NUMBER OF 2.41. David Adamson and William B. Boatright. 1957. ii, 57p. diagrs., photos., tab. (NACA Rept. 1340. Supersedes RM L50G12)

An investigation of the nature of the flow field behind a rectangular circular-arc wing at a Mach number of 2.41 has been made. Pitot- and static-pressure measurements in the flow field behind the wing and detailed pitot surveys throughout the viscous wake were made. The flow direction was measured by means of a weathercocking vane. Theoretical calculations of both sidewash and downwash using Lagerstrom's superposition method have been made and are compared with experiment. Modifications, where they are necessary to bring about better agreement between theory and experiment, are shown and discussed. These include the effect of the finite thickness of the wing and the displacement of the vortex sheet.

NACA Rept. 1343

A PHENOMENOLOGICAL RELATION BETWEEN STRESS, STRAIN RATE, AND TEMPERATURE FOR METALS AT ELEVATED TEMPERATURES. Elbridge Z. Stowell. 1958. ii, 6p. diagrs., tab. (NACA Rept. 1343. Supersedes TN 4000)

A phenomenological relation between stress, strain rate, and temperature is suggested to account for the behavior of polycrystalline metals above the equicohesive temperature. The properties of the metal included in the relation are elasticity, linear thermal expansion, and viscosity. The relation may be integrated under various conditions to provide information on creep rates, creep rupture, stress-strain curves, and rapid-heating curves. It is shown that for one material - 7075-T6 aluminum-alloy sheet - the information yielded by the relation for these four applications agrees reasonably well with test data.

NACA Rept. 1344

A SIMPLIFIED METHOD FOR APPROXIMATING THE TRANSIENT MOTION IN ANGLES OF ATTACK AND SIDESLIP DURING A CONSTANT ROLLING MANEUVER. Leonard Sternfield. 1958. ii, 11p. diagrs., tabs. (NACA Rept. 1344. Supersedes RM L56F04)

The pertinent modes of motion as well as the modal coefficient corresponding to each mode can be determined from the derived expressions for the transient motion in angles of attack and sideslip. Calculations

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made with and without the derivatives C_{Y_β} (side force due to sideslip) and C_{L_α} (lift-curve slope) indicate that although these derivatives increase the total damping of the system, they do not markedly affect the transient motion.

NACA Rept. 1347

DITCHING INVESTIGATIONS OF DYNAMIC MODELS AND EFFECTS OF DESIGN PARAMETERS ON DITCHING CHARACTERISTICS. Lloyd J. Fisher and Edward L. Hoffman. 1958. ii, 28p. diagrs., tabs. (NACA Rept. 1347. Supersedes TN 3946)

Data from ditching investigations conducted at the Langley Aeronautical Laboratory with dynamic scale models of various airplanes are presented in the form of tables. The effects of design parameters on the ditching characteristics of airplanes, based on scale-model investigations and on reports of full-scale ditchings, are discussed. Various ditching aids are also discussed as a means of improving ditching behavior.

NACA RM A58C21

THE STATIC LONGITUDINAL CHARACTERISTICS OF A TWISTED AND CAMBERED 45° SWEPTBACK WING AT MACH NUMBERS UP TO 0.96. Robert I. Sammonds and Robert M. Reynolds. August 1958. 26p. diagrs., tab. (NACA RM A58C21)

The wing-body combination tested had a wing of aspect ratio 3 incorporating twist and a distributed type of camber. The wing thickness distribution perpendicular to the quarter-chord line was the NACA 64A006 with increased leading-edge radii. The camber of the central portion of the wing was an $a = 0.8$ (modified) mean line ($c_l = 0.2$) and the root and tip were an NACA 230 mean line ($c_l = 0.1$). Comparison of these data with similar data for a conically cambered wing having identical plan form and thickness ratio showed very little effect on the maximum lift-drag ratios due to the differences in camber.

NACA RM A58E02

WIND-TUNNEL INVESTIGATION AT MACH NUMBERS FROM 0.6 TO 1.4 OF SEVERAL EJECTED PILOT-SEAT MODELS. James L. Summers. September 1958. 47p. diagrs., photo., tabs. (NACA RM A58E02)

An experimental investigation was conducted to determine the static longitudinal and lateral directional aerodynamic characteristics of basic and modified versions of a conventional upward ejected pilot-seat combination, a sled-type upward ejected pilot-seat combination, and a downward ejected pilot-seat combination. Modifications to the basic models incorporated flow deflectors for pilot protection and drag reduction and various stabilizing devices. Test Mach numbers varied from 0.6 to 1.4, angles of attack from -28° to +40°, and angles of sideslip from -16° to +12°. Reynolds numbers ranged from 0.9 million to 1.8 million based on the projected frontal height of the models.

NACA RM L58C28a

LANDING AND TAXIING TESTS OVER VARIOUS TYPES OF RUNWAY LIGHTS. Robert C. Dreher and Sidney A. Batterson. August 1958. 39p. diagrs., photos., tabs. (NACA RM L58C28a)

An investigation was made at the Langley landing-loads track to obtain data on the landing-gear loads developed during landing and taxiing tests over various types of runway lights. The tests were made at forward speeds of 112 to 167 feet per second with a fighter nose landing gear and of 13.8 to 143 feet per second with a larger main landing gear. The results show the increase in loads caused by striking the lights.

NACA RM L58E09

WIND-TUNNEL INVESTIGATION OF THE AERODYNAMIC AND STRUCTURAL DEFLECTION CHARACTERISTICS OF THE GOODYEAR INFLATOPLANE. Bennie W. Cocke, Jr. September 1958. 56p. diagrs., photos. (NACA RM L58E09)

Tests of the Goodyear Inflatoplane were made in the Langley full-scale tunnel for a range of speeds from minimum stall speed up to speeds giving load factors for wing buckling. Static aerodynamic and control data with wing-deflection photographs and wing-guy-cable loads are presented.

NACA TM 1410

THEORY AND EXPERIMENTS ON SUPERSONIC AIR-TO-AIR EJECTORS. (Theorie et expérimentation des éjecteurs supersoniques air-air.) J. Fabri and J. Paulon. September 1958. 30p. diagrs. (NACA TM 1410. Translation of Office National d'Études et de Recherches Aéronautiques. Note Technique no. 36, 1956)

A comparison of experiment with theory is made for air ejectors having cylindrical mixing sections and operating under conditions of supersonic primary flow and either mixed or supersonic regimes of mixing. The effect on ejector performance of such parameters as mixer length and cross section, terminating diffuser, primary Mach number, and primary nozzle position is presented in terms of mass flow and pressure ratio.

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NACA TM 1437

ON POSSIBLE SIMILARITY SOLUTIONS FOR THREE-DIMENSIONAL INCOMPRESSIBLE LAMINAR BOUNDARY-LAYER FLOW OVER DEVELOPABLE SURFACES AND WITH PROPORTIONAL MAINSTREAM VELOCITY COMPONENTS. Arthur G. Hansen, Case Institute of Technology. September 1958. (ii), 79p. diagrs. (NACA TM 1437)

Requirements for the existence of similarity solutions are obtained for boundary-layer equations expressed in orthogonal coordinates. Permissible forms of mainstream velocity components, the square of differential of arc length on the surface, and the similarity parameter are found. A basic class of surfaces is found from which all other permissible surfaces may be obtained. Necessary and sufficient conditions are found for expressing the ordinary differential equations resulting from the similarity transformation in uncoupled form. Uncoupling is possible only when the surface is developable and a surface coordinate system characterized by $(ds)^2 = (dx_1)^2 + (dx_2)^2$ is employed.

NACA TM 1438

ON THE FLUTTER OF CYLINDRICAL SHELLS AND PANELS MOVING IN A FLOW OF GAS. (O Flattere Tsilindricheskikh Obolochek i Panelei Dvizhushchikhsia V Potoke Gaza.) R. D. Stepanov. September 1958. 25p. diagrs., tabs. (NACA TM 1438. Translation from Prikladnaia Matematika i Mekhanika, v. 21, no. 5, 1957, p. 644-657)

The flutter of infinitely long closed cylinders, infinitely long cylindrical panels, and closed cylinders of finite length is investigated on the basis of Vlasov's shallow shell theory (also known as Donnell's theory) and a simpler approximate theory valid for shells of medium length. The air forces are given by piston theory. Values of a critical velocity above which finite steel cylinders with either simply supported or clamped ends may possibly flutter in sea-level air are tabulated for various ratios of thickness to radius and radius to length.

NACA TN 3883

PROPELLANT VAPORIZATION AS A CRITERION FOR ROCKET-ENGINE DESIGN; CALCULATIONS OF CHAMBER LENGTH TO VAPORIZE VARIOUS PROPELLANTS. Richard J. Priem. September 1958. 36p. diagrs., tab. (NACA TN 3883)

Vaporization rates of propellant sprays in a rocket combustor chamber were computed for n-heptane, ammonia, hydrazine, oxygen, and fluorine. Calculations were made for each propellant with various spray conditions, and various engine-design and operating parameters. The results are correlated with an effective length for ease in using them for design purposes. The calculations show that the effective chamber length required to vaporize a given high percentage of propellants is the shortest with oxygen and increases for fluorine, heptane, ammonia, and hydrazine in that order.

NACA TN 4005

AN EXPERIMENTAL INVESTIGATION OF THE EFFECT OF VARIOUS PARAMETERS INCLUDING TIP MACH NUMBER ON THE FLUTTER OF SOME MODEL HELICOPTER ROTOR BLADES. George W. Brooks and John E. Baker. September 1958. 68p. diagrs., photo., tabs. (NACA TN 4005. Supersedes RM L53D24)

Experimental studies have been made to evaluate the effects of parameters such as Mach number, blade angle, and structural damping on the flutter of model helicopter rotor blades in the hovering condition. The model blades had NACA 23012 and 23018 airfoil sections and each was tested at chordwise center-of-gravity locations of approximately 27.5 and 37 percent chord. Data were obtained at test-medium densities ranging from 0.0012 to 0.0030 slug per cubic foot and at various pitch angles up into the stall. Mixtures of air and Freon-12 were used for the test medium in order to extend the tip Mach number range of the tests to slightly above unity.

NACA TN 4016

SOME FACTORS AFFECTING THE VARIATION OF PITCHING MOMENT WITH SIDESLIP OF AIRCRAFT CONFIGURATIONS. Edward C. Polhamus. August 1958. 35p. diagrs., photo. (NACA TN 4016. Supersedes RM L55E20b)

A brief study of available wind-tunnel data with regard to the variation of pitching-moment coefficient with sideslip angle is presented. The effects of such factors as wing plan form, wing-body interference, and tail location are illustrated and discussed, and regions where additional data are needed are indicated.

NACA TN 4225

INTERNAL-FRICTION STUDY OF ALUMINUM ALLOY CONTAINING 4 WEIGHT PERCENT COPPER. B. S. Berry and A. S. Nowick, Yale University. August 1958. 88p. diagrs., tabs. (NACA TN 4225)

A study has been made, by means of low-frequency internal-friction measurements in both torsional and flexural vibration, of aluminum alloy containing 4-weight percent of copper during aging. Both polycrystalline and single-crystal specimens exhibit an initial internal-friction peak at 173° C (for a frequency of 1 cps) after solution treatment and quenching. This peak shows all the characteristics of a Zener relaxation, including strong anisotropy. The precipitation of the phase θ' is marked by the appearance of a second peak at 135° C (for a frequency of 1 cps) and by a rise in the high-temperature background internal friction. Possible causes of the second peak and the background changes are discussed.

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NACA TN 4281

SECOND-ORDER SLENDER-BODY THEORY - AXISYMMETRIC FLOW. Milton D. Van Dyke. September 1958. (i), 46p. (NACA TN 4281)

Slender-body theory for subsonic and supersonic flow past bodies of revolution is extended to a second approximation. Methods are developed for handling the difficulties that arise at round ends. Comparison is made with experiment and with other theories for several simple shapes.

NACA TN 4285

TRANSGRANULAR AND INTERGRANULAR FRACTURE OF INGOT IRON DURING CREEP. L. A. Shepard and W. H. Giedt, University of California, Berkeley. August 1958. 26p. diagrs., photos., tabs. (NACA TN 4285)

Creep tests were performed on ingot iron at temperatures from 700° to 1,350° F to find whether the amount of grain-boundary sliding determined the fracture mode (transgranular or intergranular). If the mode were thus determined, a critical stress rather than a critical temperature would be the criterion for intergranular fracturing. Transgranular fractures were obtained below 800° F and above 20,000 psi. At higher temperatures, all fractures were intergranular. Tests indicated that intergranular fracturing may occur without grain-boundary shearing in the lower temperature range. It was concluded that a vacancy-condensation mechanism is most probably responsible for high-temperature intergranular fracturing in ingot iron.

NACA TN 4286

MECHANISM OF BENEFICIAL EFFECTS OF BORON AND ZIRCONIUM ON CREEP-RUPTURE PROPERTIES OF A COMPLEX HEAT-RESISTANT ALLOY. R. F. Decker and J. W. Freeman, University of Michigan. August 1958. 54p. diagrs., photos., tabs. (NACA TN 4286)

The effects of the addition of small amounts of boron and zirconium on creep properties of an alloy containing 55 percent nickel, 20 percent chromium, and 15 percent cobalt, with molybdenum, titanium, and aluminum were studied. These additions improved the creep-rupture properties at 1,600° F because of a stabilizing effect on the grain boundaries. These additions prolonged the life to fracture and allowed higher deformations before fracture. A number of optical and electron photomicrographs trace the development of microcracks and matrix changes through the creep process.

NACA TN 4287

RELATIONSHIP OF METAL SURFACES TO HEAT-AGING PROPERTIES OF ADHESIVE BONDS. J. M. Black and R. F. Blomquist, Forest Products Laboratory. September 1958. 30p. diagrs., tabs. (NACA TN 4287)

A study has been made to determine the probable causes of deterioration of each of several adhesives in bonds to stainless steel at temperatures from 400° to 550° F. Preliminary studies of aluminum surfaces on which ions of metals used in stainless steel were introduced showed that iron was probably catalyzing a thermal deterioration of the adhesive. The addition of zinc naphthenate, cerium naphthenate, or manganese dioxide increased the adhesive resistance to thermal deterioration. Other observations indicated probable specific relationships among the chemical structure of the adhesive, the metal adherent, and the resultant thermal stability of bonds after aging at high temperatures.

NACA TN 4288

TURBULENCE AND TEMPERATURE FLUCTUATIONS BEHIND A HEATED GRID. R. R. Mills, Jr., A. L. Kistler, V. O'Brien, and S. Corrsin, Johns Hopkins University. August 1958. 67p. diagrs. (NACA TN 4288)

In the approximately isotropic velocity and temperature fluctuation fields behind a hot grid, measurements were made of fluctuation levels and of various double and triple correlation functions. The double and triple correlation coefficient functions are of roughly the same spatial extent for the vector and scalar fields. As anticipated from theoretical considerations, the temperature fluctuations die out more slowly than does the turbulence.

NACA TN 4302

ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF AERODYNAMIC FORCES AND MOMENTS ON LOW-ASPECT-RATIO WINGS UNDERGOING FLAPPING OSCILLATIONS. Donald S. Woolston, Sherman A. Clevenson, and Sumner A. Leadbetter. August 1958. 25p. diagrs., tab. (NACA TN 4302)

Forces and moments associated with flapping oscillations of finite wings at low speeds are considered. A comparison of theoretical results, based on lifting-surface theory, and experimental results is made for a rectangular wing of aspect ratio 2. Calculated results are also given for three tapered wings of aspect ratio 3 with varying amounts of sweepback.

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NACA TN 4304

MATRIX METHOD FOR OBTAINING SPANWISE MOMENTS AND DEFLECTIONS OF TORSIONALLY RIGID ROTOR BLADES WITH ARBITRARY LOADINGS. Alton P. Mayo. August 1958. 51p. diagrs., tabs. (NACA TN 4304)

The method includes the cantilever, teetering, and hinged blades in hovering and in steady forward flight. The method is comparatively short, involves only standard matrix procedures, and does not require that the mode shapes or natural frequencies be known.

NACA TN 4306

TEMPERATURE AND THERMAL-STRESS DISTRIBUTIONS IN SOME STRUCTURAL ELEMENTS HEATED AT A CONSTANT RATE. William A. Brooks, Jr. August 1958. 77p. diagrs., tab. (NACA TN 4306)

Analytical solutions are given for the temperature and thermal-stress distributions in thick skins and structural elements such as angle, channel, T-, and H-sections when heated at a constant rate. Certain of the analytical solutions are evaluated for selected cross-sectional proportions. The results are presented in the form of charts involving dimensionless temperature, stress, and time parameters and therefore are applicable for different materials and heating rates and absolute size of the section. The results have been found useful for analyzing and correlating experimental data.

NACA TN 4307

EXPERIMENTAL MEASUREMENTS OF THE EFFECTS OF AIRPLANE MOTIONS ON WING AND TAIL ANGLES OF ATTACK OF A SWEPT-WING BOMBER IN ROUGH AIR. Jerome N. Engel. August 1958. 25p. diagrs., photo., tabs. (NACA TN 4307)

Flight-test data obtained from an airplane at an altitude of 5,000 feet are analyzed to determine the effects of airplane vertical translation and pitching motions. Power-spectral techniques are used in order to determine the contributions of these motions to the angles of attack of the wing and tail at various frequencies, and these results are compared with the direct gust-induced angle of attack.

NACA TN 4316

FRICTION AND WEAR WITH REACTIVE GASES AT TEMPERATURES UP TO 1200° F. Gordon P. Allen, Donald H. Buckley, and Robert L. Johnson. September 1958. 26p. diagrs., photos. (NACA TN 4316)

CF_2C1_2, CF_3C1, and SF_6 gases were used to lubricate hardened M-1 tool steel and other materials. A hemisphere rider (3/16-in. rad.) under a 1200-g load slid on a rotating disk at 120 ft/min. CF_2C1_2 was effective up to 1200° F and CF_3C1, while not as good a lubricant, gave less corrosion. Small amounts of SF_6 added to CF_2C1_2 improved lubrication. SF_6 alone reduced wear but not friction of tool steel sliding against tool steel. Of the iron, copper, and nickel alloys studied, silicon-nickel alloys gave the best results. With silicon nickel, SF_6 gave both low wear and low friction at 600° F. For steel, corrosion was important with all gases.

NACA TN 4317

TURBOJET ENGINE NOISE REDUCTION WITH MIXING NOZZLE-EJECTOR COMBINATIONS. Willard D. Coles, John A. Mihaloew, and Edmund E. Callaghan. August 1958. 33p. diagrs., photos., tab. (NACA TN 4317)

Maximum sound pressure level reductions of 12 decibels and sound power level reductions of 8 decibels were obtained with lobe nozzle and ejector combinations on two full-scale engines. The ejectors provided 3 to 5 decibels of the sound power level reduction. Several combinations of ejectors and nozzles were used and acoustic and engine performance data are presented. A study of jet profiles and boundaries at the ejector exit shows the effectiveness of the lobe nozzle and ejector combinations in diffusing the jet to a larger, lower velocity stream. Calculated noise reductions based on ejector exit flow conditions are not realized experimentally, probably because the noise generated inside the ejector is appreciable.

NACA TN 4320

COMPRESSIBLE LAMINAR FLOW AND HEAT TRANSFER ABOUT A ROTATING ISOTHERMAL DISK. Simon Ostrach and Philip R. Thornton. August 1958. 18p. diagrs., tab. (NACA TN 4320)

The flow and heat transfer about a rotating isothermal disk are reexamined to include the effects of compressibility and property variations. If viscous dissipation is neglected, the compressible problem is correlated to the incompressible problem by assuming linear variations of viscosity and thermal conductivity with temperature. Certain inaccuracies in several previous incompressible solutions are noted and corrected. The effect of compressibility appears as a distortion of the normal coordinate and normal velocity component and as a multiplicative factor in the heat-transfer coefficient, the Nusselt number, and in the expressions for the skin-friction components and torque required to rotate the disk.

NACA TN 4321

AN ANALYTICAL STUDY OF TURBULENT AND MOLECULAR MIXING IN ROCKET COMBUSTION. David A. Bittker. September 1958. 22p. diagrs. (NACA TN 4321)

Approximate calculations for the diffusion of gases have been performed to obtain an idea of the importance of gaseous mixing in rocket combustion. Mixing lengths for two simplified diffusion models are

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calculated for various turbulence conditions. Results are independent of any particular propellant combination. With sources in a single injection plane, mixing occurs in less length than is needed for evaporation of typical engine sprays. When downstream sources are used to simulate vaporization within the chamber, mixing is more significant. Calculations only indicate the magnitude of the effect since the models used are greatly simplified.

NACA TN 4323

NATURAL CONVECTION INSIDE A FLAT ROTATING CONTAINER. Simon Ostrach and Willis H. Braun. September 1958. 27p. diagrs. (NACA TN 4323)

Froude number is found to be the parameter that determines the effect of body rotations on internal natural convection flows. Explicit forms of Froude number are determined for the cases of predominant rotation and predominant axial force. In a heated flat cylindrical container no significant convective effects are generated by rotations alone. Moreover, rotation tends to inhibit the flow and heat transfer generated by an axial body force in such a configuration. Insertion of radial vanes in the container eliminates the detrimental effects of rotation and improves the heat transfer.

NACA TN 4324

METHOD FOR DETERMINING THE NEED TO REWORK OR REPLACE COMPRESSOR ROTOR BLADES DAMAGED BY FOREIGN OBJECTS. Albert Kaufman. September 1958. 25p. diagrs., photo. (NACA TN 4324)

This method includes the effects of the location and depth of damage, the material fatigue strength and notch sensitivity, and the maximum-vibratory-stress level of the blade in engine operation. The method was compared with experimental results from fatigue tests of blades edge-nicked in the laboratory and was found to be an acceptable basis for blade inspection. The amount of strength restored by reworking the damaged area was also investigated.

NACA TN 4325

A MACH 4 ROCKET-POWERED SUPERSONIC TUNNEL USING AMMONIA-OXYGEN AS WORKING FLUID. Robert W. Graham, Eleanor Costilow Guentert, and Vearl N. Huff. September 1958. 53p. diagrs., photos. (NACA TN 4325)

To simulate the high heating rates encountered in hypersonic flow, the exhaust gases from an ammonia-oxygen rocket have been used to power a supersonic tunnel. A gas temperature of 4500° R at Mach 4 was produced in the 15-inch test section of the tunnel. The calibration pressure data indicate reproducibility of test conditions in this facility. Physical, transport, and one-dimensional aerodynamic data for combustion products of ammonia and oxygen are included.

NACA TN 4328

STUDY OF HYDROGEN EMBRITTLEMENT OF IRON BY INTERNAL-FRICTION METHODS. R. E. Maringer, E. B. Swetnam, L. L. Marsh, and G. K. Manning, Battelle Memorial Institute. September 1958. 62p. diagrs., photos., tab. (NACA TN 4328)

The effects of electrolytic charging on the properties of relatively pure iron and tempered 4340 steel were investigated metallographically and by observing internal-friction behavior from -196° to 430° C. Severe structural damage, consisting of blisters and internal cracks, resulted even after comparatively short charging times. The internal friction of recrystallized iron was particularly sensitive to hydrogen charging. Internal friction of iron and steel below room temperature exhibits phenomena resulting from the interaction of hydrogen atoms and moving dislocations.

NACA TN 4339

HYDRODYNAMIC IMPACT LOADS OF A -20° DEAD-RISE INVERTED-V MODEL AND COMPARISONS WITH LOADS OF A FLAT-BOTTOM MODEL. Philip M. Edge, Jr. August 1958. 36p. diagrs., photo., tabs. (NACA TN 4339)

Hydrodynamic-impact-loads data were obtained at the Langley impact basin from tests of a narrow-beam model. Fixed-trim impacts were made in smooth water over a range of landing conditions at a beam-loading coefficient of 19.15, with a few impacts at beam-loading coefficients of 27.90 and 36.07. Loads, moments, motions, and bottom pressures were measured throughout each of the impacts. The maximum impact loads for the inverted-V model are compared with loads obtained for a flat-bottom model.

NACA TN 4343

A COMPARISON OF TWO METHODS FOR CALCULATING TRANSIENT TEMPERATURES FOR THICK WALLS. James J. Buglia and Helen Brinkworth. August 1958. 19p. diagrs., tab. (NACA TN 4343)

A comparison is made of two different methods of calculating transient temperatures for thick walls with arbitrary variation of heat-transfer coefficient and adiabatic-wall temperature. Numerical calculations for special cases for which the exact solutions are available show that both methods give accurate results. Hill's method (NACA Technical Note 4105) is shown to be generally superior to Dusinberre's method (Trans. A.S.M.E., vol. 67, no. 8) in both speed and accuracy, if a table of memory coefficients is available.

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NACA TN 4344

PERFORMANCE AT LOW SPEEDS OF COMPRESSOR ROTORS HAVING LOW-CAMBERED NACA 65-SERIES BLADES WITH HIGH INLET ANGLES AND LOW SOLIDITIES. James C. Emery and Paul W. Howard. August 1958. 28p. diagrs. (NACA TN 4344)

Tests were made on three blades at solidities of 0.5, 0.75, and 1.0, without guide vanes or stators, over ranges of blade-setting angles and quantity-flow rates. The performance measured in these tests is compared with performance estimated from two-dimensional cascade data for the purpose of extending the correlation of cascade and compressor-rotor data over a range of high-inlet-angle conditions.

NACA TN 4346

APPROXIMATE METHOD FOR CALCULATING MOTIONS IN ANGLES OF ATTACK AND SIDESLIP DUE TO STEP PITCHING- AND YAWING-MOMENT INPUTS DURING STEADY ROLL. Martin T. Moul and Teresa R. Brennan. September 1958. 42p. diagrs., tabs. (NACA TN 4346)

The method presented herein for calculating airplane response in a steady roll to pitching- and yawing-moment inputs approximates the complete four-degree-of-freedom steady-roll response by neglecting the high-frequency mode and simplifying the remaining modal coefficients. This technique was employed in NACA Report 1344 to approximate the airplane response due to angle of attack of the principal axis. Motions from the approximate method are compared with five-degree-of-freedom solutions, and a procedure for applying the method to design calculations is suggested.

NACA TN 4348

EFFECT OF TEMPERATURE ON DYNAMIC MODULUS OF ELASTICITY OF SOME STRUCTURAL ALLOYS. Louis F. Vosteen. August 1958. 19p. diagrs., tabs. (NACA TN 4348)

The effect of temperature on Young's modulus of elasticity was determined from flexural beam vibration tests for 2024-T3 and 7075-T6 aluminum alloys, AZ31A-0 magnesium alloy, RS-120 titanium alloy, and type 303 stainless steel at temperatures from room temperature to 900° F. The test frequencies were varied from 40 to 550 cycles per second. The results are compared with values of moduli obtained from conventional stress-strain tests. The data show that the dynamic modulus decreases with temperature but does not decrease as rapidly as the static modulus. It is shown that the difference between the static modulus and dynamic modulus is due to internal friction and cannot be attributed to creep.

NACA TN 4350

THEORETICAL DISTRIBUTION OF LAMINAR-BOUNDARY-LAYER THICKNESS, BOUNDARY-LAYER REYNOLDS NUMBER AND STABILITY LIMIT, AND ROUGHNESS REYNOLDS NUMBER FOR A SPHERE AND DISK IN INCOMPRESSIBLE FLOW. Neal Tetervin. September 1958. 36p. diagrs. (NACA TN 4350)

Calculations have been made by use of an approximate method for a sphere in the supercritical Reynolds number region. The same quantities have also been calculated for the front face of a much blunter body, namely, for a disk. For the disk the unusual result obtained was that the boundary-layer thickness decreased with an increase in distance from the stagnation point. Only at extremely large Reynolds numbers did the laminar boundary layer over a disk or over the forward portion of a sphere become unstable with respect to the Tollmien-Schlichting type of waves.

NACA TN 4353

EXPLORATORY WIND-TUNNEL INVESTIGATION AT HIGH SUBSONIC AND TRANSONIC SPEEDS OF JET FLAPS ON UNSWEPT RECTANGULAR WINGS. Vernard E. Lockwood and Raymond D. Vogler. August 1958. 37p. diagrs. (NACA TN 4353)

The investigation was conducted on an unswept rectangular NACA 65A006 wing with an aspect ratio of 3.33 and a much thicker wing of the same plan form which were modified at the trailing edges to provide several jet-flap configurations. Most of the data were obtained at an angle of attack of 0°. Lift, drag, and pitching-moment data are presented for a momentum-coefficient range varying from 0.30 at a Mach number of 0.40 to 0.03 at a Mach number of 1.10.

NACA TN 4354

MEASUREMENTS IN A SHOCK TUBE OF HEAT-TRANSFER RATES AT THE STAGNATION POINT OF A 1.0-INCH-DIAMETER SPHERE FOR REAL-GAS TEMPERATURES UP TO 7,900° R. Alexander P. Sabol. August 1958. 15p. diagrs., photos., tab. (NACA TN 4354)

The heat-transfer rates were determined at Mach numbers between 6.4 and 13.9 from measurements of the surface-temperature change with time of a thin-film-platinum resistance surface thermometer. The test results are presented and compared with the predictions of two theories, and the compatibility of these results with other experimental results obtained with both a thin-film surface thermometer and a calorimeter-type gage is pointed out. Data from tests in which a thin-film thermocouple was used are also included for comparison.

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NACA TN 4356

EFFECTS OF COMPRESSIBILITY ON ROTOR HOVERING PERFORMANCE AND SYNTHESIZED BLADE-SECTION CHARACTERISTICS DERIVED FROM MEASURED ROTOR PERFORMANCE OF BLADES HAVING NACA 0015 AIRFOIL TIP SECTIONS. James P. Shivers and Paul J. Carpenter. September 1958. 28p. diagrs. (NACA TN 4356)

An investigation has been conducted at the Langley helicopter test tower to determine the low tip Mach number blade maximum mean lift coefficient and high tip Mach number compressibility effects. Data are presented for blade tip Mach numbers from 0.27 to 0.81 and corresponding Reynolds numbers from 1.64×10^6 to 4.78×10^6. Synthesized rotor-blade section-lift and profile-drag-coefficient data derived from experimental data are presented and compared with previously obtained two-dimensional data.

NACA TN 4357

LIFT AND PROFILE-DRAG CHARACTERISTICS OF AN NACA 0012 AIRFOIL SECTION AS DERIVED FROM MEASURED HELICOPTER-ROTOR HOVERING PERFORMANCE. Paul J. Carpenter. September 1958. 28p. diagrs., photo. (NACA TN 4357)

Rotor hovering performance from which the major portion of the synthesized data were derived is presented for tip Mach numbers from 0.28 to 0.70. The principal effect of increasing the blade-tip Mach number is a large increase in blade drag which occurs at a progressively lower blade mean lift coefficient as the tip Mach number is increased. These synthesized airfoil data should be useful in helicopter-rotor-performance calculations.

NACA TN 4358

SUPERSONIC WAVE INTERFERENCE AFFECTING STABILITY. Eugene S. Love. September 1958. 19p. diagrs., photos. (NACA TN 4358. Supersedes RM L55L14a)

Some of the significant interference fields that may affect stability of aircraft at supersonic speeds are briefly summarized. Illustrations and calculations are presented to indicate the importance of interference fields created by wings, bodies, wing-body combinations, jets, and nacelles.

NACA TN 4360

MEASUREMENTS OF THE EFFECTS OF WALL OUTFLOW AND POROSITY ON WAVE ATTENUATION IN A TRANSONIC WIND TUNNEL WITH PERFORATED WALLS. Joseph M. Spiegel, Phillips J. Tunnell, and Warren S. Wilson. August 1958. 27p. diagrs. (NACA TN 4360)

Various wind-tunnel perforated-wall configurations were tested in the transonic speed range to evaluate the effects of wall outflow and wall porosity on the wave reflection on various models in the test section. The maximum outflow was 9.5 percent of the total mass flow and the porosity was varied from 0.60 to 24.4 percent open.

NACA TN 4366

THE EFFECTS OF AN INVERSE-TAPER LEADING-EDGE FLAP ON THE AERODYNAMIC CHARACTERISTICS IN PITCH OF A WING-BODY COMBINATION HAVING AN ASPECT RATIO OF 3 AND 45° OF SWEEPBACK AT MACH NUMBERS TO 0.92. Fred A. Demele and K. Harmon Powell. August 1958. 57p. diagrs., photo., tabs. (NACA TN 4366)

An investigation has been conducted to determine the effectiveness of a leading-edge flap in improving primarily the drag characteristics of a swept-wing-body combination. With the flap deflected, the wing had a camber and twist distribution similar to that resulting from the incorporation of conical camber in the forward portion of a plane wing. Aerodynamic data were obtained for flap angles to 16° over a Mach number range of 0.25 to 0.92 at a Reynolds number of 3.2 million, and over a Reynolds number range of 3.2 to 15 million at a Mach number of 0.25. Lift-drag ratios are compared with those of a similar model incorporating conical camber.

NACA TN 4371

SOME OBSERVATIONS RELATING TO RECOVERY OF INTERNAL FRICTION DURING FATIGUE OF ALUMINUM. S. R. Valluri, California Institute of Technology. September 1958. 30p. diagrs., tab. (NACA TN 4371)

Recovery of internal friction during periods of rest in specimens subjected to fatigue stresses in torsion was studied experimentally with high-purity aluminum. The effective heat of activation for the process is found to be about 10,000 calories per gram molecule or less. The dislocations responsible for the recovery of internal friction may be the same as those responsible for fine slip which, according to one existing theory, is the mechanism responsible for fatigue failure. Experimental results indicate that obtaining a recovery factor independent of stressing history may possibly be associated with installing a cyclic process in which the subgrain structure is well established.

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NACA TN 4374

RATE OF REACTION OF GASEOUS FLUORINE WITH WATER VAPOR AT 35° C. Vernon A. Slabey and Edward A. Fletcher. September 1958. 16p. diagrs., tabs. (NACA TN 4374)

Fluorine and water vapor react extremely slowly or not at all in the gas phase at 35° C at partial pressures of the reactants up to 40 mm of mercury. They react at surfaces; the kinetics are first order with respect to each of the reactants. At Kel-F wax-coated surfaces, the rate of disappearance of fluorine is expressed by $-\frac{dF_2}{dt} = 1.6 \times 10^{-4} A_w [F_2][H_2O]$, where $-\frac{dF_2}{dt}$ is the rate of disappearance of fluorine in moles per second, A_w is the surface area (sq cm) of the reaction vessel, and $[F_2]$ and $[H_2O]$ are the concentrations in moles per liter of the reactants. Neither ozone nor hydrogen peroxide is formed to a measurable extent in the reaction.

NACA TN 4375

APPROXIMATE SOLUTIONS OF A CLASS OF SIMILARITY EQUATIONS FOR THREE-DIMENSIONAL, LAMINAR, INCOMPRESSIBLE BOUNDARY-LAYER FLOWS. Arthur G. Hansen and Howard Z. Herzig. September 1958. 26p. diagrs. (NACA TN 4375)

An analysis is presented for obtaining approximate solutions of the similarity equations for three-dimensional laminar-boundary-layer flows over a flat surface under main-flow streamlines that are translates and representable as infinite series expansions. For the particular case of streamline shapes described by a power of the distance along the surface from the leading edge, relatively simple expressions are obtained for flow deflection at the bounding surface, limiting streamline shape, and shear stress at the surface.

NACA TN 4388

EFFECTS OF NOSE ANGLE AND MACH NUMBER ON TRANSITION ON CONES AT SUPERSONIC SPEEDS. K. R. Czarnecki and Mary W. Jackson. September 1958. 17p. diagrs., photo. (NACA TN 4388)

An investigation has been made to determine the transition characteristics of a group of smooth, sharp-nosed cones varying from 10° to 60° in included apex angle over a Mach number range from 1.61 to 2.20 and a range of Reynolds number per foot from about 1.5×10^6 to 8×10^6. Increasing the cone angle is shown to decrease slightly the transition Reynolds number, whereas the effects of changes of Mach number and unit Reynolds number are negligible. When transition occurred within 15 to 20 percent of the model length from the base there was a dropoff in transition Reynolds number.

NACA TN 4389

EFFECT OF ADVANCE RATIO ON FLIGHT PERFORMANCE OF A MODIFIED SUPERSONIC PROPELLER. Jerome B. Hammack and Thomas C. O'Bryan. September 1958. 20p. diagrs., photos. (NACA TN 4389)

Results of a flight investigation of a modified supersonic propeller at the design Mach number of 0.95 indicated a propeller efficiency of approximately 79 percent. The departure from optimum angle of advance has a small effect for the advance ratios investigated.

NACA TN 4390

EFFECTS OF FREQUENCY AND AMPLITUDE ON THE YAWING DERIVATIVES OF TRIANGULAR, SWEPT, AND UNSWEPT WINGS AND OF A TRIANGULAR-WING—FUSELAGE COMBINATION WITH AND WITHOUT A TRIANGULAR TAIL PERFORMING SINUSOIDAL YAWING OSCILLATIONS. William Letko and Herman S. Fletcher. September 1958. 52p. diagrs., photos., tabs. (NACA TN 4390)

Except for the complete wing-fuselage-tail configuration the results indicate that the damping in yaw and the rolling moment due to yawing increase with angle of attack, and at high angles of attack the oscillatory values are considerably greater than the steady-state values. The values of the oscillatory derivatives for the complete-model configuration are considerably greater than the steady-state values through the entire angle-of-attack range. In general, the greatest changes in yawing derivatives with amplitude and frequency occurred in the low range of amplitude and frequency.

NACA TN 4392

A THEORETICAL STUDY OF STAGNATION-POINT ABLATION. Leonard Roberts. September 1958. 29p. diagrs. (NACA TN 4392)

A simplified analysis is made of ablation cooling near the stagnation point of a two-dimensional or axisymmetric body which occurs as the body vaporizes directly from the solid state. The automatic shielding mechanism is discussed and the important thermal properties required by a good ablation material are given. The results of the analysis are given in terms of dimensionless parameters.

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N-21033X*

Aeronautical Research Council (Gt. Brit.)
ON THE POST-BUCKLING BEHAVIOUR OF STIFFENED PLANE SHEET UNDER SHEAR. E. H. Mansfield. 1958. 21p. diagrs. ARC R & M 3073; ARC 15,610. Supersedes RAE Report Structures 136. (Ask for N-21033X*)

The post-buckling behavior of a flat plate reinforced by stringers and frames is considered theoretically, attention being concentrated on the case of pure shear loading. Formulas and graphs are presented for the rapid determination of the shear stiffness, shear strain, and induced compressive stresses in stringers and frames. The analysis is an extension of work by Kromm and Marguerre.

N-35208, Addendum, Feb. 1954-Feb. 1958*

Aeronautical Research Council (Gt. Brit.)
AUTHOR INDEX TO THE REPORTS AND MEMORANDA AND CURRENT PAPERS OF THE AERONAUTICAL RESEARCH COUNCIL (FEBRUARY 1954 TO FEBRUARY 1958). 1958. 49p. ARC R & M 2570 (Revised). (Ask for N-35208, Addendum, Feb. 1954-Feb. 1958*)

N-42171X*

Aeronautical Research Council (Gt. Brit.)
SUPERSONIC FLOW PAST QUASI-CYLINDRICAL BODIES OF ALMOST CIRCULAR CROSS-SECTION. D. G. Randall. 1958. 17p. diagrs., tabs. ARC R & M 3067; ARC 836. Supersedes RAE Tech.Note Aero 2404. (Ask for N-42171X*)

The supersonic flow over bodies for which surface boundary condition may be satisfied on a circular cylinder is considered. The method is based on the linearized small-perturbation theory of supersonic flow. The disturbance velocity potential is obtained as a Fourier series each term of which contains a certain basic function and the first 11 of these functions are evaluated. The pressure distribution and wave drag have been calculated for some bodies consisting of circular cylinders surmounted by canopies. An extension of the method to solve certain wing-body interference problems is also described.

N-44963X*

Aeronautical Research Council (Gt. Brit.)
WIND-TUNNEL TESTS ON THE EFFECT OF BODY FREEDOMS ON THE FLUTTER OF A MODEL WING CARRYING A LOCALISED MASS. D. R. Gaukroger and E. W. Chapple. 1958. 33p. diagrs. ARC R & M 3081; ARC 18,725. Supersedes RAE Report Structures 204. (Ask for N-44963X*)

Wind-tunnel test results for the flutter of a sweptback wing carrying a localized mass, and having symmetric or antisymmetric freedoms of the root, are given. The tests were made on a model wing of 23° sweepback, the chordwise and spanwise positions of a localized mass being varied for two localized mass values. In most of the symmetric flutter tests the inertia conditions of the fuselage were constant and representative of full scale. For the antisymmetric tests, the fuselage rolling moment of inertia was varied. The test results indicate that, in general, the symmetric flutter case is more critical than the antisymmetric for masses at outboard positions on the wing, but for heavy inboard masses the antisymmetric case may be the more critical. The results are too complex for any detailed use in predicting the effects of mass loading on the flutter of particular aircraft.

N-46420X*

Aeronautical Research Council (Gt. Brit.)
SUPERSONIC WIND-TUNNEL FLUTTER TESTS OF TWO RECTANGULAR WINGS. P. R. Guyett. 1958. 15p. diagrs., photos., tabs. ARC R & M 3080; ARC 18,760. Supersedes RAE Report Structures 206. (Ask for N-46420X*)

Two rectangular wings were flutter tested in a supersonic wind tunnel using a technique in which a structural stiffness was varied to give flutter at the Mach number. Results are in reasonable agreement with calculations using theoretical three-dimensional derivatives and arbitrary wing modes, though the calculated critical stiffnesses are rather higher than the test values. It is shown theoretically that structural damping has an important effect upon stiffness required to avoid flutter, and may be destabilizing.

N-46784X*

Aeronautical Research Council (Gt. Brit.)
OPERATIONAL FORMULAE FOR RESPONSE CALCULATIONS. S. Neumark. 1958. 48p. diagrs., tabs. ARC R & M 3075; ARC 18,941. Supersedes RAE Report Aero 2570. (Ask for N-46784X*)

The paper presents systematic tables of formulas whose purpose is to facilitate the operational solution of response problems reducible to linear differential equations with constant coefficients and with simple forcing functions. The formulas enable the user to find operational equivalents of a wide class of simple functions and to find functional equivalents of a great number of operational expressions. The introductory text describes the method of deriving the formulas and explains how to use them in solving response problems. A number of examples are appended which show the advantages of the tables and give solutions of several typical problems.

N-48426X*

Aeronautical Research Council (Gt. Brit.)
MULTI-CHANNEL SLIP RINGS FOR STRESS AND TEMPERATURE MEASUREMENT. R. Chaplin. 1958. 18p. diagrs., photo. ARC CP 389. (Ask for N-48426X*)

The development of the various types of slipring is outlined in the text and the design of a brush and ring type of slipring is discussed in detail. It is shown

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that a slipring unit of this type can be made sufficiently robust to be a permanent part of the instrumentation of any rig. A highly stable contact potential is obtained in this design making possible stress measurements below 1/2 ton/sq in. in steel and temperature measurements with errors of less than 1° C using chromel-alumel thermocouples.

N-50085X*

Aeronautical Research Council (Gt. Brit.)
SOME CONTRIBUTIONS TO JET-FLAP THEORY AND TO THE THEORY OF SOURCE-FLOW FROM AEROFOILS. L. C. Woods. 1958. 37p. diagrs. ARC CP 388. (Ask for N-50085X*)

This paper presents a theoretical study of the thrust, lift, and moment on an airfoil due to a two-dimensional jet of air ejected from the trailing edge at an angle τ to the main stream. It is rigorously proved that in subsonic compressible flow the ideal thrust of the jet (assumed not to mix with the main stream) is independent of the exit angle τ. The theory for the lift and moment is developed for incompressible flow only. It is not rigorous, being based on the assumption that jets of equal momentum and at equal values of τ have essentially the same influence on the main stream. The theory is in satisfactory agreement with the few experimental values available. Two appendixes have been added to the paper.

N-50128X*

Aeronautical Research Council (Gt. Brit.)
METHODS FOR DETERMINING THE WAVE DRAG OF NON-LIFTING WING-BODY COMBINATIONS. L. M. Sheppard. 1958. 28p. diagrs. ARC R & M 3077; ARC 19,320. Supersedes RAE Report Aero 2590. (Ask for N-50128X*)

The area rule, moment of area rule, and transfer rule methods for estimating the wave drag of wing-body combinations are discussed. It is pointed out that the moment of area rule and the transfer rule are different forms of the area rule, and that the transfer rule expresses the interference wave drag in a simple form. The existing methods of wave-drag estimation are restricted to combinations with bodies having continuous surface slope and here an extension to combinations with bodies having discontinuous surface slope is given. This paper is concerned with the theoretical methods and their associated numerical techniques and no numerical results or particular applications are presented.

N-51760, pt. 1/X*

Aeronautical Research Council (Gt. Brit.)
DYNAMICS OF A DISSOCIATING GAS. I. EQUILIBRIUM FLOW. M. J. Lighthill. November 14, 1956. 36p. diagrs., tabs. ARC 18,837; FM 2481; TP 499. (Ask for N-51760, pt. 1/X*)

Includes equilibrium theory of a pure dissociating diatomic gas; law of mass action for dissociative equilibrium; detailed expressions for partition functions; equations of equilibrium in a hydrodynamically convenient form; summary of thermodynamics of an ideal dissociating gas; requirements for equilibrium flow; conditions behind a shock wave; effects of non-uniformity of shock-wave strength; properties of isentropic changes; flow about bluff bodies; approximations of Newtonian type; higher approximations; summary of Freeman's analysis for bodies of revolution; bodies of revolution with shock-wave separation at the base; shape of shock wave beyond where it separates from the body; and constant density approximation to flow near front stagnation point.

N-59612, 2851-2950*

Aeronautical Research Council (Gt. Brit.)
PUBLISHED REPORTS AND MEMORANDA OF THE AERONAUTICAL RESEARCH COUNCIL. 1958. 7p. ARC R & M 2950. (Ask for N-59612, 2851-2950*)

N-62511*

Aeronautical Research Council (Gt. Brit.)
AN INVESTIGATION OF THE NOISE PRODUCED BY A SUBSONIC AIR JET. J. H. Gerrard, University of Manchester. June 30, 1955. 34p. diagrs., tabs. ARC 17,724; FM 2270. (Ask for N-62511*)

To investigate the theoretical predictions of Lighthill on aerodynamic sound, measurements have been made of the sound field of a 1-inch air jet issuing from a long pipe. The measurements have been made over a wide frequency band (30 to 10,000 cycles/sec) and in 1/3 octave bands in this frequency range. The mean Mach number at the pipe orifice was varied from 0.3 to 1.0. The dependence of the apparent position of the noise sources on frequency and jet speed was investigated. The dependence of the noise intensity upon jet speed is examined in terms of the power law relation.

N-62776*

Aeronautical Research Council (Gt. Brit.)
A THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE FLOW OVER A FAMILY OF RECTANGULAR WINGS OF BICONVEX SECTION AT $M = 1.42$. R. C. Lock. 1958. 43p. diagrs., photos. ARC R & M 3055; ARC 18,331. (Ask for N-62776*)

An account is given of experiments made at $M = 1.42$ using three rectangular half-wing models having biconvex sections with thickness ratios 0.04, 0.06, and 0.08, mounted on a reflection plate. Measurements

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were made of the pressure on the upper surface of the wing and of pressure and flow direction in the neighborhood of the wing tip. Direct shadow photography and observation of surface-oil patterns enabled various details of the flow to be visualized. The results are correlated with the linearized theory and with certain second-order modifications to this theory. It is found that in general the linearized theory provides a sufficient approximation to the detailed flow only for the thinnest wing at very small incidences. In most cases the suggested modifications effect a considerable improvement.

N-62777*

Aeronautical Research Council (Gt. Brit.)
PRESSURE-PLOTTING MEASUREMENTS ON AN 8 PER CENT THICK AEROFOIL WITH TRAILING-EDGE FLAP BLOWING. J. Williams and A. J. Alexander, National Physical Laboratory. 1958. 34p. diagrs., photo., tab. ARC R & M 3087; ARC 18,487. (Ask for N-62777*)

Wind-tunnel experiments were carried out on an 8-percent-thick airfoil between end plates, with blowing from a slot in the knee of a 25-percent-chord trailing-edge flap, to improve the lifting efficiency of the flap. Both the blowing-slot width and position were varied. The sectional lift and pitching moment were derived by chordwise integration of the surface static pressures measured at the midspan station. Tuft observations as well as surface-pressure measurements were made to determine the extent of the turbulent separation region on the trailing-edge flap and of the laminar separation bubble on the airfoil nose.

N-62780*

Aeronautical Research Council (Gt. Brit.)
FLOW IN A JET DIRECTED NORMAL TO THE WIND R. Jordinson. 1958. 17p. diagrs. ARC R & M 3074; ARC 18,783. Supersedes Imperial College Aeronautics Dept. Paper 35. (Ask for N-62780*)

Experiments to study the flow in an air jet, which is ejected normal to an airstream from an orifice in a plane floor, have been made for several values of the ratio of wind velocity to jet exit velocity. The path of the jet and the shape of the jet cross section were determined; this cross section was found to be of horseshoe shape away from the orifice. It was also found that the jet draws up with it air from the floor boundary layer.

CN-62852*

Royal Aircraft Establishment (Gt. Brit.)
A MACHINE FOR MAKING REPRODUCTION WITH CONTACT. APPLICATION TO THE MANUFACTURE OF TURBINE BLADES. (Machine à reproduire à palpeur sans contact. Application à l'usinage des ailettes de turbine.) Roland Moreau. July 1957. 6p. RAE Library Translation 680. Translation from Technique et Science Aéronautiques, no. 5, 1956, p. 221-225. (Ask for CN-62852*)

Brief details are given of a machine which allows the manufacture of profiles and shapes to any given design. The required shape is drawn in white on a black background, full size, placed on the machine, and a photoelectric servo device controls the cutter so as to provide an accurate replica of the original design. It is suggested as a good method for the manufacture of turbine and compressor blades.

N-63153*

Royal Aircraft Establishment (Gt. Brit.)
PROGRAMME FATIGUE TESTS ON NOTCHED BARS TO A GUST LOAD SPECTRUM. W. A. P. Fisher. March 1958. 19p. diagrs., photo., tabs. RAE Tech. Note Structures 236. (Ask for N-63153*)

A series of program fatigue tests in axial loading was made on notched bars machined from extruded alloy to D.T.D.363A. The load spectrum represented a simplified truncated gust spectrum. The alternating load in each program was steadily increased to a maximum (corresponding to a 27.5-ft/sec gust) and down again. The program was repeated till failure of the specimen. The average number of programs to failure was in each case greater than that predicted by the Miner hypothesis $\Sigma n/N = 1$. Further tests are recommended in which material, type of specimen, and order of loading are varied.

CN-63154*

Royal Aircraft Establishment (Gt. Brit.)
CHEMICAL FINISHES FOR GLASS AND THEIR INFLUENCE ON THE PROPERTIES OF GLASS-FIBRE LAMINATES. E. W. Russell. February 1958. 19p. diagrs., tabs. RAE Report Chem. 516. (Ask for CN-63154*)

Measurements of the adsorption of water on glass fibers are presented and discussed in relation to those properties of fibers, fabrics, and laminates which are water sensitive. Chemical finishes for glass have permitted considerable improvement in laminate quality and associated properties. Those finishes, in particular the silane types, which confer moisture resistance to the glass, markedly influence the moisture-sensitive properties of laminates.

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N-63170*

Royal Aircraft Establishment (Gt. Brit.)
10 FT. X 7 FT. TUNNEL TESTS UP TO M = 0.94 OF NOSE DROOP AND A BLUNT-NOSED NACA 3-00 TYPE SECTION ON A $7\frac{1}{2}$ PER CENT THICK 50° SWEPT WING. A. L. Courtney. March 1958. 44p. diagrs., photos., tabs. RAE Tech.Note Aero 2556. (Ask for N-63170*)

This note describes further tests made during 1954 as part of a research program to improve the subsonic longitudinal stability characteristics of a 50° swept wing of aspect ratio 3.1 by means such as nose-droop, chord-extensions, fences, change of airfoil section, etc. Lift, drag, pitching moment, and root bending moment were measured with the basic 7-1/2 percent thick RAE 101 section, with a symmetrical blunt-nosed NACA 3-007.5 section, and with a full-span drooped and thickened nose, at Mach numbers up to 0.94 and Reynolds numbers between 1.7×10^6 and 6×10^6. Oil-film flow patterns show several interesting features which are discussed in some detail. The occurrence of an unusual adverse scale effect on the drooped wings at low Mach number is also discussed.

N-63247*

Royal Aircraft Establishment (Gt. Brit.)
THE INFLUENCE OF A MODEL ON PLENUM CHAMBER INDICATION OF MACH NUMBER IN A SLOTTED WALL WIND TUNNEL. L. C. Squire and A. Stanbrook. February 1958. 14p. diagrs. RAE Tech.Note Aero 2541. (Ask for N-63247*)

In many transonic tunnels the Mach number in the working section is determined from a pressure measured in the plenum chamber, on the assumption that this pressure is uniquely related to the free-stream static pressure. The effect of a number of different sting-mounted models on this relationship has been investigated in the 3-ft tunnel at RAE Bedford. The results show that the Mach number determined from the pressure in the plenum chamber is not affected by the presence of any of the models in the working section, provided that the pressure is not measured near the downstream end of the plenum chamber.

N-63251*

Aeronautical Research Council (Gt. Brit.)
MEASUREMENTS OF THE FLUCTUATING PRESSURE ON THE SURFACE OF A CIRCULAR CYLINDER. PART I. CYLINDER OF 1" DIAMETER. J. H. Gerrard, University of Manchester. January 29, 1958. 24p. diagrs., tabs. ARC 19,844; FM 2637; N.18. (Ask for N-63251*)

Results are presented of measurements of the fluctuating pressure on the surface of a 1-inch-diameter cylinder placed in an airstream at Reynolds numbers between 10^4 and 10^5. Conclusions are drawn concerning the fluctuating lift and drag coefficients.

N-63278*

Aeronautical Research Council (Gt. Brit.)
SOME PRACTICAL PROBLEMS IN THE FIELD OF COMBUSTION KINETICS. R. E. Miller, University of Durham. June 6, 1958. 3p. ARC 20,223; CF 444. (Ask for N-63278*)

The shock tube provides a tool for obtaining kinetic data which is of great potential value to combustion workers. It was recently suggested that a review be written of the most important practical problems to which the shock tube might be applied. The present note is an attempt to set out some of the more obvious of these problems.

N-63402*

Royal Aircraft Establishment (Gt. Brit.)
THE FATIGUE AND TENSILE PROPERTIES OF REDUX JOINTS BETWEEN ALUMINIUM ALLOY DTD 646 SHEETS AT TEMPERATURES OF -60° C, ROOM TEMPERATURE AND +70° C. N. J. F. Gunn. March 1958. 12p. diagrs., tabs. RAE Tech.Note Met. 277. (Ask for N-63402*)

Tensile and fatigue tests at temperatures of -60° C, room temperature, and +70° C, have been conducted on Redux bonded test pieces made from unclad 12 s.w.g. aluminum alloy sheet to DTD specification 646. The results show that in tension the joint suffers a loss in strength at +70° C of about 45 percent and may have an increase at -60° C of about 15 percent. When tested in fluctuating tension the joints suffer a loss in strength at +70° C but at -60° C an increase or decrease in strength seems to depend on the life under stress.

N-63403*

Royal Aircraft Establishment (Gt. Brit.)
COMBINED FLEXURE AND TORSION OF A CLASS OF THIN HEATED WINGS: A LARGE-DEFLECTION ANALYSIS. E. H. Mansfield. March 1958. 47p. diagrs. RAE Report Structures 237. (Ask for N-63403*)

This paper presents a large-deflection analysis for combined flexure and torsion of solid or hollow wings of biconvex section with a parabolic chordwise temperature distribution. The analysis embraces the buckled, as well as unbuckled, regimes.

N-63425*

Royal Aircraft Establishment (Gt. Brit.)
TESTS ON TWO AUSTRALIAN EXTRA-WIDE-ANGLE LENSES. M. Marchant. March 1958. 23p. diagrs., photos., tab. RAE Tech.Note T.D.31. (Ask for N-63425*)

This paper gives the results of laboratory tests on two samples of a type of extra-wide-angle lens which were designed and made at W.R.E., Salisbury, S. Australia, for use in the Australian target aircraft camera system known as AMPOR Mk.III. They have a nominal field of over 180°.

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N-63426, pt.1*

National Gas Turbine Establishment (Gt. Brit.)
A TURBINE NOZZLE CASCADE FOR COOLING STUDIES. PART I - THE MEASUREMENT OF MEAN NUSSELT NUMBERS AT THE BLADE SURFACE. R. I. Hodge. May 1958. 25p. diagrs., photo., tab. NGTE Memo. M.308. (Ask for N-63426, pt.1*)

A description is given of a cascade tunnel designed and built to evaluate various cooling systems for turbine blading. Details of the tunnel instrumentation and operating conditions are included. Gas to blade-surface mean heat-transfer coefficients have been determined in tests using a special blade. These experimental coefficients are related to blade Reynolds number and to the temperature ratio between gas and blade surface. The second part to the present pair of memorandums compares these experimental results with predicted values.

N-63426, pt.2*

National Gas Turbine Establishment (Gt. Brit.)
A TURBINE NOZZLE CASCADE FOR COOLING STUDIES. PART II - COMPARISON BETWEEN MEASURED AND PREDICTED MEAN NUSSELT NUMBERS AT THE BLADE SURFACE. R. I. Hodge. May 1958. 39p. diagrs. NGTE Memo. M.309. (Ask for N-63426, pt.2*)

The condition of the boundary layer around a turbine nozzle blade profile in a two-dimensional cascade is described at various levels of gas flow Reynolds number and turbulence. Mainstream turbulence is shown to have a modifying influence on the accepted transition criteria. Surface distributions of heat-transfer coefficient are calculated for the near isothermal case, with laminar and turbulent boundary layers. Ad hoc experiments are reported which give the blade-surface heat-transfer coefficients when the boundary layer is separated over part of the convex side. The combined calculated and estimated values of the profile average heat-transfer rate, according to the estimated boundary-layer development pattern with flow Reynolds number, are in fair agreement with the measured values quoted in part I of the present pair of memorandums.

N-63427*

Royal Aircraft Establishment (Gt. Brit.)
SOME METHODS OF RECORDING VARYING QUANTITIES IN DIGITAL FORM BY MIRROR GALVANOMETERS. B. S. Crawshaw and C. R. Hunt. February 1958. 25p. diagrs. RAE Tech.Note Instn.162. (Ask for N-63427*)

A varying quantity can be recorded in digital form on a moving photographic strip by means of a mirror galvanometer. The record may be continuous or in a series of instantaneous readings. A number of ways of doing this have been devised and some of the design principles in the various arrangements are touched upon, particularly those concerning reduction of the record area to a minimum. Features of an automatic reader which are connected with the recorder design are discussed. No one method of recording is superior in all conditions and at least three of the systems deserve further investigation.

CN-63456*

Royal Aircraft Establishment (Gt. Brit.)
A GRATICULE ILLUMINATION SYSTEM FOR EXTRA WIDE ANGLE LENSES. D. C. Kerridge. March 1958. 8p. diagrs., photos. RAE Tech.Note T.D.27. (Ask for CN-63456*)

This note traces the development of a graticule illumination system for use with the extra-wide angle lenses used in target aircraft cameras. Alternative ideas which were considered are described as they may be of use with similar lenses.

N-63458*

Aeronautical Research Council (Gt. Brit.)
THEORY OF THE BURNING OF MONO-PROPELLANT DROPLETS. D. B. Spalding and V. K. Jain, Imperial College. May 19, 1958. 13p. diagrs., tabs. ARC 20,176; CF 441; R.436. (Ask for N-63458*)

Formulas are derived for the burning rate and time of monopropellant droplets suspended in an atmosphere of their own decomposition products. The liquid temperature is assumed constant and the activation energy of the reaction is supposed high. Some experimental data are cited in qualitative support of the theory.

CN-63459*

Royal Aircraft Establishment (Gt. Brit.)
MICROSTRUCTURES OF COMMERCIAL TITANIUM AND TITANIUM ALLOYS. G. I. Lewis. March 1958. 19p. diagrs., photos., tabs. RAE Tech. Note Met.283. (Ask for CN-63459*)

Photomicrographs are presented of some titanium and titanium alloys of British and American manufacture in the as-received condition. A brief summary of the physical metallurgy of titanium and the effect of some alloying elements has been included.

N-63461*

Aeronautical Research Council (Gt. Brit.)
A ONE-DIMENSIONAL THEORY OF LIQUID-FUEL ROCKET COMBUSTION II: THE INFLUENCE OF CHEMICAL REACTION. J. Adler, Imperial College. May 28, 1958. 14p. diagrs. ARC 20,189; CF 442; R.437. (Ask for N-63461*)

The differential equations, resulting from the one-dimensional liquid-fuel rocket combustion model II of Spalding, have been integrated and temperature and velocity profiles for the fuel droplets derived. A simple approximate procedure for solving the equations is also given which gives good results when compared with exact integration.

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N-63464*

Royal Aircraft Establishment (Gt. Brit.)
THE MECHANICAL PROPERTIES AT HIGH RATES OF HEATING AND LOADING OF F.S.M. 1 STAINLESS STEEL SHEET, AT TEMPERATURES UP TO 500° C. M. S. Binning and B. Angell. February 1958. 19p. diagrs., photo., tab. RAE Tech.Note Met.282. (Ask for N-63464*)

Tensile tests have been made at temperatures up to 150° C on transverse specimens cut from austenitic stainless-steel sheet having the proprietary name F.S.M. 1 in the fully hard condition, and up to 500° C on longitudinal specimens from sheet in the half-hard condition. Tensile tests were also made on fully hard longitudinal specimens and half-hard transverse specimens at room temperature only. Heating was by electrical resistance methods, specimens being brought to test temperature in approximately 30 seconds and then tested at strain rates such that the 0.2-percent proof stress was reached in 12 to 16 seconds. A Lamb type extensometer made of Invar, equipped with alumina knife-edge blades and radiation shields of silver and platinum, was used to measure the strains which were recorded photographically. Load/extension curves are given for all the tests, and the tensile properties summarized in tabular form.

N-63513*

Aeronautical Research Council (Gt. Brit.)
SOME VISUAL OBSERVATIONS OF THE EFFECTS OF SWEEP ON THE LOW-SPEED FLOW OVER A SHARP-EDGED PLATE INCIDENCE. N. C. Lambourne and P. S. Pusey, National Physical Laboratory. January 22, 1958. 19p. text & diagrs., photos. (Diagrams and photographs issued under separate cover with same file number.) ARC 19,821; FM 2634. (Ask for N-63513*)

The report is concerned with the flow over a flat plate at incidence when separation occurs everywhere along the leading edge. Observations made by various methods of flow visualization in both water and air trace out the systematic changes that occur between the eddying or "bluff-body" type of flow when the leading edge is not swept and the orderly vortex type of flow occurring with high sweepback. Brief descriptions of flows with forward sweep are also included.

CN-64030*

Royal Aircraft Establishment (Gt. Brit.)
BIAXIAL STRESS THEORY FOR INFLATABLE WING FABRICS: DEVELOPMENT OF AN ELLIPTICAL BURSTING TEST. A. Baker and E. Mikolajewski. April 1958. 20p. diagrs. RAE Tech.Note Chem.1327. (Ask for CN-64030*)

Equations are derived to describe the biaxial stretching of bias-ply fabric in terms of non-Hookean fiber elasticity, with Hookean approximation for small extensions. Anisotropy in proofed fabric is attributed to differing tensile stiffness in warp and weft, and assessed by pressurizing differently oriented specimens at an elliptical orifice. Samples of two-ply twistless weave Terylene were found to be isotropic, or more isotropic than proofed cotton.

CN-64032*

Royal Aircraft Establishment (Gt. Brit.)
CAMERA, 35mm. CONTINUOUS RECORD TYPE GW.3. J. H. Brooks. April 1958. 15p. diagrs., photos. RAE Instruction Leaflet IL-TD.4. (Ask for CN-64032*)

This paper describes the Type G.W. 3 continuous record camera developed for recording cathode ray oscillograph traces at speeds ranging from 1 inch per second to 128 inches per second. A detailed description of the camera is given, together with operating instructions and notes on maintenance.

N-64033*

Directorate of Guided Weapons Research and Development (Gt. Brit.) SUPERSONIC JET DEFLECTION. PART VI. DEFLECTION BY A SLIDING BEVELLED SLEEVE OR UNGULUS. P. N. Rowe. October 1957. 7p. diagrs., photos., tab. D.G.G.W. Report/EMR/58/5. (Ask for N-64033*)

Describes experiments carried out with a nozzle surrounded by a cylindrical sleeve having a beveled exit plane slidably mounted on the nozzle so as to progressively expose an ungular surface to the jet. It is concluded that the deflection of a supersonic jet by using an ungular sleeve is an efficient method. Its main limitation is that the maximum side thrust which can be produced is restricted to about 10 percent of the axial thrust if serious losses are to be avoided. If fairly high losses can be tolerated, up to 20 percent side thrust is possible. It would appear that the sleeve will be little affected by erosion.

N-64034*

Royal Aircraft Establishment (Gt. Brit.)
CHARTS OF PEAK AMPLITUDES IN INCIDENCE AND SIDESLIP IN ROLLING MANOEUVRES DUE TO INERTIA CROSS COUPLING. W. J. G. Pinsker. April 1958. 92p. diagrs. RAE Report Aero.2604. (Ask for N-64034*)

Based on a series of systematic analog computations, charts are given for the determination of peak amplitudes in incidence and sideslip for a general family of rolling and rolling pull-out maneuvers of aircraft subject to inertia cross coupling. The principal parameters governing the stability and response characteristics of aircraft in rolling maneuvers are discussed and formulas and data are given for their determination.

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N-64035*

Aeronautical Research Council (Gt. Brit.)
CALIBRATION OF PRESTON TUBES ON A FLAT PLATE USING MEASUREMENTS OF LOCAL SKIN FRICTION. P. Bradshaw and N. Gregory, National Physical Laboratory. May 27, 1958. 14p. diagrs. ARC 20,199; FM 2684; Perf.1670.
(Ask for N-64035*)

Preston type surface pitot tubes have been calibrated in the turbulent boundary layer on a flat plate. The results agree with the previous calibration of Relf et al. The calibration, the positions of the effective centers of the tubes, and the constants in the semi-logarithmic velocity profiles differ from those found by Preston in pipe flow.

N-64036*

Aeronautical Research Council (Gt. Brit.)
SUPPORT BLOCKAGE INTERFERENCE IN WIND-TUNNEL TESTS. A. D. Young and R. C. Pankhurst. February 17, 1958. 17p. diagrs. ARC 19,903; FM 2646. (Ask for N-64036*)

This note considers the general nature of support interference and discusses in detail the contributions arising from the viscosity of the fluid, namely, wake blockage and the associated static pressure gradient.

N-64037*

Aeronautical Research Council (Gt. Brit.)
THE MEASUREMENT OF UNSTEADY FORCES AND MOMENTS ON SLENDER BODIES OSCILLATING IN A WIND TUNNEL. J. F. Clarke. October 28, 1957. 34p. diagrs., photos. ARC 19,614; 0.1358.
(Ask for N-64037*)

An apparatus for the measurement of unsteady aerodynamic reactions on slender bodies is described. It is particularly suited to tests at supersonic speeds. The forces and moments on the model are detected by strain gages attached to the model mounting sting and by supplying their bridge circuits with properly phased a-c of the right frequency, direct meter readings of the stiffness or damping reactions may be obtained. The results of a short series of tests on a cone cylinder at subsonic Mach numbers and reduced frequency parameters (based on model length) up to 0.06 are given.

N-64038*

Aeronautical Research Council (Gt. Brit.)
SOME RESULTS OF AN INVESTIGATION INTO THE USE OF AIR INJECTION IN A MODEL OF THE DIFFUSER FOR THE A.R.A. SUPERSONIC TUNNEL. E. C. Carter and K. F. Tucker. 1958. 35p. diagrs. ARC CP 386. (Ask for N-64038*)

The decrease in running and starting pressure ratios obtained at a given Mach number has been determined. Tests were made in a 4-inch by 4-inch working section tunnel operating with atmospheric downstream pressure; most tests being made at $M = 3.15$ giving a RN of approximately 2.4 million based on tunnel height. The use of 120 percent bypass injection permits the starting pressure ratio to be reduced to 3.2 from values in excess of 4 and the running pressure ratio to be reduced to under 3; both figures being obtained with a representative model and support in the working section. Further decrease in pressure ratio can be obtained with the use of larger injection quantities.

N-64039*

Aeronautical Research Council (Gt. Brit.)
HIGH REYNOLDS NUMBER TESTS ON A 70° L.E. SWEEPBACK DELTA WING AND BODY (H.P. 100) IN THE COMPRESSED AIR TUNNEL. R. W. F. Gould and C. F. Cowdrey. 1958. 23p. diagrs., photos., tab. ARC CP 387. (Ask for N-64039*)

Values of lift, drag, and pitching-moment coefficients are given for a model of the H.P. 100 delta wing with sharp leading edges and with a body attached, over a range of Reynolds numbers from 1×10^6 to 12×10^6 and at incidences up to 42°. Photographs of the traces of an oil/titanium oxide mixture, on the surface, indicating flow directions, are included. The results show no appreciable scale effect.

N-64041*

Directorate of Guided Weapons Research and Development (Gt. Brit.). A BALANCE METHOD OF MEASURING THE THRUST REACTION OF AN AIR JET. P. N. Rowe. October 1957. 7p. diagrs., tab. D.G.G.W. Report/EMR/58/3. (Ask for N-64041*)

The apparatus described has proved suitable for the purpose required but rather a large number of repeats are necessary if the smallest differences are to be detected. It is obvious that the measurement of air reservoir pressure is the major obstacle to still further improvement of accuracy. There are at least two features of the thrust measuring apparatus which could be improved in a future design. Firstly, it should be possible to suspend the calibrating weights on the nozzle axis at a point below the axis of the rotary joint. Secondly, although air leaks through the rotary joint are only some 2 to 3 percent of the flow through the nozzle, this could be virtually eliminated by the use of labyrinth glands. The present apparatus does not lend itself to these improvements.

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N-64042*

Directorate of Guided Weapons Research and Development (Gt. Brit.). LABORATORY METHODS OF MEASURING THRUST. P. N. Rowe. August 1957. 27p. diagrs. D.G.G.W. Report/EMR/58/2. (Ask for N-64042*)

This report discusses the various methods by which thrust can be measured, sets out their various advantages, and surveys apparatus that has been built and used. The survey is concerned only with laboratory apparatus and not with the full-scale testing of "hot" motors.

N-64043*

Directorate of Guided Weapons Research and Development (Gt. Brit.). THE EFFECT OF DIVERGENCE ANGLE ON THE THRUST OF A SUPERSONIC NOZZLE. P. N. Rowe. September 1957. 14p. diagrs., photos., tabs. D.G.G.W. Report/EMR/58/1. (Ask for N-64043*)

This report gives the results of a continuation of a study made originally by Coulter and others. The investigation has extended the range of divergence angle, examined the effect of small manufacturing errors, and made a check on the accuracy of the reported results. A series of nozzles has been tested. All have a rounded entry of 1-inch radius, a 1/2-inch-diameter throat, and a straight conical divergence to give a nominal area expansion ratio of 6.0:1. They are designed to discharge air at a (inverse) pressure ratio of 0.01584, that is, to discharge to standard atmosphere from a reservoir pressure of 928 lb/in.^{2} (abs).

N-64044*

Directorate of Guided Weapons Research and Development (Gt. Brit.). A NOTE ON EMPIRICAL EQUATIONS FOR THE DETERMINATION OF THE THRUST GENERATED BY AN IDEAL SUPERSONIC NOZZLE. P. N. Rowe. September 1957. 3p. tabs. D.G.G.W. Report/EMR/58/4. (Ask for N-64044*)

This note gives empirical equations for calculating the area ratio and the thrust generated by an ideal supersonic nozzle. They are simpler to evaluate than the theoretical equations and, within the range $p/p_0 = 0.01$ to 0.05, give results with an error of less than 1 percent. They are intended to aid those designing rocket motor nozzles and particularly to facilitate calculating the effect of changes in the specific heat ratio.

N-64045*

Ministry of Supply (Gt. Brit.)
THE MECHANICAL PROPERTIES OF EN 40c STEEL BAR MATERIAL (HEAT TREATED TO 100 TONS/SQ. IN.) IN TENSION, COMPRESSION AND TORSION. L. W. Derry and A. W. J. Layton. July 1958. 22p. diagrs. MOS S & T Memo. 9/58. (Ask for N-64045*)

Material was supplied to specification En 40c in the form of 1-1/8 inch-diameter bar from which tension, compression, and torsion specimens were machined, heat-treated to 100 tons/sq in. tensile strength and finally ground. Tests were performed to determine various mechanical properties of the material. Stress-strain curves are plotted for tension, compression, and torsion tests. For tension and compression tests, mean values and percentage deviations are calculated. Tangent modulus curves are also plotted.

CN-64046*

Ministry of Supply (Gt. Brit.)
FINAL REPORT ON DROP HAMMER FORMING AND FUSION WELDING OF COMMERCIALLY PURE TITANIUM SHEET. J. K. Crowe and J. D. R. Machin. May 1958. 125p. diagrs., photos. MOS S & T Memo.7/58. (Ask for CN-64046*)

The purpose of the research was to explore methods (and establish limitations) of drop hammer stamping titanium sheet and of satisfactorily assembling such parts by fusion welding, and the work was directed to overcoming production difficulties by simple practical methods not involving the use of excessively costly tools and equipment.

N-64254*

Aeronautical Research Council (Gt. Brit.)
STABILITY CRITERIA FOR LINEAR EQUATIONS WITH TIME VARYING COEFFICIENTS. P. E. W. Grensted. August 9, 1955. 6p. ARC 17,792; S & C 3032. (Ask for N-64254*)

This note attempts to find the conditions that the rates of change of the coefficients must satisfy in order that Routh's criterion is adequate when applied to the instantaneous values of the coefficients alone. Secondly, a modified Routh's criterion is derived which gives an indication of the effect that the rate of change of coefficients has on the stability of the true solution. The method used is applicable to equations of any order, and the results given here are for equations of the second, third, and fourth order.

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N-64255*

Aeronautical Research Council (Gt. Brit.)
A ONE-DIMENSIONAL THEORY OF LIQUID-FUEL ROCKET COMBUSTION. D. B. Spalding, Imperial College. May 19, 1958. 26p. diagrs. ARC 20,175; CF 440; R.435. (Ask for N-64255*)

Equations are derived for distribution of droplet radius and velocity, and gas velocity, in a liquid-fuel rocket, taking account of droplet vaporization and drag, and chemical reaction. Analytical and quadrature solutions are given. Residence-time distribution is determined. Possibility of extinction through chemical overloading is demonstrated.

CN-64256*

Aeronautical Research Council (Gt. Brit.)
CONTRACTANTS: A NEW METHOD FOR THE NUMERICAL EVALUATION OF DETERMINANTS. R. H. Macmillan. September 16, 1955. 5p. ARC 17,865; 0.1208; S & C 3037; Comp.87. (Ask for CN-64256*)

A new and simpler method for the reduction of determinants and matrices is presented. Its advantages are discussed and its justification indicated.

N-64259*

Aeronautical Research Council (Gt. Brit.)
HYDRODYNAMIC STABILITY OF THE LAMINAR MIXING REGION BETWEEN PARALLEL STREAMS. N. Curle, National Physical Laboratory. May 9, 1956. 15p. diagr., tabs. ARC 18,426; FM 2400. (Ask for N-64259*)

This antisymmetrical profile is considered by a similar method to that used for jets and wakes. Modifications are required because in this case purely symmetrical or antisymmetrical oscillations cannot arise. The critical R is $(U_1 - U_2)(2\delta_1)/\nu = 25$, where U_1, U_2 are the speeds of the two streams, and $2\delta_1$ is the "displacement-thickness" of the mixing region.

N-64261*

Royal Aircraft Establishment (Gt. Brit.)
THE CALCULATION OF ORDINATES OF TWISTED AND CAMBERED HIGH-SPEED WINGS. J. M. Watt. April 1958. 10p. RAE Report MS 55. (Ask for N-64261*)

On the basis of linear aerodynamic theory, numerical methods for the evaluation of the chordwise slope of thin wings designed for supersonic flight are described. The plan form and pressure loading are assumed and only wings with edges swept back at angles greater than the Mach angle are considered.

CN-64262*

Royal Aircraft Establishment (Gt. Brit.)
EXTRA WIDE ANGLE LENSES FOR USE IN TARGET AIRCRAFT CAMERAS. D. C. Kerridge and M. Marchant. February 1958. 16p. diagrs., photos., tabs. RAE Tech.Note TD 15. (Ask for CN-64262*)

This paper describes two types of extra-wide angle lenses developed for use in target aircraft cameras in this country. They have a total field angle of 142° and a format of just under 1-inch diameter. Details of their performance and the results of laboratory tests are given.

N-64264*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE MOTION INSIDE A REGION OF RE-CIRCULATION (CAVITY FLOW). H. B. Squire, Imperial College. November 5, 1955. 6p. diagrs. ARC 17,983; FM 2322. (Ask for N-64264*)

It is shown that the flow in a region of recirculation may be divided into a core, in which the vorticity may be constant, and a boundary layer surrounding the core. An approximate solution is given for the flow inside a circular cylinder with partly fixed and partly moving walls.

N-64267*

Aeronautical Research Council (Gt. Brit.)
A NOTE ON HYDRODYNAMIC STABILITY IN UNLIMITED FIELDS OF VISCOUS FLOW. N. Curle, National Physical Laboratory. October 21, 1955. 4p. ARC 17,953; FM 2314. (Ask for N-64267*)

A condition to be satisfied by solutions of the fourth-order Orr-Sommerfeld equation is obtained, in the form derived by McKoen, by a more fundamental approach. The condition may be used for predicting the minimum critical Reynolds number for stability.

N-64268*

Aeronautical Research Council (Gt. Brit.)
EXPRESSIONS FOR THE DAMPING AND NATURAL FREQUENCY OF LINEAR SYSTEMS. A. T. Fuller and R. H. Macmillan, Cambridge University. August 9, 1955. 15p. ARC 17,793; S & C 3033; 0.1203. (Ask for N-64268*)

Three theorems concerning the values of the roots of polynomial equations are derived by manipulation of the Routh-Hurwitz criteria. When applied to the characteristic equation of a linear system, they yield information on the dynamic constants of the dominant mode. The first theorem gives a test for locating the least negative of the real parts of the roots; the second gives a formula for this real part when its magnitude is small; and the third gives new expressions for the imaginary parts of the corresponding root-pair. Thus the degree of stability of the system

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may be estimated, and when this is small, the formulas give the natural frequency and the damping of the dominant mode in terms of the coefficients of the characteristic equation; in this condition it is also shown how to determine the dynamic constants of lesser modes in certain cases.

N-64368*

Aeronautical Research Council (Gt. Brit.)
THE RECOVERY OF AN AEROPLANE FROM A HIGH SPEED DIVE. A. D. Young, London University and S. Neumark, Royal Aircraft Establishment. April 19, 1956. 42p. diagrs. ARC 18,390; S & C 3091; Comp. 116. (Ask for N-64368*)

Detailed step-by-step calculations have been made of the recovery with fixed elevator from a high-speed dive for three different aircraft; for these calculations measured wind-tunnel data were used. The aircraft differed markedly in their restoring margin. The calculations demonstrated in all cases an initial, rapidly damped, short period oscillatory phase, a nearly constant value of ρV^2 throughout the recovery, and subsequent to the initial oscillatory phase C_m was small. These results enable three different approximation methods for calculating the recovery after the initial oscillatory phase to be developed.

N-64371*

Aeronautical Research Council (Gt. Brit.)
A THEORETICAL INVESTIGATION OF THE EFFECTS OF MACH NUMBER, REYNOLDS NUMBER, WALL TEMPERATURE AND SURFACE CURVATURE ON LAMINAR SEPARATION IN SUPERSONIC FLOW. G. E. Gadd, National Physical Laboratory. June 13, 1956. 32p. diagrs. ARC 18,494; FM 2415. (Ask for N-64371*)

Laminar separation in supersonic flow is investigated by an extension of Stratford's method. It is assumed that separation is of the usual practical type, taking place upstream of the shock wave or other agency provoking it. The results of the analysis agree well in most respects with experiment.

N-64373*

Royal Aircraft Establishment (Gt. Brit.)
EXPERIMENTAL PRESSURE DISTRIBUTIONS ON COMBINATIONS OF A CYLINDRICAL BODY WITH TWO RECTANGULAR WINGS AT MACH NUMBERS OF 1.42, 1.61, AND 1.82. A. Stanbrook and J. G. Jones. February 1958. 55p. diagrs., photos., tabs. RAE Tech. Note Aero 2532. (Ask for N-64373*)

Pressure measurements made on the wings and body of two rectangular wing and cone-cylinder body combinations in the 3-foot by 3-foot supersonic wind tunnel at the R.A.E. Bedford are presented. The measurements were made at Mach numbers of 1.42, 1.61, and 1.82, a Reynolds number of 1.52×10^6, based on wing chord, and at incidences up to 10°.

N-64374*

Royal Aircraft Establishment (Gt. Brit.)
PERFORMANCE ESTIMATES FOR THE R.A.E. 6 INCH HIGH PRESSURE SHOCK TUBE. B. A. Woods. May 1958. 45p. diagrs., tabs. RAE Tech. Note Aero 2560. (Ask for N-64374*)

Estimates are made of the performance of the RAE 6-inch high-pressure shock tube, with various driver gases, over a range of pressure ratios giving shock Mach numbers from 6 to 22. The calculations are based on a simplified model of shock-tube flow, in which the working fluid (argon-free air) is assumed to be always in chemical equilibrium, and the driver gas (either hydrogen or the products of combustion of a hydrogen-oxygen mixture) is assumed to behave as an ideal gas with constant specific heats. The results are presented in graphical form and comprise charts: (1) showing the changes in state across normal shock waves in argon-free air, (2) giving the relationship between shock wave Mach number and diaphragm pressure ratio under various initial conditions, and (3) showing the aerodynamic properties of the shock-induced flows, both in the uniform-sectioned shock tube and when expanded in a divergent nozzle (a) through an area ratio of 225, and (b) to a flow Mach number of 7.

N-64391*

Aeronautical Research Council (Gt. Brit.)
SOME STUDIES OF TRANSITION IN A LAMINAR BOUNDARY LAYER AFTER SEPARATION. B. H. Lochtenberg, Oxford University. October 29, 1955. 5p. diagrs. ARC 17,972; FM 2319.
(Ask for N-64391*)

Results are presented from an investigation of a laminar boundary layer after separation. Particular note is taken of the onset and growth to turbulence in the separated boundary layer, and some extensions to the work of Schubauer and Klebanoff on a flat plate are suggested.

MISCELLANEOUS

Errata on NACA RM E56C06, by Freche and Oldrieve. 1956.

*AVAILABLE ON LOAN ONLY.

MISCELLANEOUS

N-47555Y

Advisory Group for Aeronautical Research and Development. A SEARCH FOR DEFINITIONS AND CRITERIA RELATING TO NON-OSCILLATORY DIVERGENCE IN NEAR STEADY FLIGHT CONDITIONS. E. Billion. (Presented at Joint Session of AGARD Flight Test Techniques and Wind Tunnel Panels, Brussels, Belgium, August 27-31, 1956.) August 1956. v, 13p. diagrs. AGARD Report 72T. (Ask for N-47555Y)

Starting from the well-known notions of steady-state aerodynamic coefficients and "weathercock" stability, it is possible to state certain definitions concerning the "nonoscillatory behavior" in the neighborhood of a steady-state flight condition which are applicable to systems having several degrees of freedom and which may be extended in certain ways to nonlinear systems. A practical method for calculating the criteria of the nonoscillatory behavior is proposed, within the framework of the approximation which assumes small linearized motion. Applications of this method are made.

N-55128X

Advisory Group for Aeronautical Research and Development. HYPERSONIC FLOW ABOUT A THIN BODY OF REVOLUTION. R. Timman. July 1957. 10p. AGARD Report 141. (Ask for N-55128X)

In this paper the boundary-layer equations are derived for a thin body of revolution in hypersonic flow, taking into account the curvature of the body. A "similar" solution is found and the application of a Pohlhausen method with a suitable simple velocity profile gives the effect of radius of curvature in general terms. Further research is in progress.

CN-59327X

Advisory Group for Aeronautical Research and Development. TRANSPARENT MATERIALS FOR AIRCRAFT - A REVIEW. E. W. Russell. (Presented at 6th meeting of AGARD Structures and Materials Panel, November 4-8, 1957, Paris.) November 1957. iv, 14p. tabs. AGARD Report 160. (Ask for CN-59327X)

Developments in transparent materials for aircraft are reviewed. Extensive work has been done on the organic plastics, and offers improved performance and reliability, but with only limited advances in high-temperature performance. As alternative materials the inorganic glasses compel attention and are shown to suffer from several limitations both for windscreens and canopies. Possible lines of development are briefly indicated.

CN-62800, pt. 1*

Advisory Group for Aeronautical Research and Development. POLAR ATMOSPHERE SYMPOSIUM. PART I. METEOROLOGY SECTION. Edited by R. C. Sutcliffe. (Symposium at Oslo, July 2-8, 1956.) 1958. xi, 341p. diagrs., photos., tabs. AGARDograph 29, Part I.

Contents: ARCTIC GEOGRAPHY AND CLIMATE. F. Kenneth Hare. SIMILARITIES AND CONTRASTS BETWEEN THE ARCTIC AND ANTARCTIC MARINE CLIMATES. Richard M. Holcombe. THE RECENT VARIATIONS OF THE CLIMATE AT THE NORWEGIAN ARCTIC STATIONS. Th. Hesselberg and T. Werner Johannessen. A BRIEF REVIEW OF RESEARCH IN ARCTIC METEOROLOGY. A. D. Belmont. THE GENERAL CIRCULATION OF THE LOWER TROPOSPHERE OVER ARCTIC REGIONS AND ITS RELATION TO THE CIRCULATION ELSEWHERE. Jerome Namias. RECENT STUDIES ON THE ARCTIC TROPOSPHERE AND ITS TELECONNECTIONS. H. Flohn and G. Seidel. WINDS AND TEMPERATURES IN THE ARCTIC STRATOSPHERE. H. Wexler and W. B. Moreland. CANADIAN STUDIES OF THE HIGH-LATITUDE STRATOSPHERIC JET STREAM IN WINTER. Warren L. Godson. THE PROBLEM OF THE MAINTENANCE OF THE LOW-LEVEL ANTICYCLONIC CIRCULATION IN THE ARCTIC. Ragnar Fjortoft. THE ROLE OF TROPOSPHERIC COLD-AIR POLES AND OF STRATOSPHERIC HIGH-PRESSURE CENTERS IN THE ARCTIC WEATHER. R. Scherhag. ARCTIC WEATHER-FORECASTING PROBLEMS OF THE AIR WEATHER SERVICE. Robert D. Fletcher. ARCTIC WEATHER ANALYSIS. Richard J. Reed. THE QUANTITATIVE REPRESENTATION OF THE NORTH POLAR PRESSURE FIELD. F. Kenneth Hare. AN EMPIRICAL METHOD OF FORECASTING 24-HOUR MOVEMENT AND CHANGE OF INTENSITY OF SUB-ARCTIC NORTH ATLANTIC CYCLONES. J. J. George, P. M. Wolff, and W. L. Somervell, Jr. SOLAR RADIATION MEASUREMENTS IN THE ARCTIC OCEAN. Sigmund Fritz. LONG-WAVE RADIATION AND TURBULENT HEAT TRANSFER IN THE ANTARCTIC WINTER AND THE DEVELOPMENT OF SURFACE INVERSIONS. G. H. Liljequist. ON THE "ARCTIC WHITEOUT." Sigmund Fritz. ON THE RELATION BETWEEN METEOROLOGICAL CONDITIONS AND TOTAL AMOUNT OF OZONE OVER TROMSO. Harald Johansen. VISUAL RANGE IN THE POLAR REGIONS WITH PARTICULAR REFERENCE TO THE ALASKAN ARCTIC. J. Murray Mitchell, Jr. SOME PROBLEMS OF METEOROLOGICAL OBSERVING IN POLAR REGIONS. N. J. Schumacher. LOWER TROPOSPHERIC INVERSIONS AT ICE ISLAND T-3. A. D. Belmont. CURRENT STATUS OF SEA ICE RECONNAISSANCE AND FORECASTING FOR THE AMERICAN ARCTIC. Charles C. Bates. METEOROLOGICAL CONDITIONS AND THE ASSOCIATED SEA ICE DISTRIBUTION IN THE CHUCKCHI SEA DURING THE SUMMER OF 1955. James W. Winchester and Charles C. Bates.

(May be purchased from Pergamon Press,
122 East 55th Street, New York 22,
New York, at $12.00)

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CN-62800, pt. 2*

Advisory Group for Aeronautical Research and Development. POLAR ATMOSPHERE SYMPOSIUM. PART II. IONOSPHERIC SECTION. Edited by K. Weekes. (Symposium at Oslo, July 2-8, 1956.) 1957. xiii, 212p. diagrs., photos., tabs. AGARDograph 29, Part II.

Contents: THEORETICAL VIEWS ON DRIFT MEASUREMENTS. I. L. Jones. THE DRIFT OF AN IONIZED LAYER IN THE PRESENCE OF THE GEOMAGNETIC FIELD. K. Weekes. THE HEIGHT-VARIATION OF HORIZONTAL DRIFT VELOCITIES IN THE E-REGION. I. L. Jones. RESULTS OF IONOSPHERIC DRIFT MEASUREMENTS IN THE UNITED STATES. Vaughn Agy. RESULTS OF IONOSPHERIC DRIFT MEASUREMENTS IN NORWAY. Leiv Harang. LARGE-SCALE MOVEMENTS OF THE LAYERS. H. W. Wells. MOVEMENTS OF IONOSPHERIC IRREGULARITIES OBSERVED SIMULTANEOUSLY BY DIFFERENT METHODS. I. L. Jones, B. Landmark, and C. S. G. K. Setty. MEASUREMENTS OF IRREGULARITIES AND DRIFTS IN THE ARCTIC IONOSPHERE USING AIRBORNE TECHNIQUES. George J. Gassmann. TURBULENCE IN THE IONOSPHERE WITH APPLICATIONS TO METEOR TRAILS, RADIO STAR SCINTILLATION, AURORAL RADAR ECHOES, AND OTHER PHENOMENA. H. G. Booker. ELECTRON DISTRIBUTION IN A NEW MODEL OF THE IONOSPHERE. H. K. Kallmann. PREDICTION TECHNIQUES AT HIGH LATITUDES. J. H. Meek. GEOGRAPHIC DISTRIBUTION OF GEOPHYSICAL STATIONS ON THE POLAR CAP. A. H. Shapley. STATISTICAL RESULTS AND THEIR SHORTCOMINGS CONCERNING THE IONOSPHERE WITHIN THE AURORAL ZONE. R. W. Knecht. POLAR DISTURBANCES. J. H. Meek. POLAR BLACKOUT OCCURRENCE PATTERNS. Vaughn Agy. QUANTITATIVE MEASUREMENTS OF ABSORPTION IN THE AURORAL ZONE. F. Lied. FORECASTING OF DISTURBED HF COMMUNICATION CONDITIONS. R. C. Moore. THE SPECTRUM OF THE ELECTRON DENSITY FLUCTUATIONS IN THE IONOSPHERE. Roger M. Gallet. A THEORY OF LONG-DURATION METEOR-ECHOES BASED ON ATMOSPHERIC TURBULENCE WITH EXPERIMENTAL CONFIRMATION. H. G. Booker and Robert Cohen. SOME IMPLICATIONS OF SLANT-E_s. E. K. Smith and R. W. Knecht. RESULTS OF SCATTER MEASUREMENTS AT 36 MC/S OVER A 1200 KM PATH. Tor Hagfors.

(May be purchased from Pergamon Press, 122 East 55th Street, New York 22, New York, at $10.50)

CN-62842

Advisory Group for Aeronautical Research and Development. MEASUREMENT OF PILOT MENTAL EFFORT. Sanford I. Cohen and Albert J. Silverman, Duke University. (Presented at 10th meeting of AGARD Flight Test Techniques Panel, London, May 20-24, 1957.) May 1957. iv, 23p. diagrs., photos. AGARD Report 148. (Ask for CN-62842)

This paper discusses the factors which affect a pilot's ability to respond to situations demanding effort and methods of measuring his total psychophysiologic response. A description is given of some methods and quantitative results obtained in research at the Aeromedical Laboratory of the Wright-Patterson Air Force Base.

N-62843

Advisory Group for Aeronautical Research and Development. PRESSURE MEASUREMENT IN ARMAMENT RESEARCH. A. J. Cable. (Presented at Pressure-Measurements meetings, sponsored by AGARD Wind Tunnel and Model Testing Panel, London, March 24-28, 1958.) March 1958. iv, 10p. diagrs., tab. AGARD Report 177. (Ask for N-62843)

A description is given of some typical pressure transducers (copper-crusher gages, piezo-electric transducers, and strain-gage transducers) which have been developed and used at ARDE for internal ballistics research. A quartz piezo-electric transducer and a modified piston-type strain-gage transducer are being used for pressure measurements in the ARDE Hypersonic Wind Tunnels.

N-62844

Advisory Group for Aeronautical Research and Development. ICING PROBLEMS AND RECOMMENDED SOLUTIONS. (Quelques problemes concernant le givrage et solutions recommandees.) Edmond A. Brun, Editor. (Papers presented to AGARD Flight Test Techniques and Instrumentation Panel, July 1956.) November 1957. viii, 264p. diagrs., photos., tabs. (English & French text.) AGARDograph 16. (Ask for N-62844)

Contents: Chapter I: GENERAL SURVEY. (Generalites.) E. A. Brun, Paris U. Chapter II: ICING CONDITIONS TO BE CONSIDERED IN THE DESIGN OF PROTECTION SYSTEMS. (Conditions de givrage a considerer dans la realisation des systemes de protection.) D. Fraser and K. G. Pettit, National Research Council, Canada. Chapter III: THE MEASUREMENT OF ICING CONDITIONS. (Mesure des

MISCELLANEOUS

parametres definissant les conditions de givrage.) D. G. A. Rendel and F. J. Bigg. (Includes appendix: STATISTICAL INSTRUMENTS NOW EMPLOYED. (Appareils actuellement utilises pour des mesures statistiques.) D. Fraser and K. G. Pettit.) Chapter IV: ICING WIND TUNNEL TESTS. (Essais en soufflerie de givrage.) R. B. Morrison, J. A. Nicholls, R. E. Cullen, and H. E. Stubbs, Michigan U. (Includes appendix: BRIEF DESCRIPTION OF SOME ICING WIND TUNNEL FACILITIES. I. NACA ICING TUNNEL (Lewis Flight Propulsion Laboratory, Cleveland, Ohio, 1944). Richard V. Rhode and M. Vernon Gray, NACA. II. NRC ICING TUNNEL (Low Temperature Laboratory, Ottawa, Canada). C. K. Rush and R. L. Wardlaw, National Research Council, Canada.) Chapter V: FLIGHT TESTS IN SIMULATED ICING CONDITIONS. (Essais en vol de givrage provoque.) G. C. Abel, Aeroplane and Armament Experimental Establishment, and J. K. Thompson, Wright Air Development Center. Chapter VI: ICING FLIGHT TEST CONCEPTS. (Considerations generales sur les essais de givrage naturel en vol aux U.S.A.) James K. Thompson, Air Force.

CN-63318*

Advisory Group for Aeronautical Research and Development. OPERATIONAL RESEARCH IN PRACTICE. Edited by Max Davies and Michel Verhulst. (Report of a NATO Conference held in Paris, April 7-12, 1957.) 1958. ix, 201p. diagrs., photos., tabs. (English and French text.) AGARD.

Contents: THE NEED FOR OPERATIONAL RESEARCH. Solly Zuckerman, Birmingham University. THE STATUS OF OPERATIONAL RESEARCH IN NATO NATIONS. P. Supino, Italy; C. de Jongh, Netherlands; E. W. Lennholm, Denmark; F. Möller, Norway; Fuat Ulug, Turkey; Theodore Benecke, Germany; G. Kreweras, France. DEVELOPMENT PLANNING - OPERATIONAL RESEARCH ASPECTS. James E. Lipp, Lockheed Aircraft Corporation. SOME EXAMPLES OF SYSTEMS ANALYSIS. Handel Davies and K. E. Silman, Ministry of Supply. SCIENTIFIC AIDS TO DECISION MAKING - A PERSPECTIVE. J. R. Goldstein, Rand Corporation. METHOD OF EVALUATION OF THE EFFICIENCY OF A REPORTING SYSTEM FOR AERIAL DEFENSE. Colonel Ferre. METHODS OF AIR DEFENCE OVER GERMANY IN WORLD WAR II. Theodore Benecke. SYSTEMS OF EVALUATION AND MILITARY PLANNING. John W. Abrams, Department of National Defense, Canada. LINEAR PROGRAMING. Merrill M. Flood, University of Michigan. LOGISTIC AND TRANSPORT OPERATIONS. Glen D. Camp, George Washington University. ECONOMY AND STRATEGY. P. Masse, France. OPERATIONAL RESEARCH IN ACTION. Francesco Brambilla, Universite L. Bocconi. WAR GAMES. Robert D. Specht, Rand Corporation. ORGANIZATION FOR OPERATIONAL RESEARCH IN THE UNITED KINGDOM. G. N. Gadsby, War Department. ORGANIZATION FOR OPERATIONS RESEARCH IN THE UNITED STATES. Joseph F. McCloskey, Case Institute of Technology. SELECTION AND TRAINING OF OPERATIONAL RESEARCH SCIENTISTS. Hugh M. Cole, Operations Research Office. FUTURE FIELD FOR OPERATIONAL RESEARCH IN THE NATO COUNTRIES. H. A. Sargeaunt.

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CN-63423

Advisory Group for Aeronautical Research and Development. PROCEEDINGS OF THE SEVENTH AGARD GENERAL ASSEMBLY. (Procès-verbal de la septième assemblée générale de l'Agard.) (AGARD Conference held in Washington, D. C., November 18-26, 1957.) 102p. (Ask for CN-63423)

Contents: Standing group (NATO), by General Piatte. Department of Defense, United States of America, by Donald A. Quarles. United States Air Force, by Lt. Gen. D. L. Putt. Growth of airpower in the United States, by Gen. Nathan F. Twining. Opening remarks of chairman, by Dr. Hugh L. Dryden. Physics of the Stratosphere and Ionosphere, by W. Dieminger. Aerodynamics of Low Density Media, by G. N. Patterson. La Propulsion aux Grandes Altitudes - Propulsion at High Altitudes, by M. Barrere, R. Siestrunck, and M. F. Florio. Human Parameters of Space Flight, by Paul A. Campbell. Flight Research at High Altitude, Part 1, by Hubert M. Drake. Part 2, by Iven C. Kincheloe, Jr. Reports of Panel Chairmen: Aeromedical Panel, by E. Evrard. Combustion and Propulsion Panel, by J. Ducarme. Flight Test Techniques and Instrumentation Panel, by A. J. Marx. Structures and Materials Panel, by L. Broglio. Wind Tunnel and Model Testing Panel, by I. H. Abbott. Documentation Committee, by R. A. Kennedy. Report of AGARD Secretariat, by Frank L. Wattendorf.

N-63640

Advisory Group for Aeronautical Research and Development. EXPLORATORY STUDIES OF HYPERSONIC FLUID MECHANICS. Seymour M. Bogdonoff, Princeton University. (Presented at 11th meeting of Wind Tunnel and Model Testing Panel, Scheveningen, Netherlands, July 8-12, 1957.) July 1957. 29p. diagrs., photos. AGARD Report 142. (Ask for N-63640)

Using a helium hypersonic wind tunnel, exploratory studies have been made of the flow over simple two- and three-dimensional bodies at Mach numbers from 11 to 19. Detailed studies of the flow over a flat plate are reviewed and preliminary results are presented for other configurations, including flat plates with flaps, delta wings, base pressure models, blunt models (with and without spikes), and slim cones. Some preliminary results of boundary-layer studies and dissolving models are also discussed. In the particular area of hypersonic fluid mechanics, the helium tunnel has proved to be an extremely valuable tool. Its simplicity and ease of operation have permitted a very wide range of studies to be carried out with relatively small effort. It has provided information on flow phenomena in a Mach number range not heretofore subject to detailed investigation.

MISCELLANEOUS

N-63641

Advisory Group for Aeronautical Research and Development. DISCUSSIONS FOLLOWING THE PRESENTATION OF PAPERS ON HYPERSONICS (AGARD REPORTS 132-147). (Eleventh meeting of Wind Tunnel and Model Testing Panel, Scheveningen, Netherlands, July 8-12, 1957.) July 1957. 43p. diagr., photos. AGARD. (Ask for N-63641)

N-64381

Advisory Group for Aeronautical Research and Development. MEASURING IN-FLIGHT THRUST OF A TURBOJET-POWERED AIRCRAFT. W. J. Coleman and D. F. DeSanto, Grumman Aircraft Engineering Corp. (Presented at AGARD Flight Test Panel meeting, Paris, April 21-25, 1958.) April 1958. 38p. diagrs. AGARD Report 197. (Ask for N-64381)

Describes the theoretical formulation of a practical method for satisfactorily measuring the in-flight net thrust of a turbojet-powered aircraft. Discusses basic principles of thrust determination, current definitions, and instrumentation techniques, including details of a traversing tailpipe rake.

N-64382

Advisory Group for Aeronautical Research and Development. FATIGUE OF STRUCTURAL MATERIALS AT HIGH TEMPERATURES. B. J. Lazan, University of Minnesota. (Presented at 6th meeting of AGARD Structures and Materials Panel, Paris, November 4-9, 1957.) November 1957. vii, 27p. diagrs. AGARD Report 156. (Ask for N-64382)

The general nature of the fatigue process is reviewed with special emphasis to progressive fracture and statistical aspects. The engineering factors important in high temperature fatigue are tabulated. Special attention is paid to the effects of mean stress, alternating stress, temperature, and stress concentration. The nature and general significance of creep phenomena which occur under various combinations of cyclic stress and mean stress are discussed. The roles of damping, elasticity, and conventional fatigue properties are analyzed to provide criteria for judging resonance fatigue strength.

UNPUBLISHED PAPERS

N-62854*

Guggenheim Aeronautical Laboratory, California Institute of Technology. A SMALL BARIUM TITANATE TRANSDUCER FOR AERODYNAMIC OR ACOUSTIC PRESSURE MEASUREMENTS. W. W. Willmarth. Prepared for NACA on NACA Contract NAw-6479. May 1957. 23p. diagrs., photos. Guggenheim Aeronautical Lab., Calif. Inst. of Tech. (Ask for N-62854*)

The design, development, and calibration of a small barium titanate pressure transducer for aerodynamic or acoustic pressure measurements are described. The calibration was carried out in a shock tube. A few typical oscilloscope records of the transducer response to shock waves are shown. From the calibration, it was found that the transducer response is uniform from approximately 5 to 50,000 cps and the sensitivity of the transducer is 0.88×10^{-6} volts/dyne/cm^2.

N-63552*

Kentucky Research Foundation. FORMATION AND EFFECTS OF SUBGRAINS IN IRON. William L. Mitchell, Charles S. Crouse, and Roy E. Swift. Final report for period ending May 1, 1958, prepared on NACA Contract NAw-6461. May 1958. 71p. diagrs., photos., tabs. Kentucky Research Foundation. (Ask for N-63552*)

To study the effects of substructure on strength properties, ingot iron, high-purity iron, and a low-carbon steel were prestrained various amounts up to 15 percent and annealed at 100° C intervals from 200° C to 800° C to induce substructure. The specimens were then tested in tension to ascertain the effect of substructure on the mechanical strength of the three materials. These materials were completely recrystallized to remove any substructure in the as-received metals, and any added strength was attributed to substructure formation. The yield strength of specimens containing substructure was observed to be from 50 percent to 100 percent in excess of the yield strength of specimens tested in the fully annealed state.

DECLASSIFIED NACA RESEARCH REPORTS

This is authority for those possessing copies of the following research reports to declassify them from Confidential. Items marked (#) are UNAVAILABLE since they contain obsolete or proprietary information. Effective date of declassification September 3, 1958.

NACA RM E54K12

ALUMINUM BOROHYDRIDE - HYDROCARBON MIXTURES AS A SOURCE OF IGNITION FOR A TURBOJET COMBUSTOR. Hampton H. Foster, Edward A. Fletcher, and David M. Straight. February 1955. 24p. diagrs., photo., tabs. (NACA RM E54K12)

The use of 40 percent by volume aluminum borohydride blends with a JP-4 fuel and a mineral oil gave almost as good turbojet-combustor ignition limits as those obtained with the undiluted aluminum borohydride. The 10- and 20-percent blends gave erratic ignition. At -40° F better results were obtained with a mineral oil than with the JP-4 fuel blend. The use of 0.025-inch-diameter capillary tubes on the injection capsules was more effective than tubes of larger diameters (0.075 and 0.20) because they increase the injection duration, thus improving ignition. Aluminum borohydride gave good starts at altitude conditions in an experimental 48-inch ram-jet engine.

NACA RM E56B03

AERODYNAMIC DESIGN OF AXIAL-FLOW COMPRESSORS. VOLUME I. Compressor and Turbine Research Division. Edited by Irving A. Johnsen and Robert O. Bullock. August 1956. xii, 406p. diagrs., photos., tab. (NACA RM E56B03)

The first three chapters of vol. I are introductory, providing compressor background information and a design-system foundation for the material of succeeding chapters. Ch. I presents the general objectives and scope of the report on aerodynamic design of axial-flow compressors. The basic requirements of compressors for aircraft gas-turbine engines and the basic objectives of a compressor design system are reviewed in ch. II. A general description of the compressor design system that has been adopted for this report is provided in ch. III. Chs. IV and V review the literature on potential-flow theory and viscous effects in two-dimensional cascades, respectively.

NACA RM E56B03a

AERODYNAMIC DESIGN OF AXIAL-FLOW COMPRESSORS. VOLUME II. Compressor and Turbine Research Division. Edited by Irving A. Johnsen and Robert O. Bullock. August 1956. x, 275p. diagrs., tabs. (NACA RM E56B03a)

The first two chapters of vol. II survey and correlate experimentally obtained blade-element data. Ch. VI summarizes the data obtained in two-dimensional cascades, while ch. VII summarizes blade-element data obtained in annular cascades (compressor rotors and stators). Ch. VIII summarizes the design problem and design techniques in the meridional or hub-to-tip plane, and ch. IX provides simple chart procedures for the solution of this meridional-plane design problem. Methods for the prediction of compressor performance over a range of flow conditions and speeds (off-design operation) are presented in ch. X.

NACA RM E56B03b

AERODYNAMIC DESIGN OF AXIAL-FLOW COMPRESSORS. VOLUME III. Compressor and Turbine Research Division. Edited by Irving A. Johnsen and Robert O. Bullock. August 1956. xii, 364p. diagrs., photos., tabs. (NACA RM E56B03b)

Chs. XI to XIII concern the unsteady compressor operation arising when compressor blade elements stall. The fields of compressor stall and surge are reviewed in chs. XI and XII, respectively. The part-speed operating problem in high-pressure-ratio multistage axial-flow compressors is analyzed in ch. XIII. Ch. XIV summarizes design methods and theories that extend beyond the simplified two-dimensional approach used previously in the report. Ch. XV extends this three-dimensional treatment by summarizing the literature on secondary flows and boundary-layer effects. Charts for determining the effects of errors in design parameters and experimental measurements on compressor performance are given in ch. XVI. Ch. XVII reviews existing literature on compressor and turbine matching techniques.

DECLASSIFIED NACA RESEARCH REPORTS

NACA RM E56C10

EFFECT OF FUELS ON SCREAMING IN 200-POUND-THRUST LIQUID-OXYGEN - FUEL ROCKET ENGINE. Isaac Pass and Adelbert O. Tischler. June 1956. 25p. diagrs., photos., tab. (NACA RM E56C10)

The tendencies of fourteen fuels and three fuel blends to produce screaming were measured in a 200-pound-thrust, liquid-oxygen - fuel rocket engine. The fuels, in order of increasing screaming tendency, are (1) hydrazines (these did not scream at all); (2) branched-chain paraffins, aromatics, and amines; and (3) straight-chain paraffins. This same trend of increasing screaming tendency also correlated with increasing fuel evaporation rate. A hypothesis to explain the trend of screaming tendency with evaporation rate is described. Screaming amplitude varied from 0.1 to 0.5 of the operating pressure, but there were no significant differences among fuels with regard to oscillation amplitude.

NACA RM E58A20a

EFFECT OF FUEL DROP SIZE AND INJECTOR CONFIGURATION ON SCREAMING IN A 200-POUND-THRUST ROCKET ENGINE USING LIQUID OXYGEN AND HEPTANE. Charles E. Feiler. June 1958. 27p. diagrs., photos., tab. (NACA RM E58A20a)

Screaming was most strongly influenced by the general method of propellant preparation. The largest screaming amplitudes were observed with a triplet injector. Fuel drop size apparently was of secondary importance; however, for two injectors differing only in the mean fuel drop size produced, screaming amplitude varied inversely with drop diameter.